



Static cooling system SKS 4/3

Air & Climate Solutions

Kranz

Static cooling system

SKS 4/3

Preliminary remarks

The SKS static cooling ceiling system is made up of highcapacity elements that are suitable for installation above open suspended ceilings or for visible mounting. This system is primarily intended for cooling rooms of any type and for any use, but it can also be used for heating.

SKS-4/3 belongs to the well-known SKS system family, with the improved system design allowing for more efficient manufacturing processes. SKS-4/3 is intended for commercial applications – installation preferably above open suspended ceilings.

Construction design

The SKS cooling elements are made up of:

- copper serpentine piping in one piece, with connections for chilled water inflow and outflow,
- cooling fins, made from aluminium profile, into which the copper piping is pressed in a way to ensure effective and durable heat conduction,
- Z-shaped profiles, made from galvanized sheet metal, to which the single cooling fins are fastened and by which the complete cooling element will be suspended directly to the concrete ceiling.

The main dimensions of a cooling element are given in **Fig. 1** and further technical data is contained in the box below. The surface area of a cooling element should not exceed 5 m².

The piping for SKS-4/3 cooling elements is made exclusively from copper that is subject to permanent quality control.

As standard the cooling elements are either powder-coated or wet-painted in black; for visible mounting, however, all RAL colours as well as many other colours can be used.

Design data

The cooling output of SKS-4/3 has been determined in accordance with DIN 4715 (superseded by EN 14240). If SKS-4/3 elements are free-hanging from a concrete ceiling, the standard cooling output amounts to 175 W/m² of cooling element (projected surface area).

Graph A (page 5) shows the specific cooling output with such placement for the main range of operative room temperatures and mean water temperatures.

If SKS-4/3 elements are placed above a suspended ceiling, the latter affects the heat removal (radiation and convection) from the occupied zone if the free area is < 65%. With metal ceilings (rectangular or square tile ceilings, panel or strip ceilings, etc.) the cooling output has to be corrected in relation to both the free area according to **Graph B (page 5)** and the area covered by cooling elements according to **Graph C (page 5)**. How to determine and correct these values can be read off the **layout example (page 4)**.

The waterside pressure drop of the cooling elements in relation to water flow and dimensions is shown in **Graph D (page 5)**. If several elements are connected in series, please consider the notes to this graph.

Cooling output and pressure drop can be determined (with limited accuracy) according to said layout example using the aforementioned graphs; this, however, applies for usual types of installation.

SKS-4/3 can also be used for heating purposes. As a rule, this makes sense only in case of visible installation or with suspended ceilings having a free area $A_0 > 70\%$.

Rather high heating outputs (related to the active area) can be achieved since it is not necessary to limit the water supply temperature as is required in the cooling mode due to the dew point of indoor air.

To make it easier for you and for more safety, competent engineers at KRANTZ can make the technical selection for you, using the relevant software.

Main dimensions and materials

	Standard
Serpentine piping	copper pipe D = 12 mm x 0.5 mm, CU DHP R25, tested
Cooling fins	aluminium extruded profile
Fastening profiles	galvanized sheet metal
Connection ends	for push-in fittings or press-fitted connections: outside diameter 12 mm (standard) for solder connections: outside diameter 12 mm ± 0.1 mm
Pipe division	125 mm
Nominal length	$L \ 1\ 000 \text{ mm} \leq L \leq 4\ 000 \text{ mm}$ in steps of 100 mm ¹⁾
Nominal width	$B \ 350 \text{ mm} \leq B \leq 1\ 475 \text{ mm}$ in steps of 125 mm ¹⁾
Nominal height	85 mm ¹⁾
Installation height	≥ 185 mm, i.e. min. 50 mm clearance above and below the element
Permissible operating pressure	6 bar ¹⁾ (max 16 bars)
Weight	approx. 7 – 9 kg/m ² when filled with water

