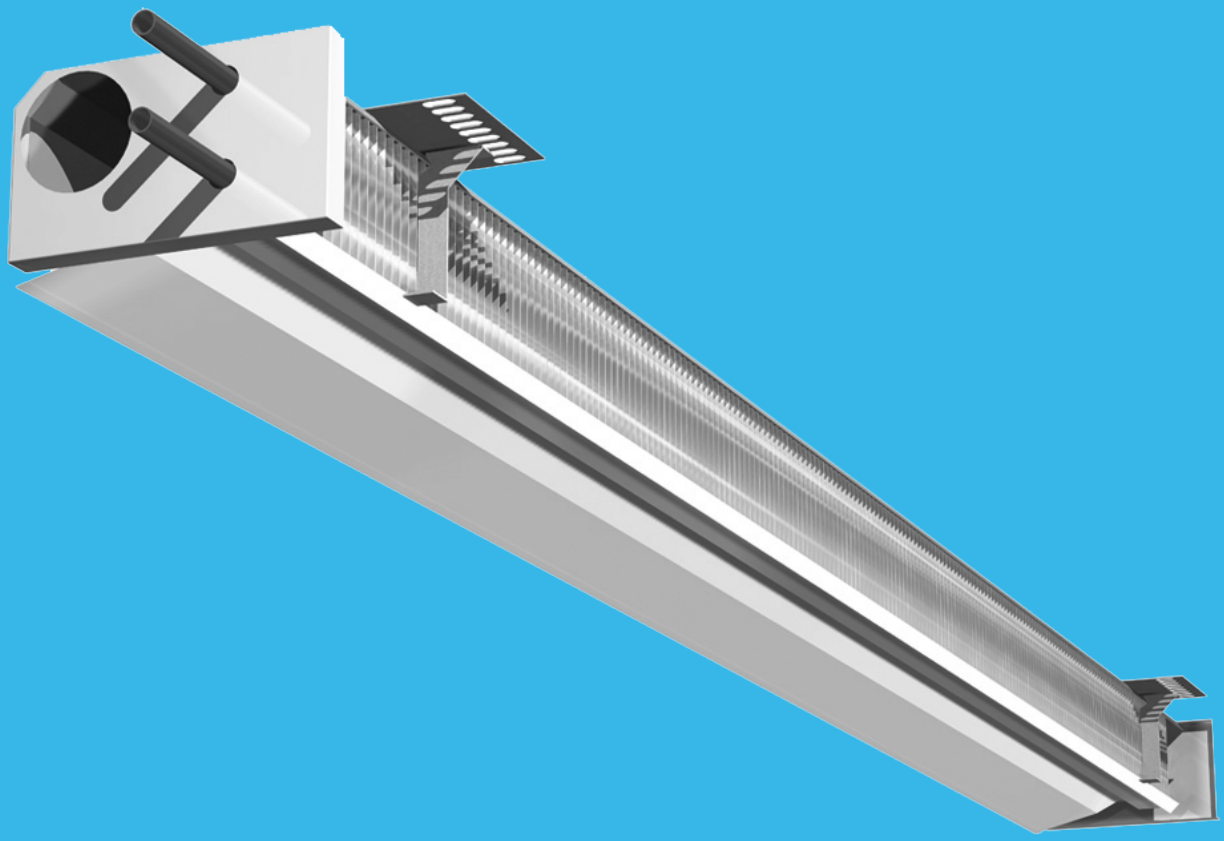

Lindab **Celo**

Active chilled beam

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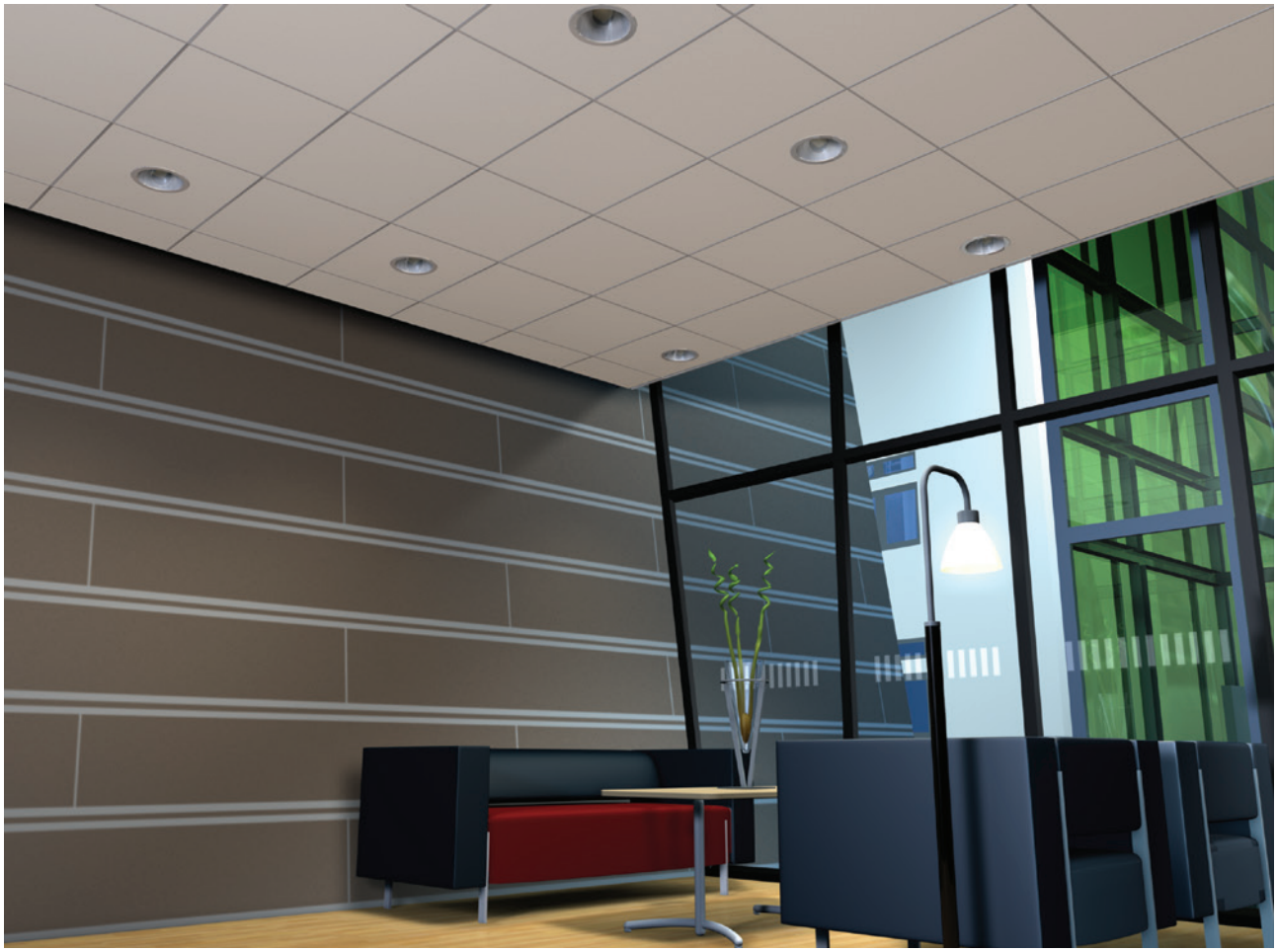
Active chilled beam Celo



Use

Lindab has developed a active chilled beam, Celo, which can be installed above a suspended ceiling.

Thus, you can conceal the ventilation and cooling features and create an unbroken ceiling without visible technical installations. The Celo concept has been developed together with Ecophon, which provides acoustic ceilings adapted for the system.

Installation

Celo is installed above the suspended ceiling. The system requires open slits in the suspended ceiling for the cooled air to exit and for the intake of warm air from the room to the chilled beam.

Worth noting

Celo is based on a unique technology, patent applied for, where the cooled air is carried down through an outlet slit in the suspended ceiling, then along the wall and down towards the floor. The cooled air has a fan-shaped distribution, which ensures low air velocities in the occupied area.

Lindabs active chilled beams are Eurovent-certified and tested according to EN-15116.

Key figures

Length:	1200 - 3600 mm (steps of 100 mm)
Width:	215 mm
Height:	127 mm
Capacity:	1030 W

Calculation setup
Room temp: 25°C, Water temp: 14-17°C, Air temp: 18°C, Nozzle air pressure: 80 Pa, Air flow: 15 l/s/m.

