

PERSONALISED VENTILATION

Project Planning Guide for existing installations



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EXHAUSTO

FOR A BETTER FLOW



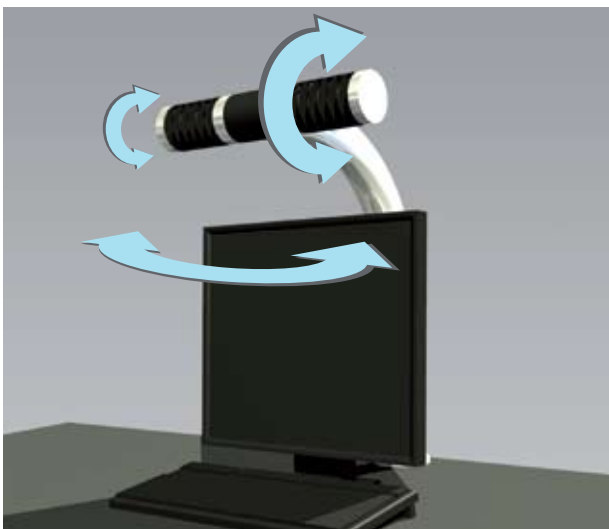
Project Planning of existing ventilation installations with Personalised Ventilation

This Project Planning Guide describes how Personalised Ventilation (PV) can be added to existing CAV and VAV/DCV ventilation installations.

If the individual employee is able to make adjustments to their own microclimate, they create their own indoor climate experience and, by implication, his own best working capacity and performance. This adjustment may include changing air direction, both horizontally and vertically, and airflow between 0 and 10 l/s (36 m³/h), to suit the individual user. However, never more than 8 l/s is specified for each Personalised Ventilation air transfer device, as 10 l/s is only desirable for a very short interval in extreme circumstances.



The airflow can be variably adjusted between 0–10 l/s (36 m³/h) using the desktop regulator.



PV-AirZone-200 device. Air direction is adjusted either by moving the nozzles up/down or by rotating the device to the right/left, until the required air direction is achieved. It is important that the air comes up from the nozzles and down into the face. This ensures it breaks through the convectional air current that lies along the body, and thus the face is enveloped in clean air.



In addition to Personalised Ventilation, we recommend that the room is also equipped with standard room ventilation. This is partly because the airflow from Personalised Ventilation may be anything between 0 and 10 l/s and will fluctuate a great deal throughout the day, and partly because 10 l/s ventilation will often be insufficient to remove excess heat from the room. Personalised Ventilation on its own will **not** normally be sufficient to maintain the required indoor climate **beyond** the personal zone of operation.

When connecting Personalised Ventilation to existing ventilation installations, special attention must be given to the following:

Special conditions	Possible solutions
High pressure in duct ($p > 70$ Pa)	Zone division and constant pressure control of the PV branches
Variable pressure	Connect PV in a different location in the duct system. If required fit a constant pressure regulator
Supply air temperature too low ($t < 18^{\circ}\text{C}$)	Connect PV before any cooling coil in the duct system
PV airflow $< 10\%$ of room air from the CAV unit	Check the ceiling fittings sound level at 70 Pa
PV airflow $> 10\%$ of room air from the CAV unit	A separate zone with pressure control for PV is made
Warm air installation	Connecting PV to an installation where the air temperature is greater than 26°C is not recommended.

Airflow Calculation

When connecting Personalised Ventilation to existing installations, the airflow in the room should be measured and checked against the actual requirements. Airflow requirements can be calculated according to DS/EN15 251.

If the airflow is found to be insufficient, the existing ventilation installation should be checked to see if it can be upgraded.

Even if this is not possible, Personalised Ventilation will still significantly improve an individual's microclimate. For the latest research findings see last page.

In 1981, the Danish Standard DS447 stipulated that a 10 l/s airflow was an acceptable level of ventilation for an office, even for an office where smoking was permitted.

Research into indoor climate and new European indoor environment Standards DS/EN15 251 and DS/EN13 779 require a greater airflow, depending on the kind of indoor climate required and the materials used in the building concerned. In addition, the cooling requirement of the room may now also be decisive for total airflow.

Room airflow according to DS/EN15 251 calculation:

The example below is for an office with an area of 60 m²/150 m³ with six people.

The room is built using materials within the "Non low-pollutant building" category and the required indoor climate level is DS/EN15 251 Class 2.