¹⁾ other values on request

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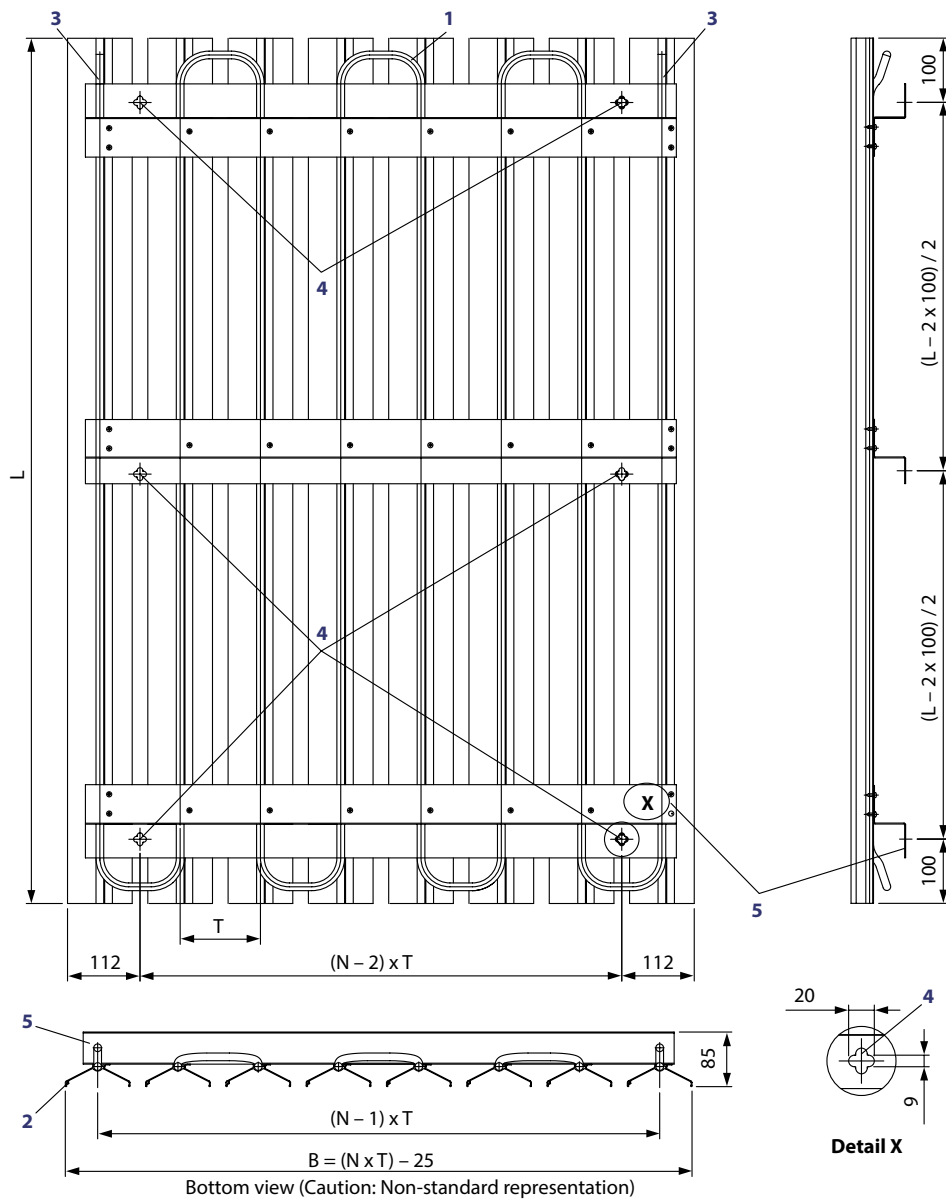


Bild 1: Cooling element SKS-4/3, main dimensions

Number of cooling fins N	Actual width B
3	350
4	475
5	600
6	725
7	850
8	975
9	1 100
10	1 225
11	1 350
12	1 475