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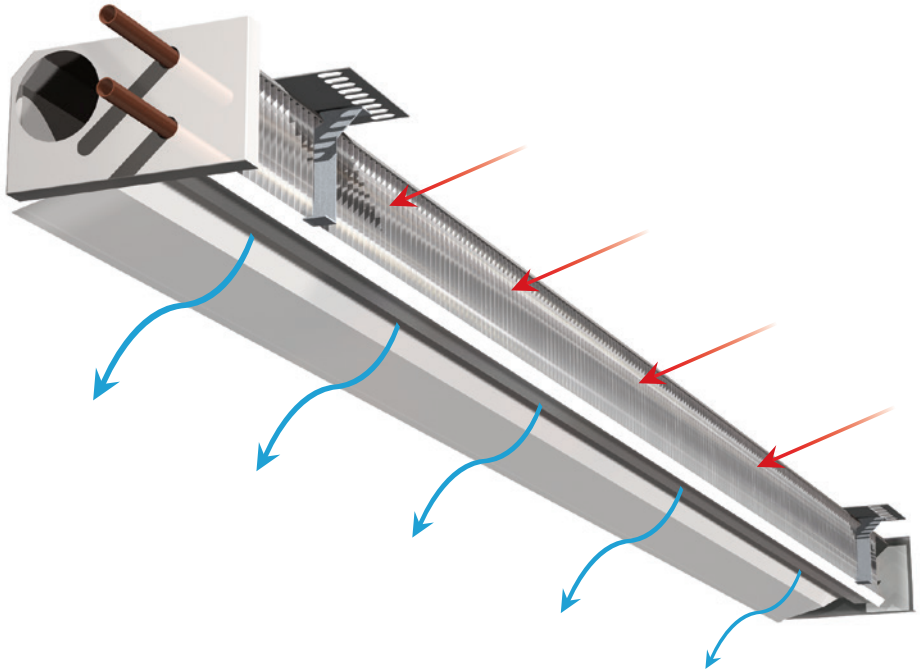
Active chilled beam Celo



Picture 1. Celo is based on the induction principle.

Function

Patent-applied-for technology guarantees a good indoor climate

Celo consists of a active chilled beam (see picture 1), which is placed above a suspended ceiling. Celo's technological solution is based on a unique technology (patent applied for), where the air is carried down through an outlet slit in the suspended ceiling, then along the entire wall and down towards the floor (see picture 2). The air has a fan-shaped distribution and all together, this ensures low air velocities in the occupied area.

The technology, where the clean cooled air is driven slowly down the wall towards the floor and where the exhaust unit is placed above the suspended ceiling, ensures good air-change efficiency in the room.

Construction

Celo is equipped with a vertical battery and a lateral air duct. There is an air connector on each end of the beam, and one of these is used for connecting the air. A cleaning hatch, with a handle, is placed on the unused connection, Lindab designation ESHU 80. The cleaning hatch provides access to the beam's air duct for cleaning and inspection. The product is supplied with factory-preset airflow and nozzle pressure.

The air is supplied to the room through Coanda nozzles placed along the air duct. The outermost nozzles have a sideways angle of 30°, an angle that decreases the closer the nozzles are to the centre. This creates a fan-shaped distribution pattern.

The nozzles are accessible for plugging from below, if you wish to change the pressure and flow pattern at a later time.

The water pipes are made of copper. Nevertheless, the water should be oxygen-free to prevent corrosion.

Picture 2. Celo's technical solution is based on a unique technology, patent applied for, where the cooled air is carried down through an outlet slit in the suspended ceiling, then along the wall and down towards the floor.

Active chilled beam Celo

Concealed installations

Celo makes it easy to create a beautiful unbroken ceiling (see picture 3). Celo provides great freedom when designing a suspended ceiling (see Picture 4). The choice is between a wall-to-wall suspended ceiling with slits and a suspended island installation.

Active chilled beams, exhaust air units, ventilation ducts and electrical installations are all placed above the suspended ceiling.

Simple installation and service

Installation of the Celo active chilled beam is simple. Careful adjustment of the suspended ceiling is not required. When the installation engineer has finished installing the beam, the ceiling installer takes over; basically, the only thing he has to do is fit the ceiling.

Since the suspended ceiling panels can be easily dismantled, the active chilled beams and the other technical installations are easily accessible for maintenance and service.

The many years of experience with conventional chilled beam systems, where the air is drawn through slits in the suspended ceiling and then brought back through a active chilled beam placed at the centre of the room, prove that there is good hygiene above the suspended ceiling. The big difference with Celo is that the active chilled beam is not visible!

Picture 3. Celo makes it easy to create a beautiful unbroken ceiling.

Picture 4. Celo provides great freedom for the design of the suspended ceiling.

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2019-06-20

Active chilled beam Celo

Data

Variants

Celo is installed above a suspended ceiling.

Lengths: Celo is available in lengths from 1.2 m to 3.6 m (in steps of 0.3 m).

Width: The width is 215 mm.

Heigth: The height is 122 mm.

Water connection: The water connection is horizontal Ø12 mm.

Air connection: The air connection is horizontal Ø80 mm.

Nozzle angle: The standard angle of the nozzles is 30°.

Surface treatment: Celo is manufactured as standard from enamelled sheet metal.

Airflow control: The product has a preset pressure drop value, so on-site adjustment is not necessary. A prerequisite is that the duct system in the building has a relatively low-pressure drop compared to the product. Where a damper is desired, you can order a balancing damper.

Colour

The product is installed unvisible behind the false ceiling and not visible from below.

Plus features

Factory preinstalled.

Integrated regula Secura: Lindab's condensation guard, developed in-house, can be fitted into Celo. Refer to the chapter Regula.

Integrated regula Connect: A connection card to provide flexibility when interconnecting chilled beams. The card can be mounted on the beam. Refer to the chapter Regula.

Air connection: The beam is available with an aditional Ø80 mm connection on the opposite side.

Air boost: Additional nozzles and plugs for future flexibility.

Accessories

Delivered separately.

Control: Refer to the chapter Regula.

Hangers: For recommended installation principles (see: "Celo Installation Instruction").

All these different hangers are available at Lindab:

-pendulum hangers (in different sizes)
-threaded rods M8
-wiring hanger system

For additional accessories please refer to the "Accessories" document on www.lindQST.com.

Active chilled beam Celo

Dimensioning

Cooling capacity air P_a

1. Start by calculating the capacity required for the room, to keep a certain temperature. Lindab's TEKNOsim is an excellent tool for this.
2. Calculate which cooling capacity, or read in diagram 1, that is supplied by the ventilation air.
3. Remaining cooling capacity needs to be cooled by the water circuit in Celo.

The formula for calculating the capacity of the air:

$$P_a = q_{ma} \times c_{pa} \times \Delta t_{ra}$$

Size comparison by $t_r = 25°C$ with:

q_a = Primary air flow rate

P_a [W] = q_a [l/s] x 1.2 Δt_{ra} [K] and

P_a [W] = q_a [m³/h] x 0.33 Δt_{ra} [K]

Minimum flow

Please note that flows below the recommended minimum water flow q_{wmin}, can result in unwanted air in the water pipes. Exceeding the nominal flows is not recommended as the capacity gains will only be minimal.

Pipe diameter	q_{wmin}	q_{wnom}
12 mm	0.025 l/s	0.038 l/s

Definitions:

P_a = Cooling capacity air [W]
P_w = Cooling capacity water [W]
P_{tot} = Cooling capacity total [W]
q_{ma} = Air mass flow rate [kg/s]
q_a = Primary air flow rate [l/s]
q_w = Water flow rate [l/s]
q_{wmin} = Minimal water flow rate [l/s]
q_{wnom} = Nominal water flow rate [l/s]
c_{pa} = Specific heat capacity air [1.004 kJ/kg K]
t_r = Room air temperature [°C]
t_{wi} = Water inlet temperature [°C]
t_{wo} = Water outlet temperature [°C]
Δt_{ra} = Temp. diff., room air and primary air temp. [K]
Δt_{rw} = Temp. diff., room air and mean water temp. [K]
Δt_w = Temp. diff. water circuit [K]
$\varepsilon_{\Delta tw}$ = Capacity correction for temperature
ε_{qw} = Capacity correction for water flow
P_{Lt} = Specific cooling capacity [W/(m K)]

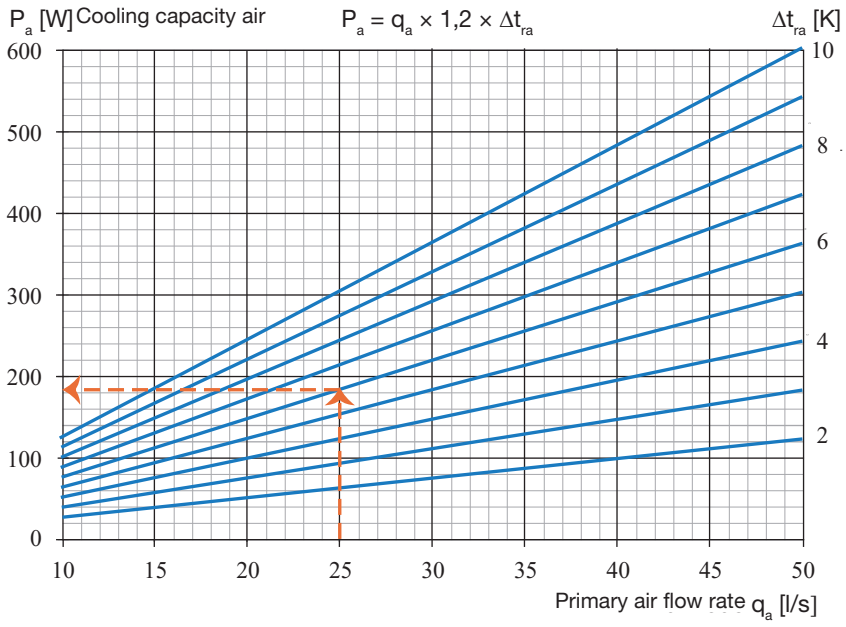

Diagram 1. Cooling capacity air P_a as function of the primary air flow rate q_a. If the air supply flow is 25 l/s and the temperature difference of the room air and the supply air is Δt_{ra}= 6 K, then the Cooling capacity of the air is 180 W.

