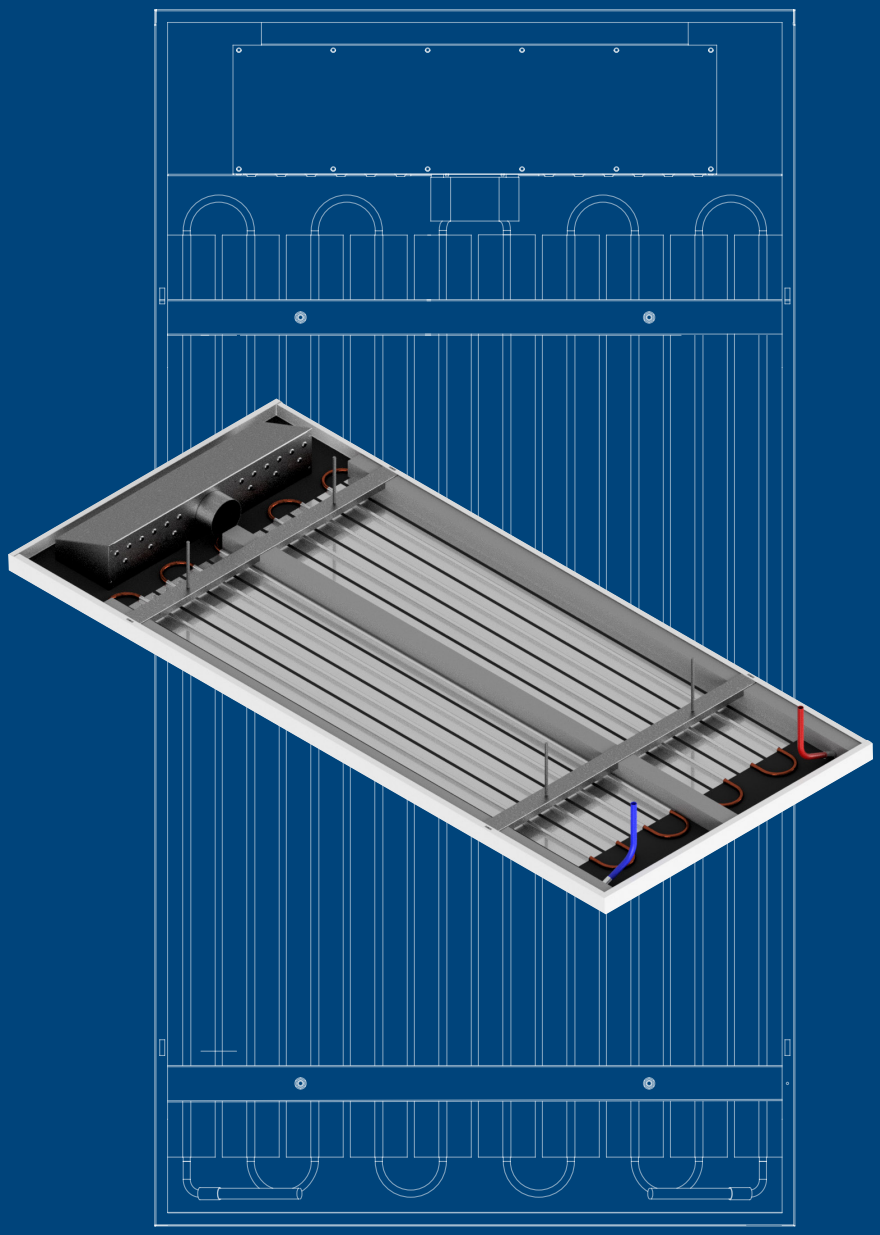

Air & Climate Solutions

Multifunction ceiling sail AVACS

DS 4170e 06.2024

Multifunction ceiling sail AVACS

Preliminary remarks, design, and function

Preliminary remarks

AVACS stands for Air Ventilation And Cooling System. The AVACS multifunctional sail combines the functions of cooling, heating, room air distribution, and sound absorption in one system. A cooling and heating system is combined with air distribution, thus significantly increasing thermal power transfer. At the same time, the AVACS creates outstanding comfort in the occupied zone thanks to the high proportion of heat radiation.

AVACS multifunctional sails can be designed in a wide range of variants, e.g.

- Single or multi-panel
- Rigid or fold-down
- With supply air function
- Optionally with recirculation, exhaust air or without air function
- Optionally with inspection section for maintenance work on control groups installed on site

AVACS are used in offices and meeting rooms, foyers, exhibition rooms, libraries, etc. to dissipate medium cooling loads.

Design and function

An AVACS multifunctional sail consists of:

- One or more perforated metal ceiling panels
- Meander-shaped bent copper tube (from the coil)
- Aluminum heat conducting profiles to accommodate the copper pipe meander and with a large contact surface to the sail element
- Steel cross profiles for suspending the sail element
- Induction unit or recirculation ventilator
- Optional exhaust air diffuser
- Optional acoustic insulation strips on the ceiling panel

All important dimensions of the multifunctional sail are shown in Fig. 1. Further technical data can be found on page 3.