Caption

- 1 Copper serpentine piping
- 2 Cooling fin
- 3 Connection for chilled water
- 4 Fastening points
- 5 Rear fastening profile
 - $L \leq 3\ 000\ \text{mm} \rightarrow 2\ \text{pieces}$
 - $3\ 000\ \text{mm} < L \leq 4\ 000\ \text{mm} \rightarrow 3\ \text{pieces}$
- B** Actual width
- L** Actual length
- N** Number of cooling fins
- T** Pipe division (standard 125 mm)

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In normal cases, the range of applications is limited by the thermal comfort criteria (see also DIN 1946, Part 2 – Influence of radiation of the heated ceiling and cold air drop at the facade (superseded by EN 13779)).

This is described in detail in our technical report „Heating and cooling with ceilings“ (ref. TB 87 E) which is available in our website.

For information on heating output and influences on thermal comfort in specific cases, please contact your local KRANTZ KOMPONENTEN agency or our head office at Aachen, department ‘Cooling and Heating Systems’.

Caption

Q	=	requisite cooling output of cooling ceiling in room, in W
q	=	specific cooling output of cooling elements, in W/m ² of cooling element (projected area)
q ₀	=	specific cooling output for A ₀ = 100% and b = 64% to DIN 4715 (superseded by EN 14240)
J _R	=	room temperature in °C, to DIN 1946-2 (superseded by EN 13779)
J _{VL}	=	chilled water supply temperature in °C
DJ _W	=	chilled water temperature difference in K
A _R	=	room ceiling surface area (floor area) in m ²
A ₀	=	free area of false ceiling (related to ceiling surface area) in %
A _{SKS}	=	requisite total surface area of SKS in m ²
A _{KE}	=	surface area L x B of a cooling element in m ²
n	=	number of cooling elements in surface area A _{SKS} in units
b	=	covered area or ratio of total SKS surface area to room ceiling surface area, in %
k _D	=	correction factor for influence of A ₀ on q
k _b	=	correction factor for influence of covered area on q
V _W	=	chilled water flow rate per cooling element in l/h (V _W > 70 l/h)
Dp	=	pressure drop of a cooling element in kPa
N	=	number of cooling fins per cooling element, in units
B	=	actual width of cooling element in m
L	=	actual length of cooling element in m

Layout example (cooling mode)

The following equations apply:

$$q = q_0 \cdot k_D \cdot k_b \quad (1)$$

$$q_0 \text{ from Graph A} \quad \text{as f (J}_R, J_W)$$

$$k_D \text{ from Graph B} \quad \text{as f (A}_0)$$

$$k_b \text{ from Graph C} \quad \text{as f (A}_0, b)$$

$$A_{SKS} = Q / q \quad (2)$$

$$n = A_{SKS} / A_{KE} = Q / (q \cdot A_{KE}) \quad (3)$$

$$V_W = (0,86 \cdot q \cdot A_{KE}) / DJ_W \quad (4)$$

$$b = A_{SKS} / A_R = (A_{KE} \cdot n) / A_R \quad (5)$$

$$Dp = 1,81 \cdot 10^{-5} \cdot N (L + 0,1) \cdot V_W^2 \quad (6)$$

Dp from Graph D

as f (V_W, equivalent pipe length)

Method of calculation

Requisite cooling output of cooling ceiling Q = 1 400 W
(about 60 W/m² of floor area)