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Active chilled beam Celo

Dimensioning

Cooling capacity water P_w

Follow the instructions below to read off the capacity from the diagram.

1. Calculate Δt_{rw}.
2. Product length L minus 0.2 m, to obtain the active length L_{act}.
3. Divide the primary air flow rate q_a by the active length L_{act}. Enter the result on the lower axis of diagram 2.
4. Follow the flow line to the right pressure, and then read off the specific cooling capacity P_{Lt} per active metre.
5. Multiply the specific cooling capacity that was read off by Δt_{rw} and active length L_{act}.

Example 1:
What is the cooling capacity of a 3.6 m Celo with 20 l/s and a pressure of 80 Pa ?

The room's summer temperature is assumed to be t_r = 24.5°C. The cooling water temperature in/out of Celo is 14/17°C.

Answer:
Temperature difference:
$\Delta t_{rw} = t_r - (t_{wi} + t_{wo})/2$
Δt_{rw} = 24.5 - (14+17) / 2 = 9 K

Active length:
L_{act} = 3.6 m - 0.2 m = 3.4 m
q_a / L_{act} = 20 l/s / 3.4 m = 5.8 l/(s m)

Read off, from diagram 2: P_{Lt} = 17.2 W/(m·K)

Cooling capacity: P_w = 17.2 W/(m·K) × 9 K × 3.4 m = 526 W

NB! The capacity diagram applies for the nominal water flow of q_{wnom} = 0.038 l/s. To obtain the right cooling capacity P_w for other flows, read off the capacity correction factor ε_{qw} from diagram 3, and then multiply the capacity, which is read off, by this factor as shown in example 2.

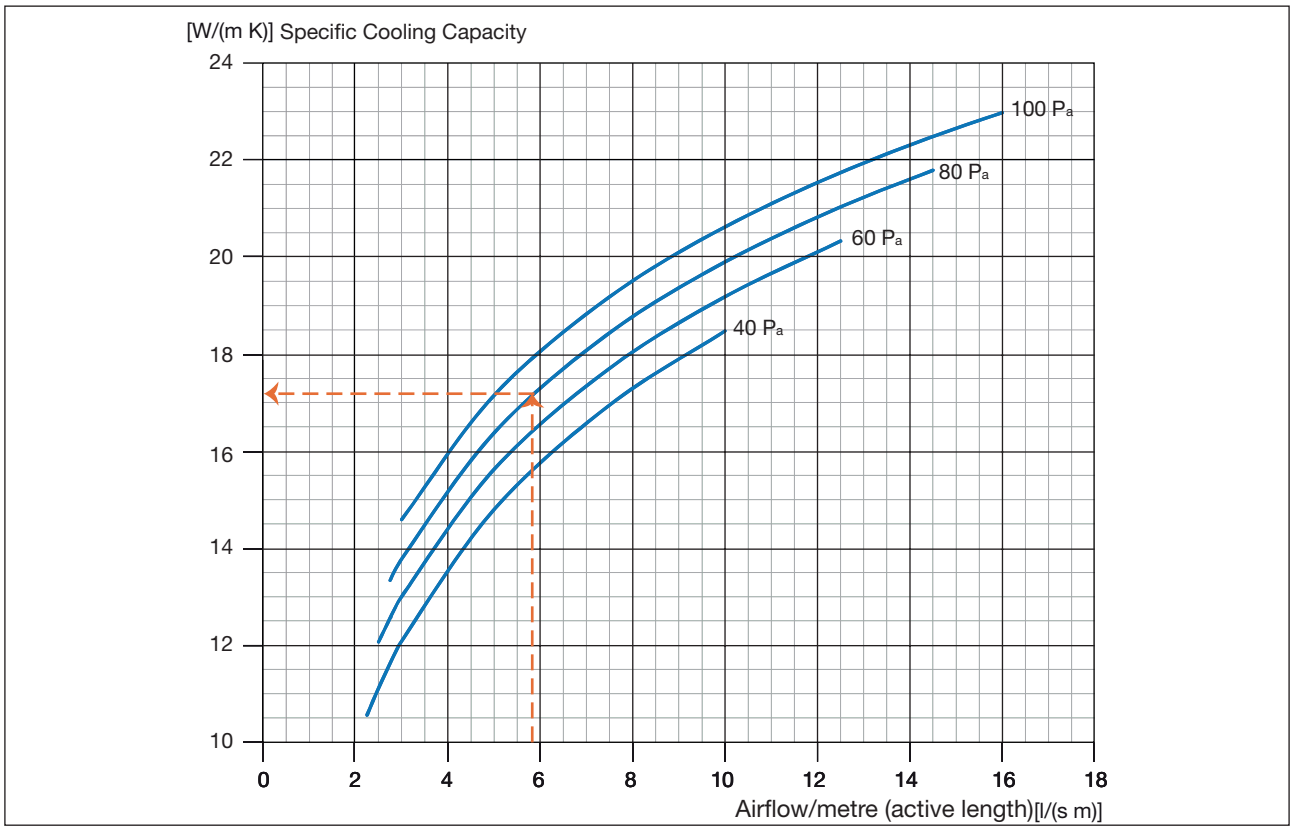

Diagram 2. Specific cooling capacity P_{Lt} as a function of primary air flow rate per active metre at nozzle pressures of 40, 60, 80 and 100 Pa.

Active chilled beam Celo

Dimensioning

Capacity correction for water flow ε_{qw}

Example 2:
Use the calculated cooling capacity and calculate the water flow: $q_w = P_w / (c_{pw} \times \Delta t_w)$
$q_w = 526 / (4200 \times 3) = 0.041$ l/s

The capacity correction ε_{qw} will then be 1.015 (see diagram 3) and the new capacity:
$P_w = 526 \times 1.015 = 534$ W.

Using the new cooling capacity, a new water flow is calculated: $q_w = 534 / (4200 \times 3) = 0.042$ l/s

Read off the capacity correction ε_{qw} at 1.02 and calculate the capacity: $P_w = 526 \times 1.02 = 537$ W.

Using the new cooling capacity, a new water flow is calculated: $q_w = 537 / (4200 \times 3) = 0.043$ l/s

Read off the capacity correction ε_{qw} at 1.025 and calculate the capacity: $P_w = 526 \times 1.025 = 539$ W.

Using the new cooling capacity, a new water flow is calculated: $q_w = 539 / (4200 \times 3) = 0.043$ l/s

Seeing that the flow is near stabile at this point in the calculation, the cooling capacity is calculated to be 539 W.

Example 3:
What is the cooling capacity of two 3.6 m Celo beams with a water circuit connected in series, $t_r = 20$ l/s, and a nozzle pressure of 80 Pa?

Answer:
Calculate the cooling capacity for one Celo, in the same way as in example 1. The value is 526 W. The total cooling capacity for two Celo beams connected in series will then be: $P_w = 2 \times 526 = 1052$ W

Use the calculated cooling capacity and calculate the water flow: $q_w = P_w / (c_{pw} \times \Delta t_w)$
$q_w = 1052 / (4200 \times 3) = 0.083$ l/s

The capacity correction ε_{qw} will then be 1.055 (see diagram 3) and the new capacity:
$P_w = 1052 \times 1.055 = 1110$ W

Using the new cooling capacity, a new water flow is calculated: $q_w = 1110 / (4200 \times 3) = 0.088$ l/s

Read off the capacity correction ε_{qw} at 1.06 and calculate the capacity: $P_w = 1052 \times 1.06 = 1115$ W

Using the new cooling capacity, a new water flow is calculated: $q_w = 1115 / (4200 \times 3) = 0.088$ l/s

Seeing that the flow is near stabile at this point in the calculation, the cooling capacity is calculated to be 1115 W.