AVACS multifunctional sails allow for optimum adaptation to a wide range of dimensions, designs and materials of the sail elements, different operating parameters as well as performance and sound absorption requirements, e.g. through:

- Free choice of pipe length
- Variable pipe spacing
- Acoustic insulation strips
- Various connection types

With the AVACS multifunctional sail, a full-surface acoustic fleece is glued to the back of the perforated ceiling panel element for sound absorption. The acoustic fleece is left out in the area of the induction unit. The contact surfaces of a sail element only ever cover part of the available surface; this means that the sound-absorbing effect is always maintained.

The full-surface fleece also ensures a uniform visual impression of the ceiling tile element from the visible side. This means that the induction unit mounted on the top, which generates an even and constant air flow above and below the ceiling sail, is not visible from the room.

The variable pipe spacing enables the cooling or heating capacity and sound absorption properties to be influenced in a targeted manner. Due to the good thermal conductivity of metal ceiling sails, the total area of an active sail is available for heat transfer.

The connection between the cooling element and the ceiling sail is made by gluing. The induction unit is fixed on construction site with two self-tapping screws (or rivets) as standard. The induction unit has a round DN 100 pipe connection as standard for the air supply.

Around 75% of the supply air fed into the induction attachment flows out above and 25% below the sail, thus circulating a very large amount of room air and continuously ensuring a pleasant and comfortable room climate. Thanks to the design of the induction unit, which has been specially adapted for this application, the cooler supply air introduced from outside does not fall down, as is usually the case with displacement flow diffusers, but flows horizontally along the underside of the AVACS sail, supported by the Coanda effect.

If a supply air discharge is not possible or not desired, the AVACS with recirculation function can be used (see Fig. 2, page 4).

The water-side connections are preferably designed for plug-in connections (max. PN 10) and adapted in shape and position to the desired ceiling construction and function, e.g. foldable over the long side. Only copper pipe, which is subject to constant quality control, is used to manufacture the elements. It is possible to integrate recessed lights, air diffusers, speakers, etc. into the sail elements.

The schematic overall structure of a multifunctional sail in the installation situation is shown in Figure 3. The main features of the AVACS are:

- The induction unit is connected to the supply air duct on site, e.g. with a flexible pipe.
- The sail elements are connected on the water side using plug-in connections and flexible hoses with max. PN 10.
- The AVACS sails do not obstruct access to the suspended ceiling space and the existing installations there.

The flexibility of the AVACS multifunctional sail on the one hand and the high manufacturing standard of metal sails based on the industry standard TAIM (Technical Working Group of Industrial Metal Ceiling Manufacturers) on the other hand provide a good basis for the extensive and low-risk selection of sail elements for functional design. Krantz offers reliability for the air-conditioning function of the multifunctional sails and a holistic air-conditioning solution through the professional technical design and complete delivery of the entire water-side installation within the sail area.