Room temperature ϑ_R = 26 °C

Chilled water supply temperature ϑ_{VL} = 16 °C

Chilled water temperature difference Δϑ_W = 2 K

Room ceiling surface area (floor area) A_R = 23 m²

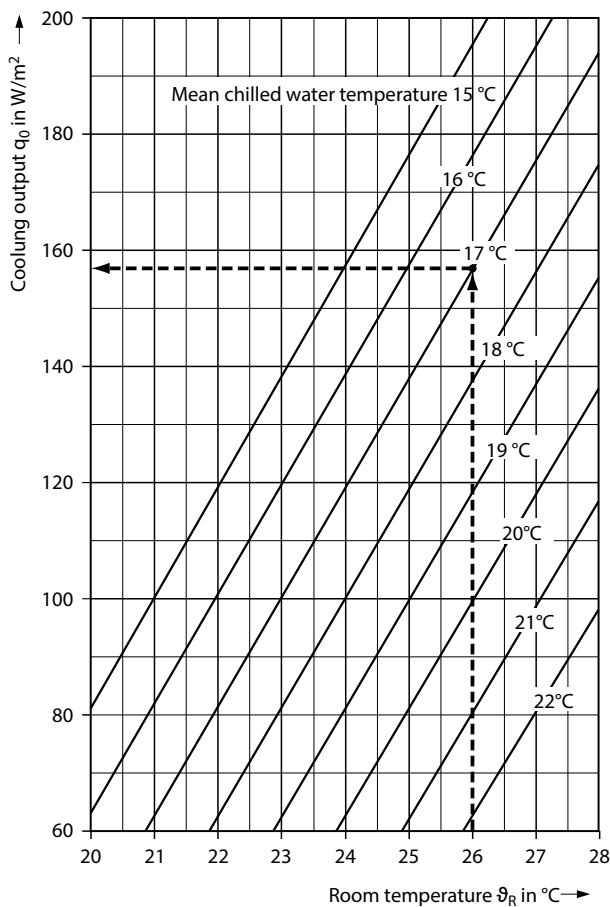
Free area of false ceiling (related to ceiling surface area) A₀ = 25%

- From Graph A: q₀ = 156 W/m²
- From Graph B: k_D = 0,74 (mean value)
- From Graph C k_b:
As the covered area b is not yet known, it must be estimated!
Assumption: b = 50 % · k_b = 1,06
- From equation (1): q = 156 · 0,74 · 1,06 = 122 W/m²
- From equation (2): A_{SKS} = 1 400 / 122 = 11,5 m²
- Check of covered area b:
b = 11,5 / 23 = 50 %, i.e. no correction necessary.
- From equation (3) we obtain n:

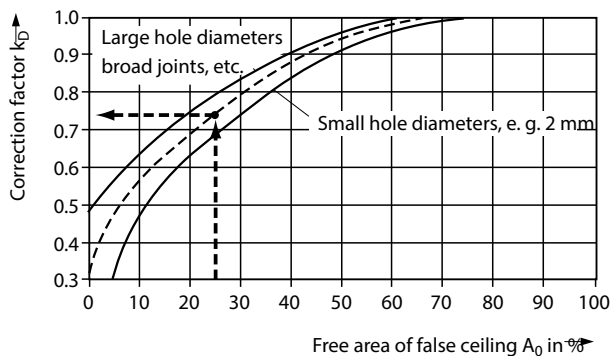
The number n of cooling elements depends on their size. Length and width are selected taking account of room dimensions, transport and installation options, pressure drop and further conditions mentioned in this brochure (see page 3). We recommend selecting 2.0 < L < 3.0 m and 1.0 < B < 1.5 m.

Assumption: $L = 3,0 \text{ m}$, $B = 0,975 \text{ m}$ · $A_{KE} = 2,9 \text{ m}^2$
 $n = A_{SKS} / A_{KE} = 11,5 / 2,9 = 3,9$
 rounded up $n = 4$ Stück
 $Q = 4 \cdot 2,9 \cdot 122 = 1\,415 \text{ W} \gg 1\,400 \text{ W}$