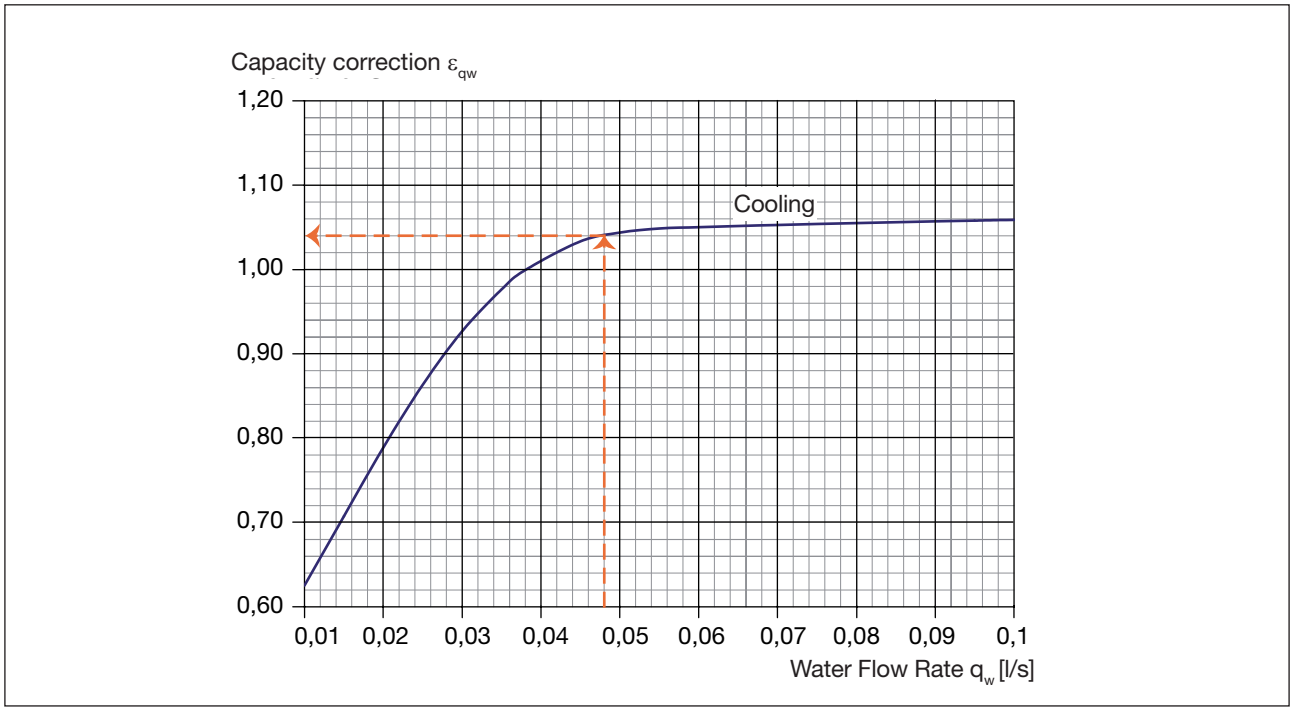

Diagram 3. Capacity correction ε_{qw} for water flow.

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Active chilled beam Celo

Pressure drop in water circuit, cooling

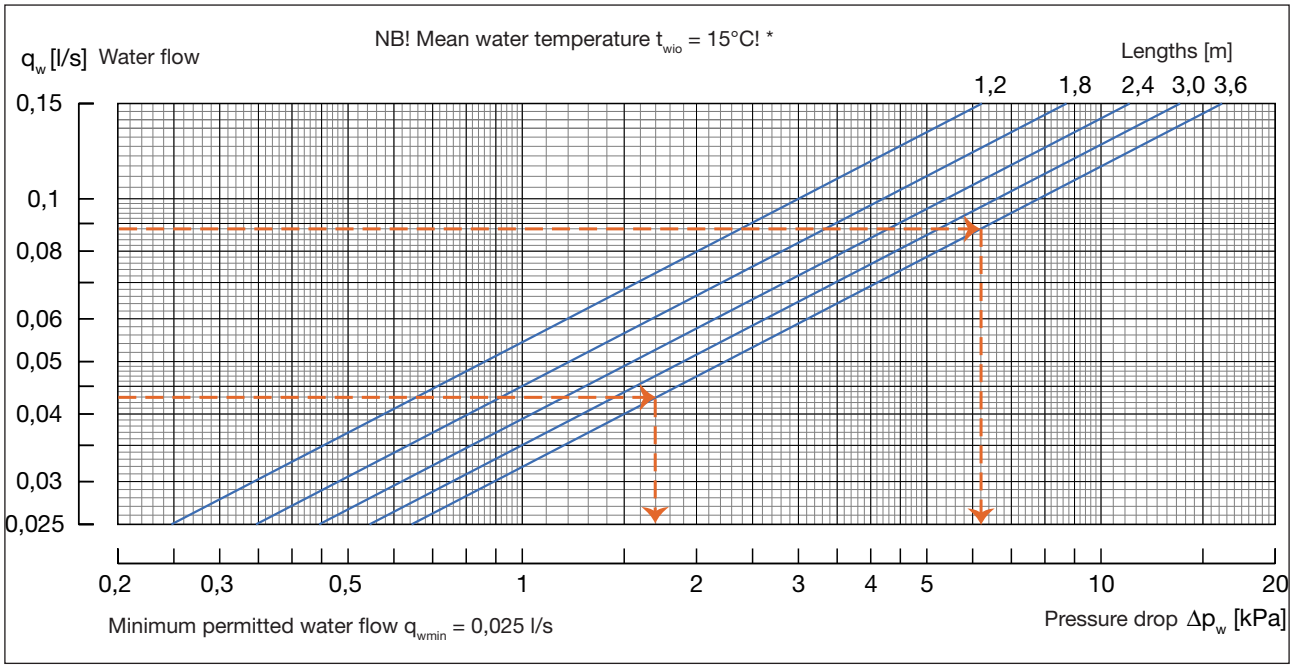

Diagram 4. Pressure drop in water circuit, cooling.

Example 4:
One 3.6 m Celo beam supplies an output of 539 W.
Δt_w = 3 K
$q_w = P_w / (c_{pw} \times \Delta t_w)$
q_w = 539 W / (4200 Ws/(kg K) × 3 K) = 0.043 l/s
The pressure drop in the water circuit in diagram 4 is read off as Δp_w = 1.7 kPa.

Example 5:
Two 3.6 m Celo beams connected in series supply an output of 1115 W.
Δt_w = 3 K
$q_w = P_w / (c_{pw} \times \Delta t_w)$
q_w = 1115 W / (4200 Ws/(kg K) × 3 K) = 0.088 l/s
The pressure drop in the water circuit in diagram 4 is read off as Δp_w = 6.2 kPa.
The combined pressure drop for two Celo beams will then be 6.2 + 6.2 = 12.4 kPa.

Definitions:

q_w	= Water flow rate [l/s]
P_w	= Cooling capacity water [W]
c_{pw}	= Specific heat capacity water [4200 Ws/(kg K)]
Δt_w	= Temperature difference water circuit [K]
t_{wio}	= Mean water temperature [°C]
Δp_w	= Pressure loss water circuit [kPa]

* Diagrams are for a certain mean water temperature t_{wio}. For other temperatures please do your calculations in our waterborne calculator in www.lindQST.com!

Active chilled beam Celo

Sound data

Sound pressure level L_p [dB(A)]

	Airflow (l/s)							
	Air pressure (Pa)	**15**	**20**	**25**	**30**	**35**	**40**	**45**
Master 40 mm	60	16	18	21	22	23	25	28
	80	18	21	23	25	27	28	31
	100	21	23	25	26	28	30	33
Focus 20 mm	60	17	19	22	23	24	26	29
	80	19	22	24	26	28	29	32
	100	22	24	26	27	29	31	34

Table 1. Celo, sound pressure level L_p [dB(A)]. The measurements were conducted with 2 Celo beams. The measurements were made in a test chamber with dimensions (L×W×H) 3.8 m × 3.2 m × 2.7. The test chamber had an installed ceiling with dimensions 3.6 m × 3.0 m, with Ecophon's acoustic panels of different types, according to the table above. The test chamber had plaster walls and a concrete floor.