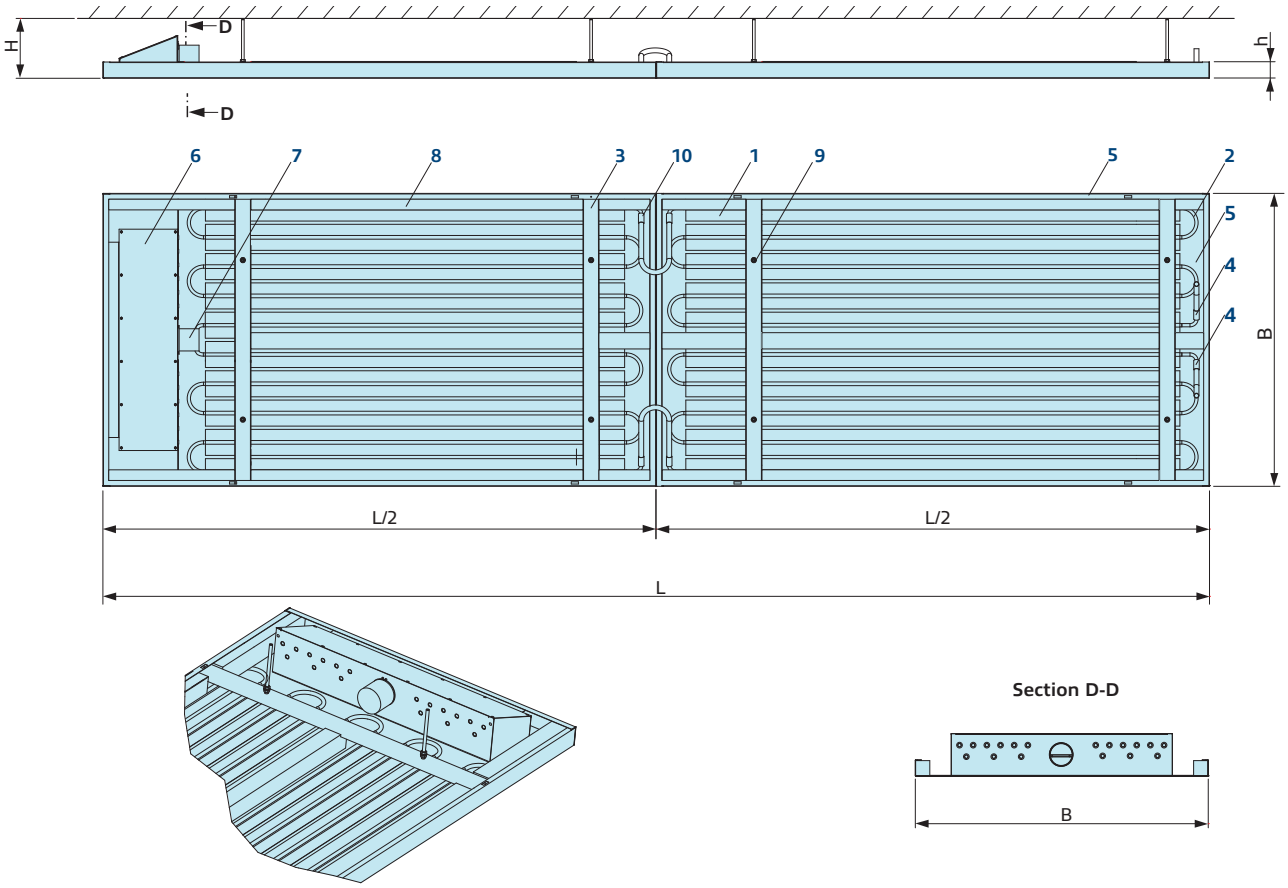

Fig. 1: *Multifunction sail AVACS with supply air function*

Caption

1	Aluminium contact profile	**6**	Induction unit	**L**	Length of the multifunction sail
2	Copper tube meander	**7**	Connection spigot	**B**	Width of the multifunction sail
3	Traverse	**8**	Sound absorber strips	**H**	Suspended height
4	Water supply and return	**9**	Threaded rod (on-site)	**h**	Nominal height
5	Metal ceiling panel, perforated, with fully bonded acoustic fleece	**10**	Connection hose		

Technical data and materials AVACS Standard

Standard nominal length L	1 000 mm - 6 000 mm[1)] (single or multi-panel), maximum single panel length up to 3 000 mm
Standard nominal width B	800 - 1 350 mm[1)]
Nominal height h	50 mm[1)], 90° upstand[1)]
Suspended height H	min. 170 mm
Pipe spacing T	variable, optimally adapted to the dimensions of the sail in terms of performance
Ceiling panel element	Galvanized sheet steel, sheet thickness s = max. 0.6 - 0.8 mm, perforated, perforation ø 2.5 mm, Perforated area approx. 16%, powder-coated similar to RAL 9010, satin finish 20
Heat conducting profile	Aluminium contactprofile, Width b = 78 mm, length adapted to the pipe meander Pipe meander made of copper pipe ø10 x 0.35 mm or ø12 x 0.35 mm
Connection end	for ø10 mm or ø12 mm push-fit connections; shaped parts: bend 90° or bend 180°
Traverse	2.0 mm galvanized sheet steel
Sound absorption	α_w = 0.5 to 0.9 depending on the installation situation and equipment
Allowable operation pressure	6 bar (up to 16 bar possible, depending on the hose connection)
Weight	approx. 8 kg/m² sail area (incl. water content, depending on pipe spacing) plus 3.4 kg AVACS supply air outlet depending on ceiling construction, fixtures, etc.