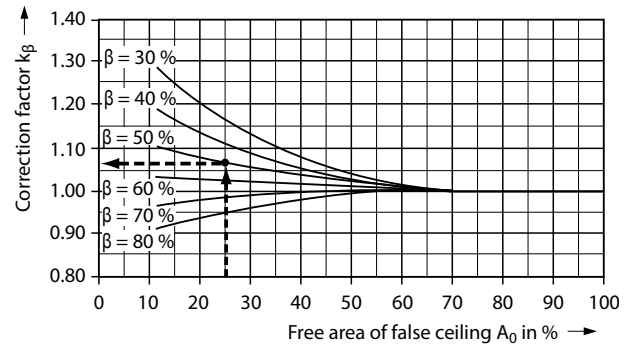
- From equation (4): $V_W = (0,86 \cdot 122 \cdot 2,9) / 2 = 152,1 \text{ l/h}$
 $V_W > 70 \text{ l/h}$, i.e. no series connection required.
- From Graph D: with $N = \text{ROUNDING OFF}(B/125) = 8$
 $8 \cdot (3,0 + 0,1) = 24,8 \text{ m}$ and
 $V_W = 152,1 \text{ l/h} \cdot D_p = 10,5 \text{ kPa}$



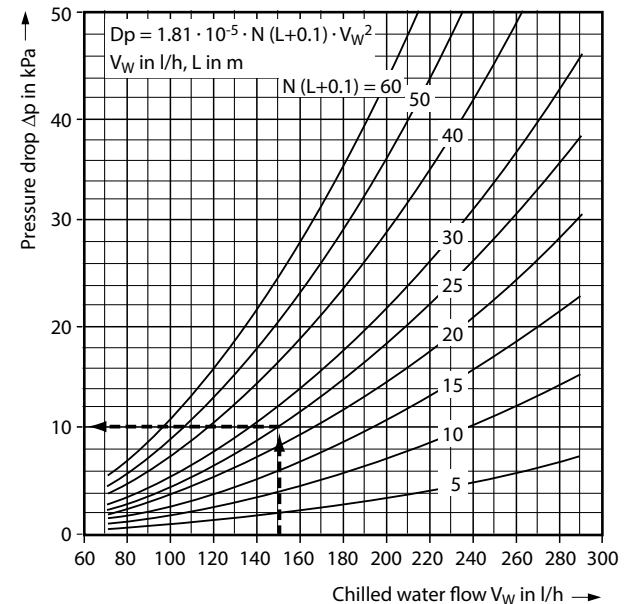
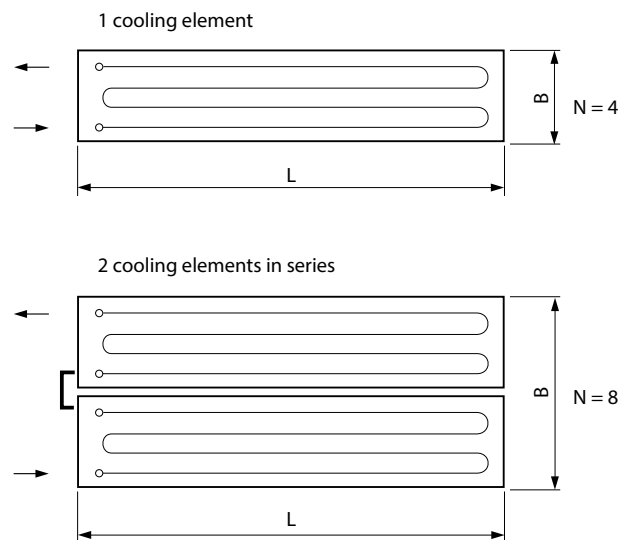
Graph A: Specific cooling output of SKS-4/3 cooling elements forming a chilled sail (DIN EN 14240)



Graph B: Influence of false ceiling



Graph C: Influence of covered area b



Graph D: Pressure drop of SKS-4/3 cooling elements

Notes to pressure drop graph

If cooling elements of equal length are connected in series, N and B refer to the sum of all N and all B .

If cooling elements of unequal length are connected in series, the equivalent pipe lengths of the single elements $[N_i (L_i + 0.1)]$ must be added together.