Sound pressure level L_{poct}

	K_{oct} (dB[A]) Octave band, average frequency (Hz)							
	63 Hz	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**	**4 kHz**	**8 kHz**
Master 40 mm	4	9	5	0	-8	-12	-12	-9
Focus 20 mm	2	9	5	1	-8	-13	-13	-10
Tolerance	±2	±2	±2	±2	±2	±2	±2	±2

Table 2. Celo's sound pressure levels L_{poct} for each octave band in the installation are calculated by adding the corrections C_{oct} from the table above to the sound pressure levels read off in the table for each ceiling at different air pressures/air flows. The sound pressure levels are calculated according to the following formula: $L_{poct} = L_p + C_{oct}$

Sound attenuation ΔL

DL[dB]	**63 Hz**	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**	**4 kHz**	**8 kHz**
Master 40 mm	27	23	22	14	12	16	14	17
Focus 20 mm	29	22	21	13	11	15	14	17

Table 3. Celo sound attenuation ΔL.

Weight & water content

Dry weight, kg/m	6.5
Water content, l/m	0.35

Table 4. Celo, weight & water content.

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Active chilled beam Celo

Determination of outlet and inlet slits

Definition of outer slit
A slit in the suspended ceiling, through which the cooled air from Celo is carried down into the room. The outlet slit is defined as the area 0.5 m on each side of the beam along the length of the beam. Outlet slit length = number of beams x (beam length + 1 m).

Outlet slit for wall-to-wall suspended ceiling with slits
The outlet slit must be at least 60 mm wide.

Outlet slit for suspended island installation
The outlet slit must be at least 240 mm wide. The width of the outlet slit affects the air velocity (see diagram 5).

Definition of inlet slit
A slit in the suspended ceiling, through which warm air from the room is carried up to Celo. The inlet slit is the slit that remains when the length of the outlet slit is subtracted from the total slit length of the room.

Inlet slit for wall-to-wall suspended ceiling with slits and suspended island installation
The surface of the inlet slit must be 0.1 m²/m of the active beam length for the system to provide the specified capacitys. Otherwise, you have to calculate the capacity reduction using the reduction factor in diagram 5.

Definition of active beam length
Active beam length = total beam length - 0.2 m

Slit space for exhaust air
In balanced ventilation systems, i.e. where the volume of exhaust air is approximately the same as the volume of supply air, no extra slit space is required.

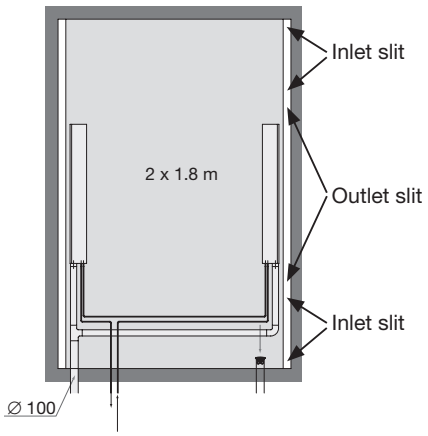


Figure 1. Two Celo beams with two open slits.

Example 6:
A Celo system is to be installed in a room with the dimensions 4.5 × 2.4 m Two 1.8-m Celo beams have been selected to achieve the correct cooling capacity. The water circuit for the beams is to be connected in series (see figure 1). The installation is carried out with one beam on each long side. What should be the width of the intake and outlet slits?

Inlet slit = total slit length - outlet slit
2 x 4.5 m - 2 x (1.8 m + 1 m) = 3.4 m

The surface of the inlet slit must be 0.1 m²/m of active beam length so as to prevent a reduction in the cooling capacity:
Intake area = 0.1 m²/m × (2×1.6 m) = 0.32 m²

Calculate the width of the slit:
3.4 m × slit width = 0.32 m² = > slit width = 0.32 m² / 3.4 m = 0.094 m = 94 mm

Since the width of the outlet slit must be at least 60 mm, this requirement is also met.

Assume that the maximum width of the slit is 70 mm, what then will be the reduction in cooling capacity?

Surface of inlet slit: 0.070 m × 3.4 m = 0.238 m²
0.238 m² /3.2 m = 0.074 m²/m of active beam length.

Read off the reduction factor from diagram 5. The value is 0.97; i.e., the capacity reduction is approx. 3%.

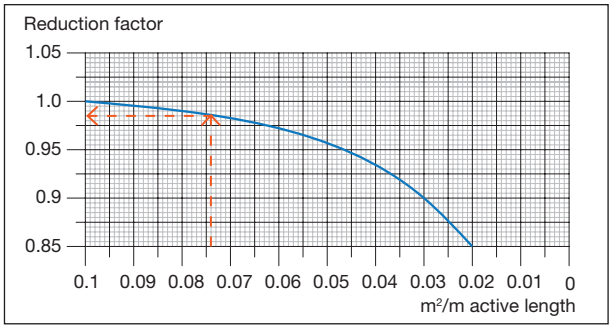


Diagram 5. Capacity reduction due to reduced inlet slit.

Active chilled beam Celo

Couplings & connections

Celo is supplied in lengths from 1.2 m to 3.6 m in steps of 0.3 m. The connection dimension for the water is o.d. 12 mm and for the air 80 mm.

Designations
Figure 2 shows the different coupling options for Celo. Type A1 has a horizontal air connection at the end and a horizontal pipe connection at the same end of the beam.

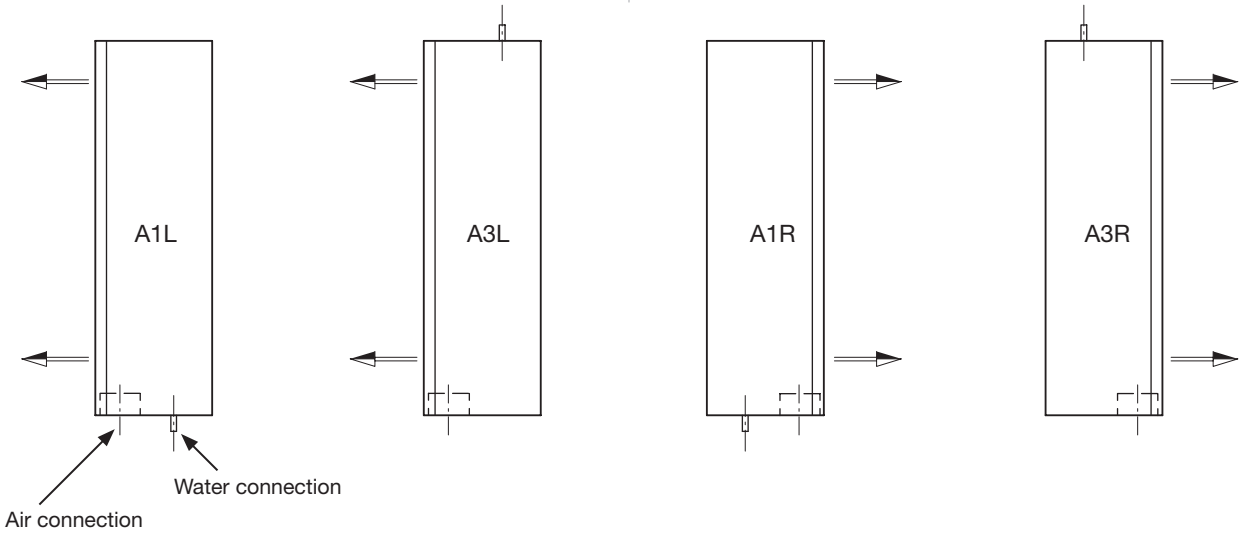
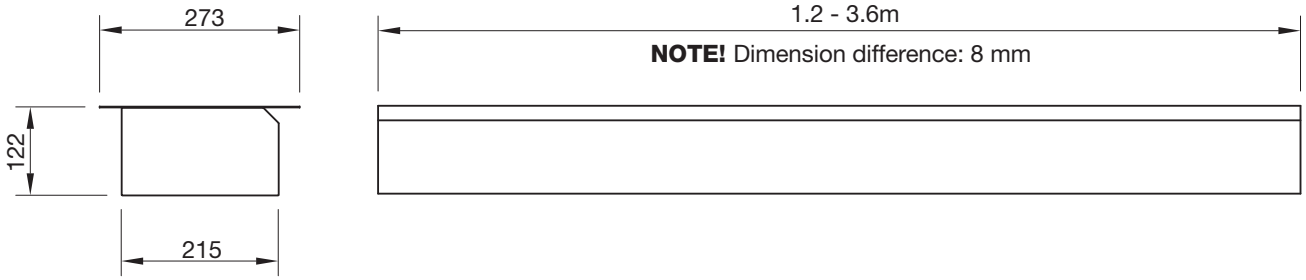


Figure 2. Celo has four different coupling options, A1L, A3L, A1R and A3R.