[1)] other designs on request

Multifunction ceiling sail AVACS

Construction

Fig. 2: *Multifunctional sail AVACS with recirculation function*

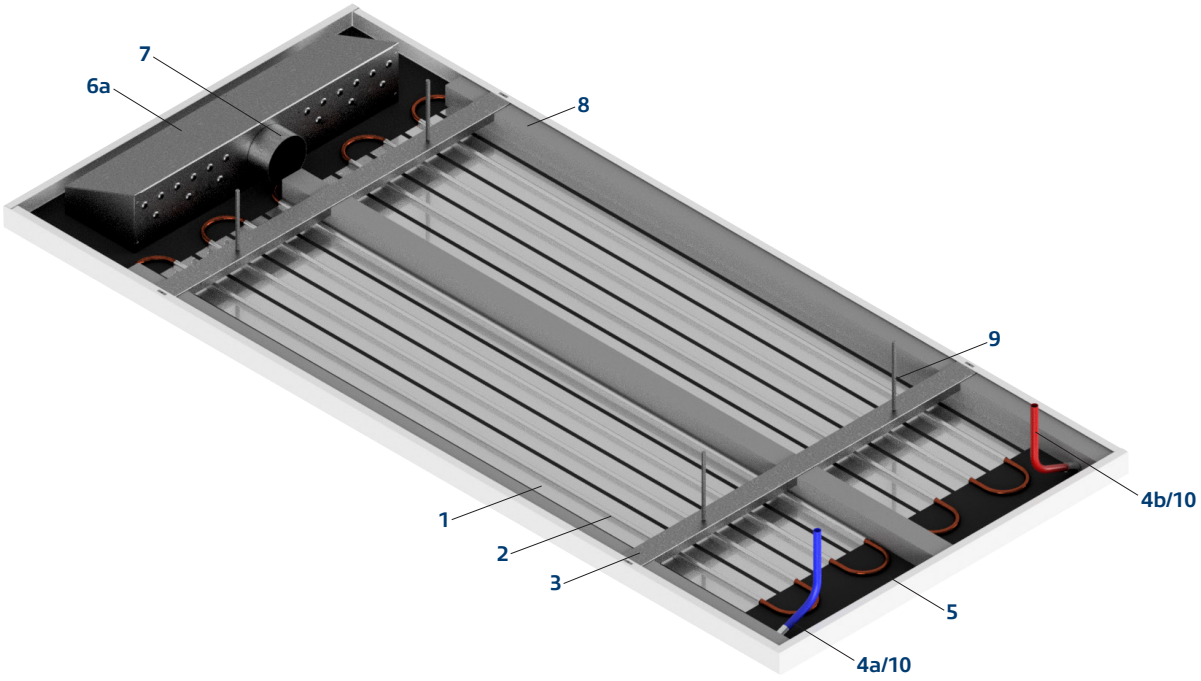

Fig. 3: *Multifunctional sail AVACS with supply air function*

Legende

1	Aluminium contact profile	**6a**	Induction unit with supply air connection
2	Copper tube meander	**6b**	Induction unit with recirculation fan
3	Traverse	**7**	Connection spigot
4a	Chilled/heating water supply	**8**	Sound absorber strips
4b	Chilled/heating water return	**9**	Threaded rod (on-site)
5	Metal ceiling panel, perforated, with fully bonded acoustic fleece	**10**	Connection hose

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Data for technical design

The standard cooling capacity of the AVACS sail was determined in accordance with DIN EN 14240 (chilled ceiling testing and evaluation) and achieves values of up to 165 W/m² (10 K).

The measurements were carried out with the following configuration:

- Ceiling panel element made of perforated sheet steel (s = 0.7 mm) with bonded acoustic fleece (predominantly made of cellulose with a thickness ≤ 0.25 mm and a grammage of 60 to 65 g/m²)
  Perforation pattern Rg 2.5 - 5.5 / Ao - 16%
- The sails were suspended from the ceiling by 150 mm using steel U-beams.
- Heat conducting profiles that were bonded to the ceiling panel element using special mounting tape
- Sound absorption strips applied to the rear 50 x 50 mm x nominal length ceiling panel

A two-part AVACS multifunctional sail with a total length of 3 400 mm and a total width of 900 mm was used as a reference for the technical design and determination of the cooling capacity. The measured specific cooling capacity based on DIN EN 14240 with a temperature difference of 8 K and ventilation of 100 m³/h above and below the sail surface is 125 W/m² (see diagram A). The reference area is always the active area of the sail, i.e. according to Fig. 1.

In contrast to the test room (DIN EN 14240), there are many factors in the actual application area that influence the performance of the AVACS:

- Convective heat transfer at the sail surface when turbulent mixed ventilation is provided by ceiling diffusers or similar.
- Radiant heat exchange when room walls have higher surface temperatures.
- The heat transfer on the rear side when insulation and rear ventilation are changed.

Numerous laboratory measurements and project-specific experience show that the factors deviating from the test room often lead to an increase in performance in reality. However, precise statements can only be made after realistic laboratory tests.

The maximum water-side pressure loss of the cooling elements of 30 kPa depends on their dimensions and the cooling water flow.

On request, you can also have our employees carry out an exact performance determination and the design of the AVACS multifunctional sails.

Note

The sound absorption essentially depends on the suspension height, the occupancy of the ceiling sails, the arrangement of the sails and, if necessary, the concealment of the sails by other structures. Depending on the aforementioned points, absorption values of up to α_w = 0.9 can be achieved. (see diagram C, page 6)

Please contact Krantz if you require changes to the structure and material, or if you have special application requirements.

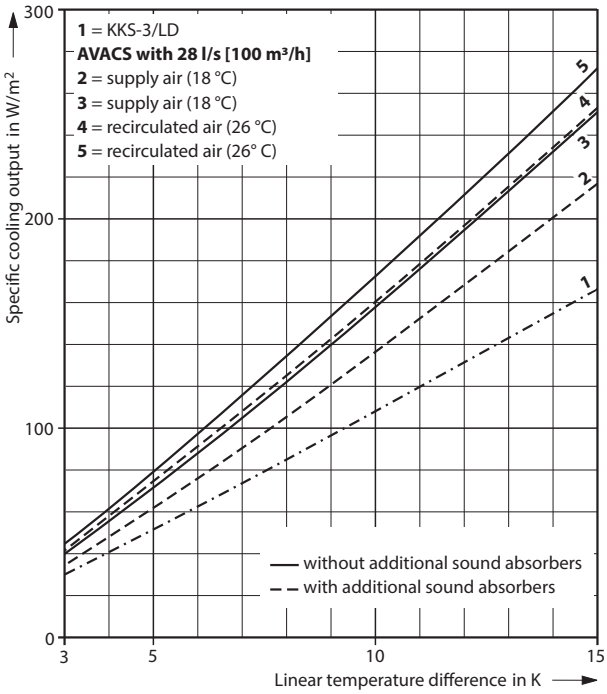

Diagram A: *Specific cooling capacity of multifunctional sails AVACS according to DIN EN 14240*