1. Total airflow is checked against the required air quality for the room, using DS/EN15 251 table B3.

Indoor environment class 2

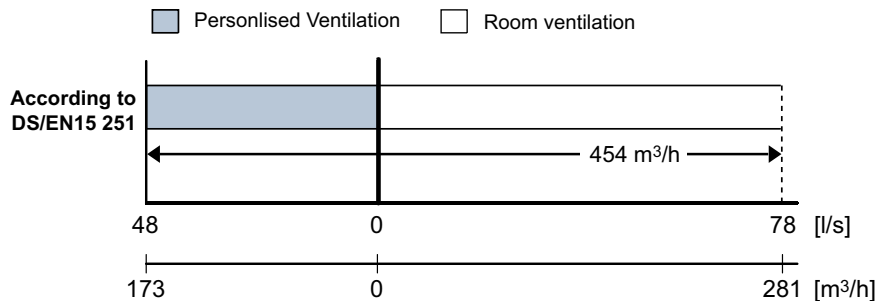
$$\Rightarrow 7 \text{ l/s} \times 6 \text{ people} = 42 \text{ l/s}$$

"Non low-pollutant" building

$$\begin{aligned} \Rightarrow 1.4 \text{ l/s} \times 60 \text{ m}^2 &= 84 \text{ l/s} \\ \text{Total} &= 126 \text{ l/s} \\ &= 454 \text{ m}^3/\text{h} \end{aligned}$$

2. Total airflow for Personalised Ventilation q_{v-PV} is calculated.

$$\begin{aligned} \Rightarrow q_{v-PV} &= 6 \text{ people} \times 8 \text{ l/s} \\ &= 48 \text{ l/s} \\ &= 173 \text{ m}^3/\text{h} \end{aligned}$$



DS/EN15 251:2007 Table B.3

Class	Airflow pr. person l/s	Airflow relative to the pollutant emission of the building		
		Very low-pollutant building l/s x m ²	Low-pollutant building l/s x m ²	Non low-pollutant building l/s x m ²
1	10	0.5	1.0	2.0
2	7	0.35	0.7	1.4
3	4	0.2	0.4	0.8

Connection to an existing CAV unit

A CAV unit is a unit that has constant volume flow. A smaller number of Personalised Ventilation devices can be connected to the unit.

Calculations show that up to 10% of the air from the CAV unit can be 'given over to' Personalised Ventilation, without problems arising.

This can be done by disabling a number of supply air devices or by reducing the airflow in all of the devices.

If the situation arises where all of the Personalised Ventilation devices are closed (an airflow of approx. 1 l/s continues), the pressure loss will increase, as will the airflow across the room's supply air fittings. The sound level across the room's supply air devices should be checked to make sure that the level is acceptable at a pressure loss of approx. 70 Pa.



CAV = Constant Air Volume

Constant airflow (the ventilation unit operates in one zone and the control of the entire installation is achieved, for example, using motion sensors or a timer)

When commissioning, make sure the Personalised Ventilation airflow is around 8 l/s when all of the air transfer devices are fully-open.

Connection to an existing VAV/DCV unit

VAV/DCV units are installations that are pressure-controlled. Connecting Personalised Ventilation requires that the following guidelines are observed:

- The ventilation installation must be able to deliver the required airflow (room and Personalised Ventilation) without the specific pressure loss in the duct system being greater than approx. 1.5 Pa/m
- The pressure in the duct system from the first to the last branch that has Personalised Ventilation must not be greater than 40% of the required pressure in the duct (approx. 30 Pa at 8 l/s + pressure loss in the service column/connection duct approx. 40–60 Pa)

The installation must be divided up into several zones with individual pressure control if the 40% rule cannot be maintained. A Lindab service column can be supplied with built-in pressure regulator, for up to six Personalised Ventilation devices.

If the above guidelines are followed, then the airflow across the devices will be within +/- 15%, as described in the DS 447 - the Standard for Ventilation Systems.

The new duct system for Personalised Ventilation must be sized according to the information in this guideline.



VAV = Variable Air Volume

Variable airflow (large/small air volume, usually achieved by means of motion sensors, timers or similar methods)



DCV = Demand Controlled Ventilation

Demand-controlled ventilation (usually determined by temperature and/or CO₂ sensor)

Air balance

If there are many PV devices in the zone, it is recommended that the zone extraction is regulated with a volume-flow regulator, which is connected in a master/slave connection to a volume-flow unit in the supply. This will ensure that airflow to and from the zone is equal.

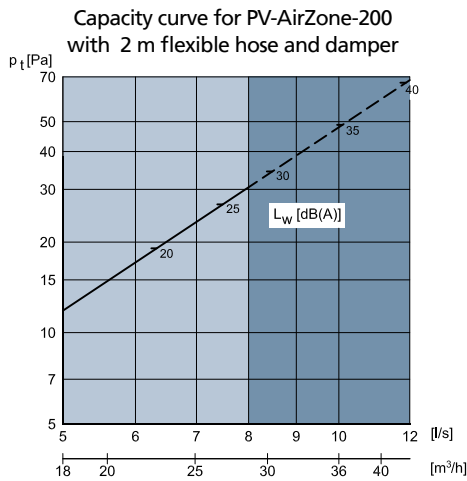
Duct sizing at a glance

When sizing the duct system for a VAV/DCV unit, it is important that there is more or less equal pressure in all of the distribution ducts, so that the required supply airflow is achieved in the individual room ventilation devices and the Personalised Ventilation devices.

It is also very important to use supply air devices that have more or less the same pressure loss as the Personalised

Ventilation devices (approximately 30 Pa at 8 l/s + pressure loss in the connection duct/service column approx. 40–60 Pa).