Width, height & length



Connection dimensions, mm

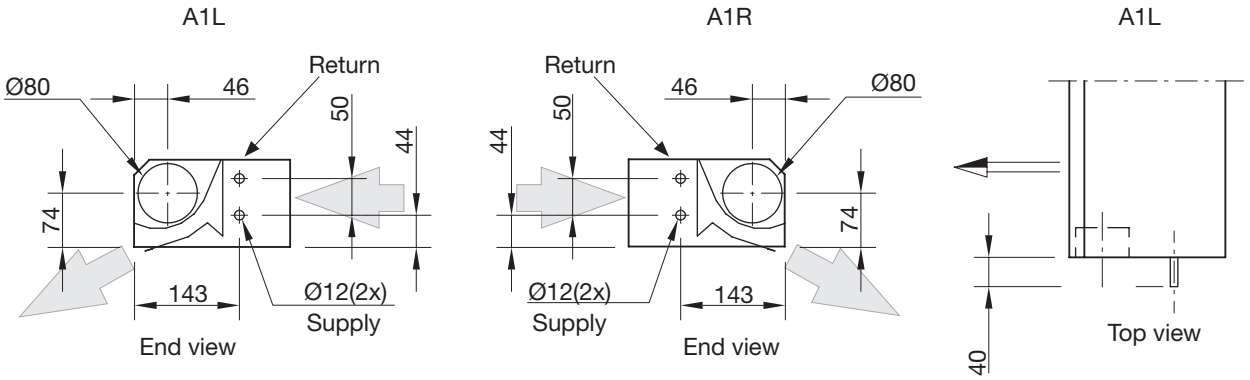


Figure 3. Celo, width, height and connection dimensions.

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Active chilled beam Celo

Installation

Celo is installed above the suspended ceiling. The beam is attached to the ceiling joist with suspended wires, threaded rods or screws. Installation components can be ordered as accessories.

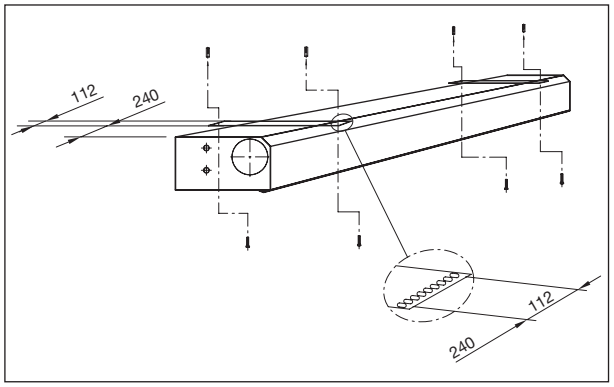

Figure 4. Dimensions for fixing points.

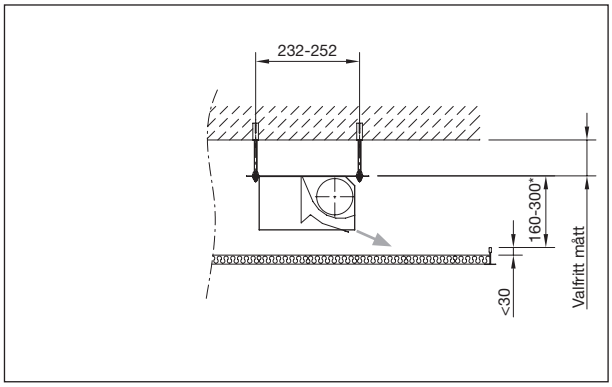

Figure 5. Dimensions for suspended installation. Suspended island installation.

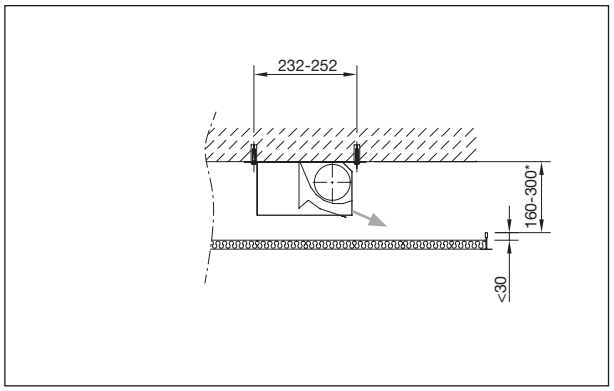

Figure 6. Measurement for installation on to a ceiling joist. Suspended island installation.

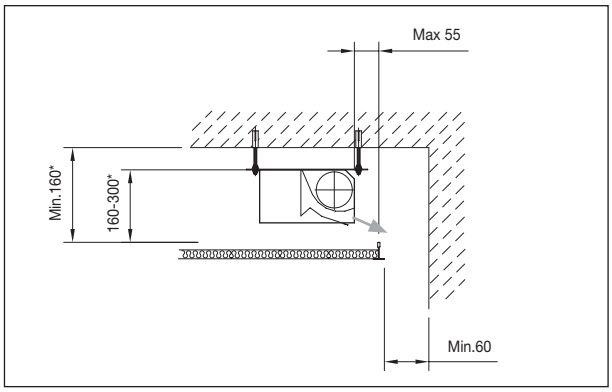

Figure 7. Dimensions for installation, outlet along the wall.

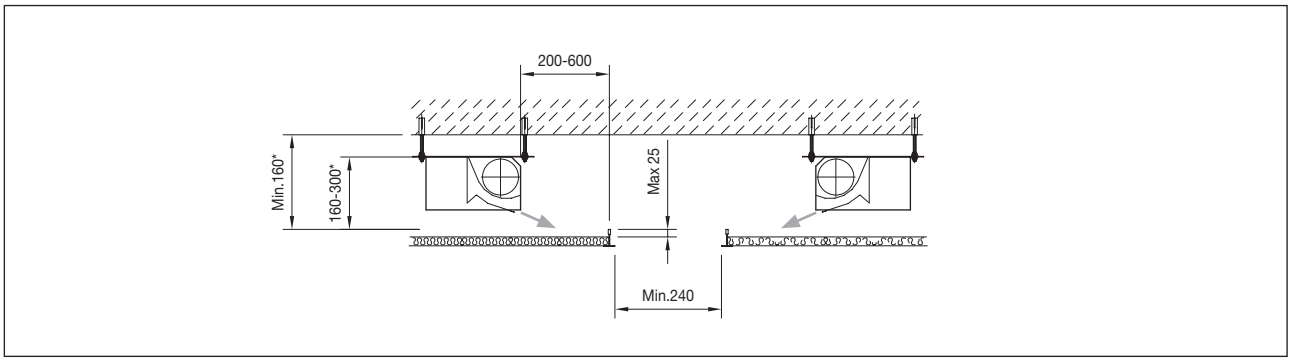

Figure 8. Dimensions for suspended island installation. The maximum dimension of 25 mm is between the upper edge of the suspended ceiling and the highest point of the ceiling that can interfere with the air current.

* The dimension is between the upper edge of the beam and the highest point of the ceiling that can interfere with the air current.

Active chilled beam Celo

Installation examples

Wall-to-wall suspended ceiling with slits
To achieve a sufficiently high water flow according to the capacity diagram when shorter units are used, it is often necessary to have two Celo beams connected in series.

When the water circuit is connected in series, the same water flow goes through both beams. This results in a water flow through the beam that is twice as large as the flow in parallel-coupled beams, at the same temperature difference (supply/return) and cooling capacity.

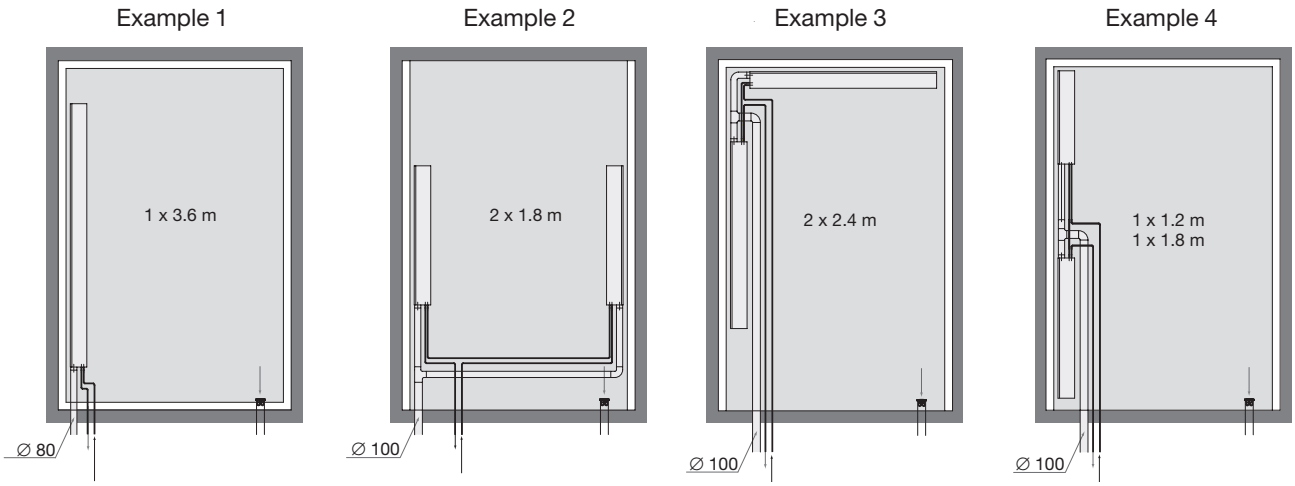

Figure 9. Four examples of how Celo beams can be placed in combination with different slits in the suspended ceiling, including suitable water and air connection.