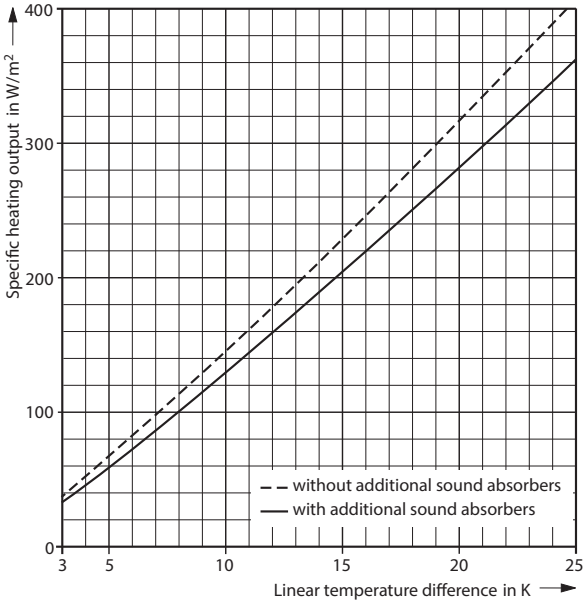

Diagram B: *Specific heat output of multifunctional sails AVACS (at 100 m³/h supply air volume flow; supply air temperature 20°C) according to DIN EN 14037*

Multifunction ceiling sail AVACS

Performance diagrams

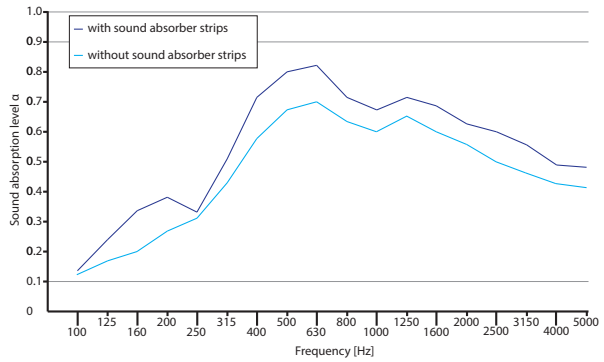

Diagram C: *Sound absorption measured on the AVACS multi-functional sail with a bonded acoustic fleece, perforation Rg 2516, at 200 mm suspension height*

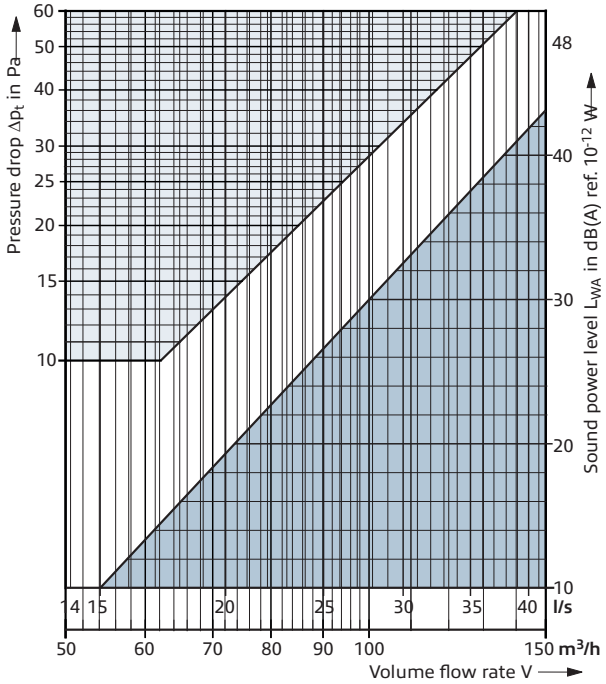

Diagram D: *Sound power level and pressure loss as a function of the volume flow (supply air function)*

Table 1: *Sound power level of the AVACS with supply air function*

Volume flow rate	pressure loss	L_{WA}	Sound power level L_{WA} Octave centre frequency in Hz							
m^3/h	Pa	dB(A)	63	125	250	500	1 K	2 K	4 K	8 K
50	7	—	30	11	15	12	—	—	—	—
75	15	21	35	21	24	21	17	—	—	—
100	29	30	38	29	31	28	25	21	14	—
125	47	37	41	35	37	34	31	30	23	10
150	68	43	43	40	41	38	36	37	31	20