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Design specifications (cooling mode)

This section deals with the job „Designing an SKS-4/3 cooling ceiling system“ which is only one part of the overall architectural and technical design work for a building. General information on cooling ceiling design is contained in our technical brochures „Cooling ceiling technology“ (K 181/e) and „Cooling ceiling system description“ (DS 4076 e).

The chilled water supply temperature shall be selected above the dewpoint temperature of the indoor air. To prevent condensation, the chilled water supply pipes shall be fitted with dewpoint sensors, at least in rooms with the highest anticipated indoor air humidity. It is essential that the dewpoint sensors be sufficiently flushed by air at actual room conditions. Usually, this is not a problem because of the free area required in a suspended ceiling fitted with SKS-4/3 cooling elements.

The layout shall be carried out in line with the prevailing regulations and standards (in Germany mainly DIN 1946-2 (superseded by EN 13779)), the local weather conditions as well as the actual conditions of the building (e.g. mechanical ventilation or openable windows).

Usual layout conditions in Germany are:

- operative room temperature $\vartheta_R = 26\text{ °C}$
- chilled water supply temperature $\vartheta_{VL} = 16\text{ °C}$
- chilled water return temperature $\vartheta_{RL} = 18\text{ °C}$,

i.e. an output-determining temperature difference of 9 K between operative room temperature and mean chilled water temperature.

The cooling output being high, the requisite covered area is generally 30 – 60% only. This affords large space for ceiling utilities. It is preferable to suspend the cooling elements and the related chilled water pipework – mainly from copper – directly to the concrete ceiling, above lights, air diffusers, sprinkler heads, etc., so as to ensure full accessibility to all ceiling utilities and to allow for subsequent changes or supplements to the system.

Tables A and B show the cooling outputs that can be achieved at the aforementioned layout conditions, in relation to the free area of the suspended ceiling and the area covered by SKS-4/3 cooling elements.

Table A: Cooling output in W/m^2 of cooling element

Free area A_0 in %	Covered area b in %		
	30	45	60
20	130	119	111
25	135	126	119
40	147	143	139
> 65	157	157	157

Table B: Cooling output in W/m^2 of ceiling surface area

Free area A_0 in %	Covered area b in %		
	30	45	60
20	39	54	67
25	41	57	71
40	44	64	83
> 65	47	71	94

These tables show that above-average cooling outputs can already be achieved at a medium percentage of covered area, in conjunction with a sufficiently open ceiling or visible installation of SKS-4/3 elements.

For comparison, the cooling outputs achievable at an outputdetermining temperature difference of 7 K are shown in **Tables C and D**.

Table C: Cooling output in W/m^2 of cooling element

Free area A_0 in %	Covered area b in %		
	30	45	60
20	100	92	85
25	104	97	91
40	119	110	107
> 65	120	120	120

Table D: Cooling output in W/m^2 of ceiling surface area

Free area A_0 in %	Covered area b in %		
	30	45	60
20	30	41	51
25	31	44	55
40	36	50	64
> 65	36	54	72

The high output of SKS-4/3 cooling elements can thus be used to advantage for

- achieving above-average cooling outputs in rooms with high heat loads,
- significantly reducing the active cooling surface area,
- reducing the chilled water flow rate via higher chilled water temperature differences $\Delta\vartheta_W > 2\text{ K}$,
- operation with chilled water supply temperature $\vartheta_{VL} > 16\text{ °C}$

The minimum chilled water flow rate per cooling element amounts to 70 l/h. If this value is not reached, one of the following measures should be taken

- to enlarge the elements concerned,
- to connect several elements in series, or
- to allow a smaller chilled water temperature difference for these elements (i.e. lower return temperature)

Otherwise, a too low flow velocity within the cooling element will impair its output (see output curve in **Graph A, page 5**).

The waterside pressure drop of a cooling element is determined by its specific cooling output, its size (length x width) and the selected chilled water temperature difference. As a rule, it should be $\leq 20 - 30\text{ kPa}$ but, on the other hand, it should be significantly higher than the piping resistance of its water path within the control loop so as to ensure a steady water distribution in line with the layout.