NB! Each active chilled beam has an air connection of Ø80 mm. Each active chilled beam has a maximum air volume to fulfil the desired noise levels. Two beams cope with a greater total air volume.

To avoid increased air velocities, the distance from end to end should be greater than 1200 mm (see figure 9, example 4). Lindab's control valves can be used as exhaust air units.

Suspended island installation
Celo can also be installed in a suspended island. The picture below shows examples of this.

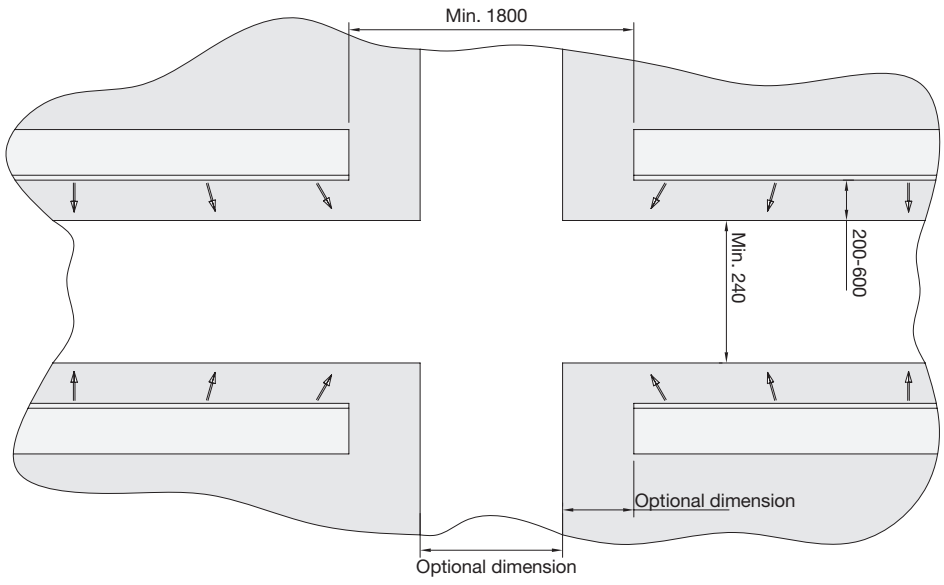

Figure 10. The picture shows four corners where suspended ceiling islands meet.

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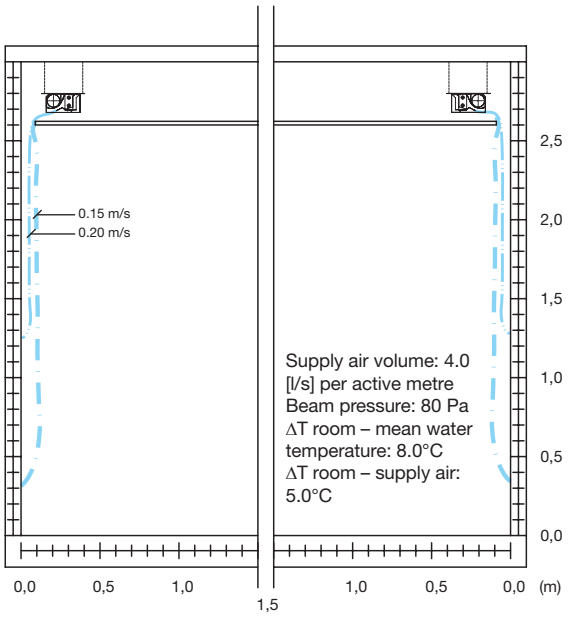
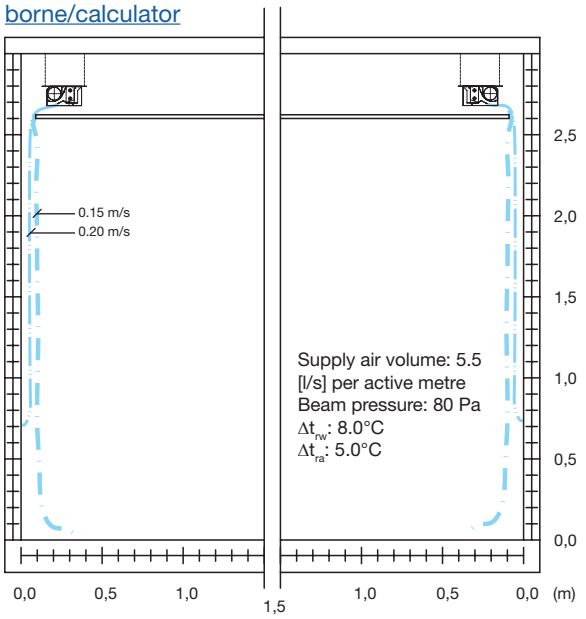
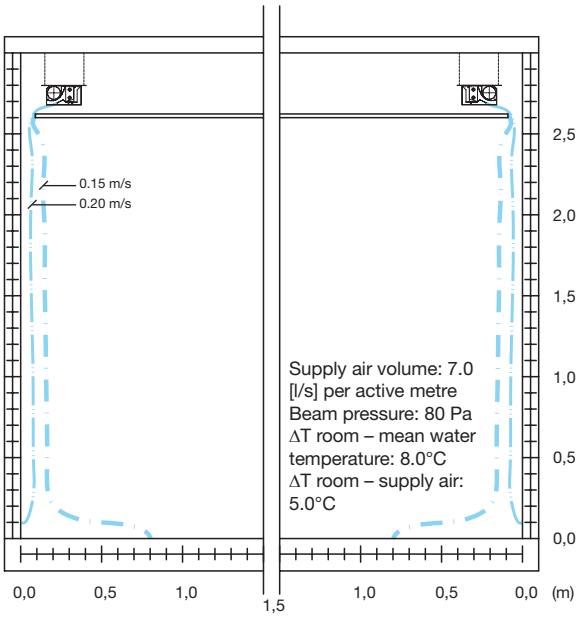
Active chilled beam Celo

Distribution diagrams, Celo

Calculations for other distances between cooling baffles and for the selection of other air volumes are referred to the Indoor Climate Program. www.lindQST.com/water-borne/calculator







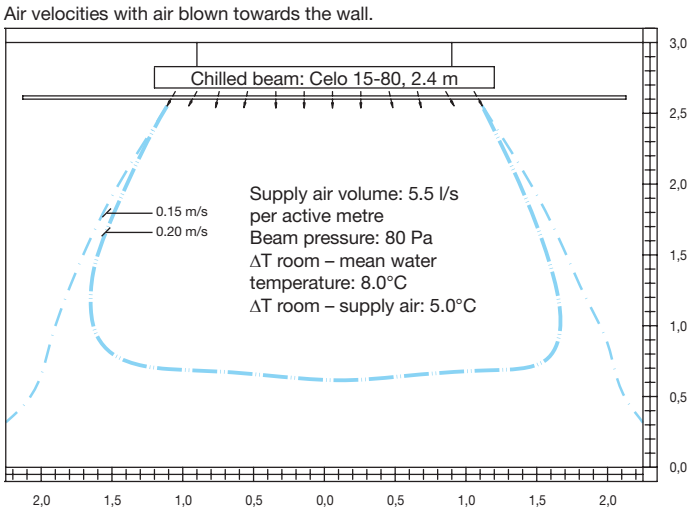
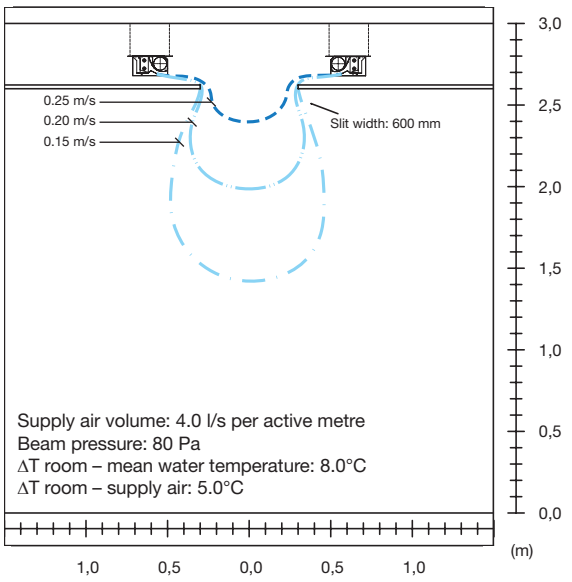
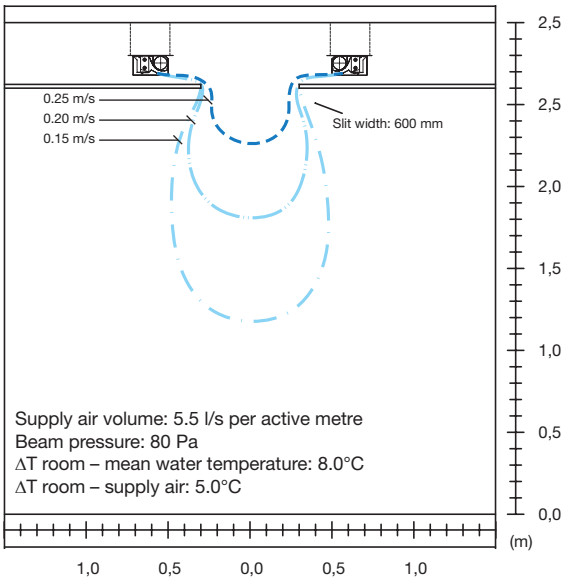