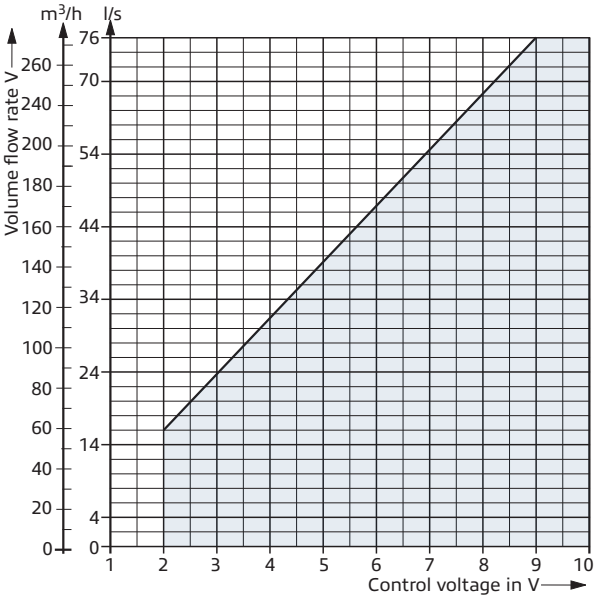

Diagram E: *Volume flow as a function of the control voltage (AVACS with recirculation function)*

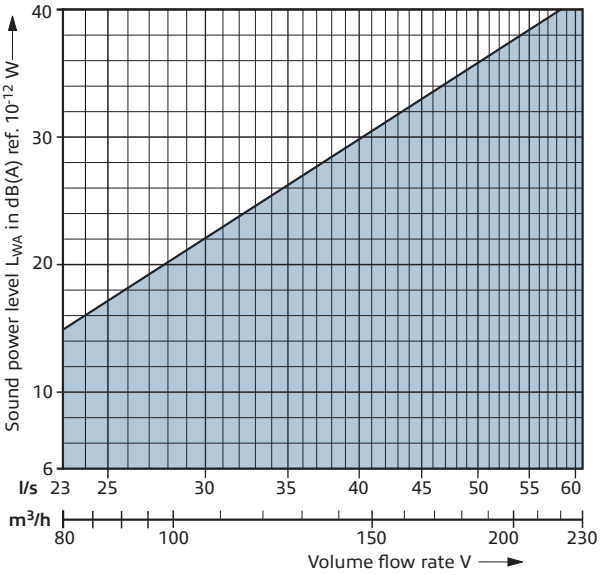

Diagram F: *Sound power level as a function of the volume flow (air recirculation function)*

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Instructions for planning - cooling mode

This section deals with essential details of the design and implementation planning of AVACS multifunctional sails. The complex coordination and decision-making process required between the engineer and architect to select the optimum solution for the ceiling, type of chilled ceiling, type of room ventilation, etc. is described in our publications K 181 "Chilled ceiling technology" and DS 4076 "System description of chilled ceilings".

The air conditioning aspects of such chilled ceiling modules are very closely linked to the work of architects, lighting planners and acousticians. The following questions must therefore be answered in the design planning:

- What cooling capacity is to be provided by the cooling ceiling?
- Which installations are planned in the ceiling and according to which basic scheme?
- Is a flexible or fixed room layout desired?
- To what extent is the ceiling surface required for sound absorption?

The answers have a significant influence on the ceiling type, ceiling design and possible occupancy density. In addition to the room layout and the number and arrangement of fixtures and fittings, the ceiling pitches and friezes also have a significant influence on the achievable occupancy density.

The ceiling type, the material and the dimensions of the sail elements determine the design of the heat conducting profiles and the achievable specific cooling capacity. Many variable details are required for a precise description, which can often only be determined by the architect or drywall builder during the execution phase.

Important details for planning

- Dimensions (L x W) of the sail elements
- Ceiling system (type of attachment of the sail elements to the substructure) and associated details of the ceiling panel elements
- Total cooling capacity required from the cooling ceiling per m^2 ceiling area
- The ceiling layout, in particular information on the dimensions and position of fixtures, e.g. lights and air diffusers
- The required sound absorption values of the ceiling construction
- Information on the properties of the acoustic fleece
- Information on the rear sound absorption strips
- Is the chilled ceiling sail combined with a ventilation system and how are the supply air and exhaust air introduced into and extracted from the room?

The tender text on page 11 contains all the essential information required for the calculation and cooling capacity specification.

The design takes into account the applicable regulations (in Germany primarily DIN 1946-2), the climatic conditions at the geographical location and the specific conditions of the building (e.g. controlled ventilation or openable windows).

The usual design parameters are:

Operative room temperature	ϑ_R =	26 °C,
Cooling water supply temperature	ϑ_{VL} =	17 °C,
Cooling water return temperature	ϑ_{RL} =	19 °C,

i.e. a performance-determining temperature difference of 8 K between the operating room temperature and the average cooling water temperature.

Under optimum conditions, i.e. occupancy density of approx. 85% and turbulent mixed ventilation from the ceiling, the cooling capacity can then be up to 80 W/m^2 room area.

Even higher cooling loads can be dissipated using high-performance cooling elements from the SKS family.

The cooling water flow should not fall below a minimum of 45 litres per hour per cooling water circuit or group of elements. Otherwise, performance will be reduced due to insufficient flow velocity in the copper pipe meander.

If the size of the sail elements used is < 1 m^2 , the minimum volume flow can only be achieved by connecting several sail elements in series. Groups with a pressure loss of 25 to 30 kPa are generally formed due to other advantages, e.g. reduced costs of the cooling water installation.