In practice, connections according to the Tichelmann principle have proved effective.

To a large extent, the suspended ceiling can be designed and installed independently of the SKS-4/3 cooling elements.

Only the following must be specified:

- the material (as a rule sheet metal or aluminium sheet),
- the free area, but not the exact hole or joint pattern,
- the position of the cooling elements within the suspension height of $\geq 185\text{ mm}$ (at least: nominal height +50 mm above and below the element)

If the element width is $< 1.20\text{ m}$, there should not be any problem with the detailed coordination required later as the standard for the spacing of suspension points in metal ceilings is 1.20 m . For elements with length and width $> 1.20\text{ m}$, one may expect extra cost for the suspended ceiling structure, e.g. for girders.

Yet it is not possible to use acoustic mats or similar material on perforated ceiling tiles in conjunction with SKS-4/3 cooling elements.

The general influence of SKS-4/3 cooling ceilings on thermal comfort – with or without mechanical ventilation – is described in detail in our brochure „Cooling ceiling system description“ (DS 4076 e) as well as in other publications.

Cooling ceilings make for great satisfaction of room occupants thanks to the following features:

- nearly constant temperatures over the entire room height,
- low indoor air velocities,
- heat removal by radiation and convection favourable in terms of physiology,
- no noise, etc.

In commercial applications, for keeping to the indoor air velocities specified by DIN 1946-2 (superseded by EN 13779), we recommend limiting the specific cooling output to $q < 160\text{ W/m}^2$ of cooling element.

It is quite possible, and even recommended for most applications, to combine SKS-4/3 cooling elements with various air distribution systems. In such case, the directions contained in the aforementioned brochure „Cooling ceiling system description“ are to be taken into account.

For design specifications for the heating mode, refer to our technical report 'TB 87e' or consult us.

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Installation instructions

All dimensions referring to suspension and water connection are mentioned in **Fig. 1 on page 3**; further data, e.g. **weight** and nominal pressure, is mentioned on **page 2**.

The SKS-4/3 cooling elements are best suspended directly from the concrete ceiling using M8 threaded rods that require plugs suited to the material and structure of the concrete ceiling and authorized by building authorities.

Where required, sound-absorbing components will be added to prevent emissions from external noise sources in the room, e.g. pump or valve noise, building noise and the like.

With rather great suspension heights or dense and regular arrangement in groups, an intermediate structure made up of steel mounting profiles is useful in many cases (fewer suspension points in the ceiling, easy alignment, etc.).

It is not allowed to suspend or fasten other components or ceiling utilities to the cooling fins or Z-shaped profiles of the cooling elements.

As a rule – especially for a small percentage of covered area – the cooling elements should be distributed evenly throughout the room. With a higher percentage of covered area, arrangement in groups makes sense, also weighted to the cooling load. The elements can be mounted abutting lengthwise (without clearance) or abutting endwise in case of one-sided chilled water connection.

Above and below SKS-4/3 cooling elements there should be ≥ 50 mm clearance to ceiling utilities and to the concrete or suspended ceiling. Less clearance, especially to large-surface components beneath the cooling elements, is likely to impair the cooling output.

The water connection must be made in compliance with the general rules for water systems; in particular, it should be without tension and should not hinder the venting of the elements.

SKS-4/3 cooling elements are delivered stacked on wooden pallets (up to 20 elements on one pallet), wrapped in plastic film. We recommend using a fork-lift truck for unloading and transport on site. Upon request the packages will be prepared for unloading with a crane.

Intermediate storage is recommended in roofed-over, dry, non-dusty spaces. Elements taken out of the packages should be mounted immediately. Prior to the installation of the cooling elements, all trades should have completed any kind of work generating a lot of dust or whirling dust up.