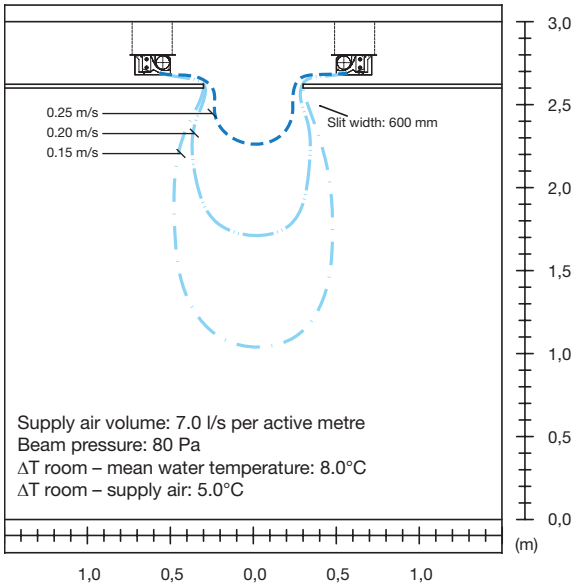
Figure 11 - 14. Air velocities, wall-to-wall suspended ceiling with slits along walls.

Active chilled beam Celo

Distribution diagrams, Celo







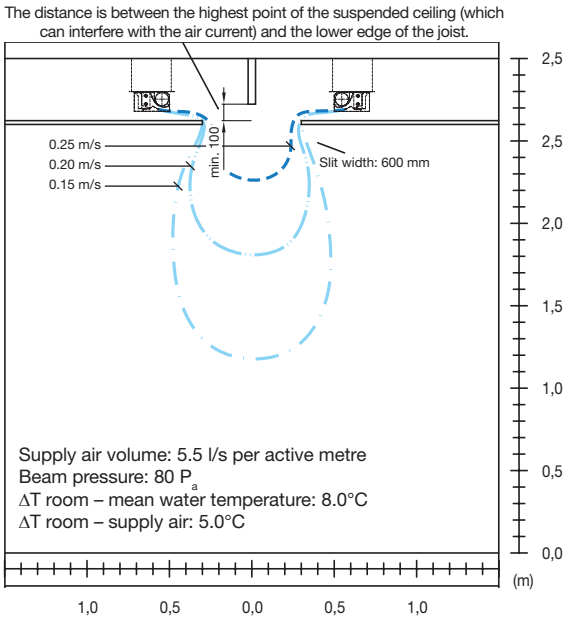


Figure 15 - 18. Air velocities, suspended island installation

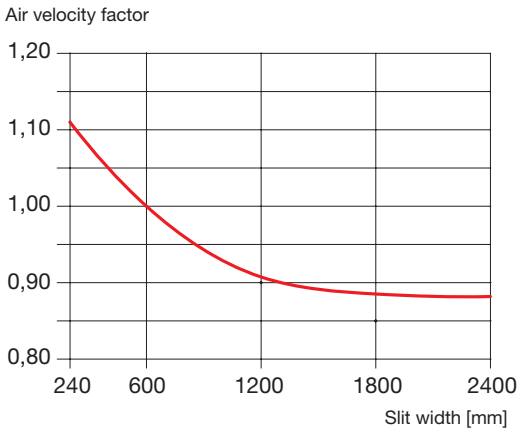


Diagram 6. With a slit width of 600 mm, the air velocities shown above apply for suspended islands. When the slit width is less than 600 mm, the air velocity increases. When the slit is wider than 600 mm, the air velocity decreases.

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Active chilled beam Celo

LindQST - just a click away

The Lindab Quick Selection Tool, lindQST®, is a very fast, easy-to-use and flexible online tool for your daily work.
Calculate the Celo here

Picture 5. LindQST - Indoor Climate Designer

LindQST® helps you select the right waterborne products, e. g. active chilled beams, passive radiant chilled beams, radiant cooling- and heating panels and fasade units and quickly finds the corresponding documentation.

In *Waterborne Documentation* you can easily find all available product documentation. Always in the latest version.

In *Waterborne Calculator* you can do a professional calculation based on your specific input data to finetune your choice or calculate different variants of the product. Smart warnings piont out if a set-up will not work.

In *Waterborne Selector* you can compare the proposed products according to your specific reguirements and select the one which fits best to your needs .

Not enough? With *Indoor Climate Designer* you can insert your selected waterborne product into your room and simulate the actual air distribution, optimize the placing in the ceiling taking into account the calculated air velocities and sound levels.

You can at anytime display your selection and calculations graphically. In addition, you can print or save all results and related documents for your documentation (incl. data sheets, dxf-files and room books).

With lindQST® you will easily find the most suitable product for your project.

It provides an easy and quick access to the latest product information, technical specifications and assembly instructions on the Internet, making it the ideal tool installers, consultants and architects alike.
www.LindQST.com

- Fast product selection waterborne products in accance to Eurovent (chilled beams and facade units).
- Easy access to all current documentation.
- Fast design of waterborne products.
- Indoor Climate Designer: Graphical representation of the spatial situation in 2D / 3D and floor plans from AutoCAD®.
- Calculation of capacities, sound power levels, pressure losses and flow conditions.
- 3D particles or smoke show the air distribution in the room.
- Diagram showing the time course of the CO_2 concentration in the room.
- Room book generation and data sheet for individual rooms and outlets or entire projects.
- Project can be saved and exchanged in its own project area.

Active chilled beam Celo

Control

Lindab offers control equipment that is very simple to use. To avoid heating and cooling being activated, the systems are controlled sequentially (Regula Combi). It is also possible to control only the heating or the cooling (Regula Duo). For the technical data, refer to the chapter Regula.

Designations

Product/Version:	Celo
Connection diam. water, [mm]:	12
Connection dim. air, [mm]:	80
Coupling options. air:	A
Coupling options, water:	1, 3
Air injection direction:	L/R
Length, [m]:	Length in metres
Air quantity, [l/s]:	Must always be specified
Nozzle pressure, [Pa]:	Must always be specified
Distribution profile:	Standard (30°)
Plus features:	See page 5

Programme text

Celo with fan-shaped distribution pattern for concealed installation above a suspended ceiling.

Active chilled beams from Lindab	**Qty**
Product:	
Celo 12-80-A1L-1.8 m	40
Air quantity:	15 l/s
Nozzle pressure:	80 Pa
Plus features:	
Regula Secura	
Regula Connect	
Accessories:	
Regula Combi:	20
Control valve, cooling	20
Actuator, cooling	20
Product:	
Celo 12-80-A1R-1.8 m	20
Air quantity:	15 l/s
Nozzle pressure:	80 Pa
Plus features:	
Regula Secura	
Regula Connect	
Accessories:	
Regula Combi:	10
Control valve, cooling	10
Actuator, cooling	10
Accessory installation components:	
Suspension wire, 0.5 m:	160

Order code

Product	**Celo**	**12**	**80**	**A1R**	**1.8**	**80**	**15**
Water connection:							
12 mm							
Air connection:							
80, 2x80 (opposite end)							
Connection type:							
A1L, A1R, A3L, A3R							
Product length:							
1.2 m - 3.6 m (In steps of 0.1 m)							
Static nozzle pressure (Pa):							
Air volume (l/s):							

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Most of us spend the majority of our time indoors. Indoor climate is crucial to how we feel, how productive we are and if we stay healthy.

We at Lindab have therefore made it our most important objective to contribute to an indoor climate that improves people's lives. We do this by developing energy-efficient ventilation solutions and durable building products. We also aim to contribute to a better climate for our planet by working in a way that is sustainable for both people and the environment.

Lindab | For a better climate