Fig. 4: *Installation examples for multifunctional sails AVACS*

Multifunction ceiling sail AVACS

Instructions for planning and implementation

The following correlations must be taken into account in the implementation planning:

- Width B of the ceiling panel elements, pipe spacing T and thus number of pipe rows or position of the connection ends
- Arrangement of the water supply and return lines
- Forming of groups with as equal a pressure loss as possible
- Securing the desired functions, e.g. folding down and automatic venting
- Minimisation of costs, e.g. through optimum hose lengths, position, type and number of group connections on the supply and return lines

Krantz offers comprehensive planning and delivery of multifunctional sails with accessories:

- flexible connection hoses,
- modular supply and return ducts with connection option at the room boundary (without shut-off and control valves), matched to the ceiling surface, ceiling type and ceiling design as well as the cooling capacity in conjunction with the overall ventilation and air conditioning solution.

The cooling water flow temperature must be selected above the dew point temperature of the room air. To prevent the formation of condensation, dew point sensors must be provided on the flow pipes or the contact profile near the flow connection - at least in rooms with the highest expected room air humidity. The dew point sensors should be sufficiently surrounded by air of the current condition in the room.

The general influence of chilled ceilings on thermal comfort - with or without controlled ventilation - is described in detail in our publication DS 4076 "System description of chilled ceilings" and other publications. There you will also find information on the combination of chilled ceilings with various air distribution systems. This is recommended for most applications.

Chilled ceilings contribute through

- almost constant temperatures across the room height,
- low room air velocities,
- physiologically favourable heat dissipation through radiation and natural convection,
- no noise emissions etc. contribute to a very high level of user satisfaction.

Instructions for implementation

A prerequisite for installation should be detailed planning based on the ceiling plans approved by the architect. Important information is conveniently entered in these, such as

- Number and arrangement of sails
- Cooling capacity to be dissipated/heating capacity to be provided
- Position of the connection ends of the cooling elements and, in the case of several installations, their type
- Water-side connections between sail elements and the specification, e.g. type of connecting hose, etc.
- Position of the supply and return lines and their connection points and connections to groups
- Volume flows and pressure losses at connection points of the supply and return lines to the cooling water network

Sustainability

- AVACS can reduce energy costs by efficiently combining air and water-side cooling
- Consisting of recyclable materials with a very high recycling rate
- Reduces "grey energy" thanks to well thought-out designs and reduced use of materials
- Consisting of tested low-pollutant or pollutant-free materials in accordance with applicable regulations

Certificates

- Ceiling sail with environmental supplier declaration in accordance with DIN EN ISO 14021
- Quality management certified according to ISO 9001
- Classification A1 of fire behaviour according to DIN EN 13 501-1, absorber excluded
- Production in accordance with the guidelines of TAIM - Technical Working Group of Industrial Metal Ceiling Manufacturers
- Tested pollutant-free powder coating
  - Contains no lead, cadmium, chromium IV or their compounds
  - Contains no PVC
  - Contains no halogenated materials
  - Contains no substances that release hydrogen chloride (HCl) or hydrogen bromide (HBr) in the event of fire
  - Contains no formaldehyde

Assembly instructions

The installation of the suspended multifunctional sails is carried out by specialised companies for interior/drywall construction. The sail components must be integrated into their installation process.

The ceiling sails are suspended from the bare ceiling on threaded rods (Fig. 5 and Fig. 6).

The supply and return pipes are installed parallel to or immediately after the installation of the ceiling substructure, e.g. plasterboard ceiling, by the installer. The tightness test of these network sections must be carried out before the installation of the sail elements.

In the next step, the multifunctional sails are slid over the suspended traverses and fastened with screws so that they cannot move and can be detached again.

In our installation instructions, you will find a detailed description of the installation work required for the professional installation of the multifunctional sails.

We kindly ask you to observe them.

Constructions with hinged or detachable sails are very advantageous for an inspection of the ceiling. As an option, we offer an service opening that can be used to access the control groups fitted on site for maintenance purposes after dismantling, meaning that the sail does not necessarily have to be installed in a suspendable version.

Infrared thermography can be used to verify the completeness and functionality of the sail installation after installation (see also VDI 2079, supplement 1 "Functional acceptance test of room cooling surfaces").

To prevent condensation, the functions of the condensation sensors and the relevant control circuits and their control valves must be checked in accordance with the manufacturer's specifications.

Fig. 5: *For assembly, the traverses are suspended from the ceiling using threaded rods and aligned*

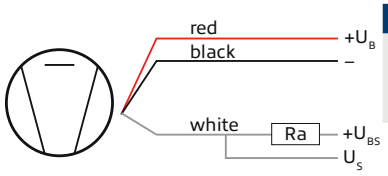
Fig. 6: *Multifunctional sails pushed over the traverses*

Electrical connection of the recirculation fan

Voltage supply of the recirculation fan: 24 V DC ± 15%.

The speed of the recirculation fan can be set via a 0-10 V DC signal.