For large-size cooling elements, the use of travelling winches is recommended to facilitate installation.

Operation and maintenance

To prevent condensation, we recommend using condensate controllers where appropriate.

The cooling elements and the chilled water pipes, fittings and connections shall be checked following the manufacturers' specifications.

Quick Features

- High specific cooling output:
Standard cooling output 175 W/m² of cooling element without suspended ceiling (to DIN 4715 (superseded by DIN EN 14240))
 - Small percentage of covered area at medium cooling load affords large space for ceiling utilities
 - Supply temperatures > 16 °C lessen or prevent the condensation risk, which lowers the cost for measurement and control systems
 - Chilled water temperature differences > 2 K save on investment and operating costs
- Suitable for very high cooling outputs as required in TV studios and mechanical rooms, or for industrial applications
- Uses the retention capacity of the concrete ceiling
- Slight temperature differences in the occupied zone
- Combinable with any air distribution system
- The cooling elements are independent of the false ceiling, i.e. design and installation of mechanical equipment and ceiling can largely occur separately
- Low installation height, thus
 - well suited for renovation and retrofitting
 - savings on building costs or building volume in new buildings
- The core of the system is copper serpentine piping, which means
 - no special requirements for chilled water quality
 - low system costs
 - long lifetime
 - assured quality
 - operating pressure up to 16 bars
- Good dynamic response
- No combustible components
Fire safety: Construction material class A2-s1, d0, EN 13501-1
- High-quality system manufactured to DIN EN ISO 9001 and from quality-controlled copper piping

Type code

SKS-4/3 ___ x ___ / ___ t

Cooling ceiling

Length

Width

Installation type

Connection type

Length

- 1 000 mm ≤ Nominal length ≤ 4 000 mm in steps of 100 mm

Width

- 350 mm ≤ Nominal width ≤ 1 475 mm in steps of 125 mm

Installation type

Z = concealed installation in false ceiling plenum
S = visible Installation

Connection type

S = push-in fitting or press-fitted connection, outside diameter 12 mm
L = solder end, outside diameter 12 mm

Tender text

.... units

Static cooling ceiling system SKS-4/3 consisting of single, compact, high-capacity cooling elements for easy ceiling installation, with:

- copper piping 12 x 0.5 mm featuring a smooth, neat and dry inside surface to DIN 1787, tolerances to DIN 8905, in serpentine design with connections for chilled water inflow and outflow as straight pipe ends,
- triangular cooling fins made from aluminium extruded profile, with chilled water pipes pushed into,
- rear fastening profiles for uniform levelling of cooling fins, serving as suspensions from the ceiling (number dependent on cooling element length)

All visible parts are powder-coated or wet-painted.

Connection type

- Pipe end for push-in fitting, press-fitted or solder connection (standard $D_a = 12$ mm)

Colour

- black (matt) similar to RAL 9005 (standard)
- other colour to RAL

Technical data

Cooling output per cooling element:	W
Cooling water supply temperature:	°C
Cooling water flow per cooling element:	l/h
Room temperature:	°C
Free area of suspended ceiling:	%
Covered area (exclusive of piping):	%
Pressure drop per cooling element:	kPa
Max. operating pressure (standard):	700 kPa
Water quality:	Mains water
- Standard dimensions:	
Nominal length:	3 000 mm
Nominal width:	975 mm
Nominal height:	85 mm
Pipe division:	125 mm
Connection:	one-sided
- Special dimensions:	
Nominal length:	mm
Nominal width:	mm
Nominal height:	mm
Make:	KRANTZ
Type:	SKS-4/3 ___ - ___ - ___

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www.krantz.de DS 4094e Bl. 10 06.2022

Krantz GmbH

Uersfeld 24, 52072 Aachen, Deutschland

Tel.: +49 241 441-1

Fax: +49 241 441-555

info@krantz.de | www.krantz.de

The logo for Krantz, featuring the word "Krantz" in a stylized, blue, cursive script font.