The motor starts with its minimum speed at a signal setting of 1 V which is continuously increased up to 10 V.



Wire color	Function
red	+24 V
black	GND
white	0-10 VDC

Fig. 7: *Electrical connection of the recirculation fan*

Multifunction ceiling sail AVACS

Features

Features at a glance

- Energy transfer by convection and radiation, resulting in very high thermal comfort
- Standard cooling capacity based on DIN EN 14240 up to 165 W/m² (10 K)
- Small temperature differences in the occupied zone
- Suitable for refurbishments in office and exhibition areas
- Combination with concealed air distribution systems possible
- Supply air or recirculated air volume flows between 50 and 120 m³/h can be realised according to design
- Very high performance in relation to the actively occupied area (area/performance ratio) thanks to integrated induction unit
- Very high thermal comfort due to air distribution below the sail area
- Induction unit not visible from below
- Additional ventilation of the room may not be necessary due to the integrated induction unit
- Optimum exchange between fresh and stale air thanks to the combination of induction unit and exhaust air diffuser
- Ventilation function with conditioned supply air through uniform horizontal air discharge
- Also well suited for heating
- AVACS multifunctional sails with a wide range of surface finishes and installations possible
- Good acoustic properties
- Low suspended height, min. 170 mm, therefore
  - Well suited for renovations
  - Saves installation space and costs in new buildings
- Technical design by Krantz possible, ensuring safety, reliability and an integrated system solution
- Thanks to professional technical building services and drywall construction methods:
  simple installation ➔ short installation times
- Basic elements: copper tube meander and induction unit, resulting in
  - Cooling water quality according to VDI 2035
  - Favourable system costs
  - Long service life
  - Assured quality
  - Operating pressure up to 16 bar depending on the installation
- High-quality production in accordance with DIN ISO 9001 and from quality-monitored copper pipe
- Available without flammable components

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Tender text

AVACS Multifunctional sail

as a cooling/heating radiant ceiling sail in an optically sophisticated design for the removal of sensitive heat loads by means of convection and radiation. The optional ventilation function carries the conditioned air into the room and mixes it with the room air due to the high induction effect. A built-up air cushion at the outlet surface minimizes ceiling staining. All air guidance systems are integrated invisibly from below in the ceiling system.

consisting of:

- the substructure according to factory recommendation with building authority-approved steel dowels at least M6, threaded rods M6 or Nonius hangers with two safety pins per hanger, provided by the client. The number of suspension points depends on the static requirements. The sail ceiling panels are suspended by the client from the raw ceiling in a rigid and height adjustable manner using galvanized cross traverses, included in the scope of delivery. The material is made of galvanized sheet steel with a sheet thickness of at least 2.0 mm.

- the ceiling panels made of galvanized sheet steel 0.7 mm, with micro perforation, standard similar to RAL 9010, coated on the back with an acoustically effective black fleece. For oversize (length >3000 mm), several acoustic panels can be combined into a sail system. The individual ceiling panels have a circumferential unperforated edge, approximately 10 mm wide; hole pattern of the ceiling panel 2.5 mm, 16% free cross-section. Circumferential bending 90°, front webs with C-fold 50/20 mm and longitudinal webs with G-fold 50/20/7 mm, overlapping corners riveted. Manufacture and execution of the ceiling elements is based on DIN EN 13964 and the technical rules of the TAIM e.V..

- the cooling/heating register, which is glued in as a factory prefabricated unit to match the ceiling system. It consists of copper pipe meanders with a diameter of 10/12 * 0.35 mm as D-pipe, which are embedded in large-area heat conduction profiles made of aluminum and are glued into the ceiling panel elements.

- the AVACS supply air (optional, see specification item) with round pipe connection, suitable for flex pipe DN100, for targeted airflow from the facade to the inside of the room, which is fastened on the front side by the client using two sheet metal screws. (Note: Coordination with the ventilation trade is necessary).

- the AVACS recirculating air (optional, see specification item) for recirculating air operation (roller fan) for targeted airflow on the multifunctional sail, which has to be fastened in a traverse on the front side by the client using two sheet metal screws and connected electrically. In addition, a scoop tongue (baffle plate) is glued into the back of the ceiling panel.
(Note: Coordination with the electrical / I&C trade is necessary).

- acoustic insulation strips made of grey melamine resin (optional), which are inserted into the ceiling sails when they are installed to increase the degree of sound absorption (3 strips 50 mm x 50 mm in sail length).

- suspension cables if the ceiling panels should be folded down for maintenance purposes (optional), the folding depth is limited by means of thin wire ropes, 2 ropes per ceiling panel provided.

- air volume-related telephony silencer TSD (optional), rectangular with controller for constant volume flow, in flat design, suitable for on-site installation above the multifunctional ceiling sails for connection to the AVACS supply air, airtight, made of galvanized sheet steel with round connection spigot, which is fastened on site using threaded rods, insertion loss 24 dB (at 500 Hz) measured in accordance with EN ISO 7235, maximum supply air volume flow 100 m³/h
(Note: Coordination with the ventilation trade is necessary).

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