If the installation's size makes this impossible then it must be either subdivided into zones or fitted with a decentralised constant pressure control for Personalised Ventilation. A Lindab service column can be supplied with built-in damper and constant pressure control.



Sound level dB(A) at 0.5 m with atmospheric sound dissipation in a room with 6 Personalised Ventilation devices and a room sound attenuation of 12 m²-Sabin:

$$L_{p(A)} = L_{w(A)} - 4 \text{ dB}$$

Example: 8 l/s

$$L_{w(A)} \text{ read} = 28 \text{ dB(A)}$$

$$L_{p(A)} = L_{w(A)} - 4 \text{ dB} = 28 - 4 = 24 \text{ dB(A)}$$

Recommended range

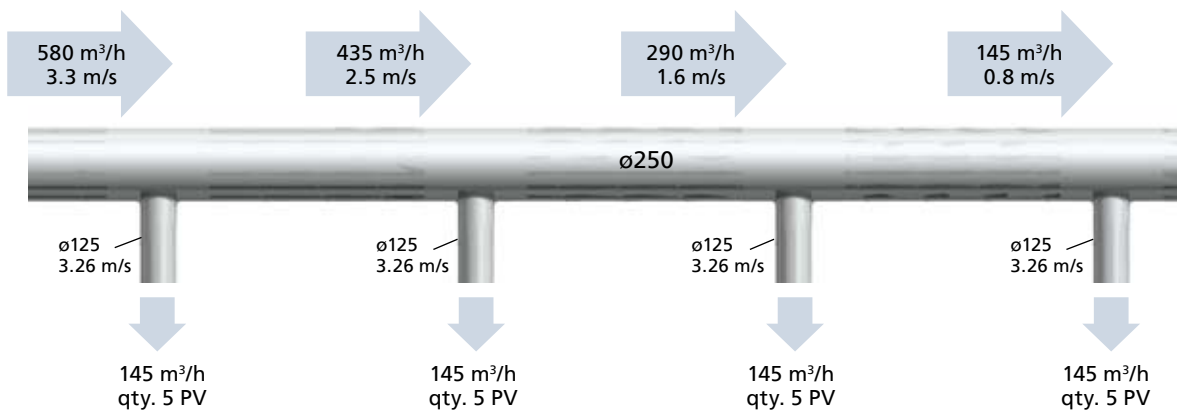
Sizing the duct system for Personalised Ventilation.

When specifying the duct system, maintaining a minimum variation of static pressure between the first and last branches in the distribution duct is recommended. Further, reducing

specific pressure loss to approximately 1.0–1.5 Pa/m of duct is recommended to minimise energy consumption. This is best achieved using one of the following two methods:

Method 1 - Avoid changing duct sizing

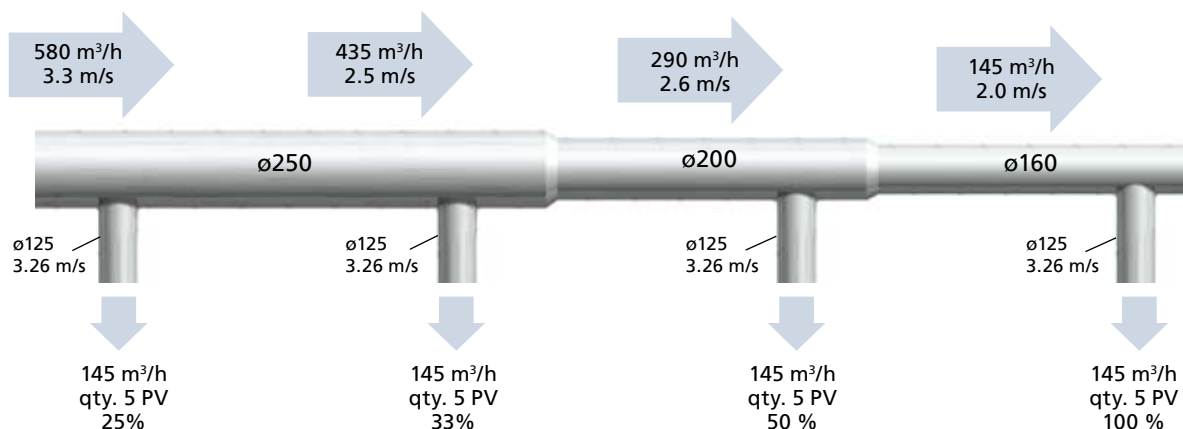
Example of sizing VAV/DCV unit with no changes in duct diameter.



Duct sizing at a glance - continued

Method 2 - the 30% method

The duct diameter remains the same as long as airflow in each duct branch is less than 30% of the airflow in the duct just before it. If the branch airflow accounts for more than 30% of airflow in the duct just before it, duct diameter is reduced by one size. At each subsequent branch, the duct is reduced one size.



Pressure loss in the distribution duct from the first to the last branch should not exceed 40% of the static pressure required in the duct.

At a glance - Table

If many Personalised Ventilation devices share a single duct section, use the "at a glance" table.

Duct sizing	No. of PV devices at 8 l/s	Max. duct length [m]
$\varnothing 63$ mm	1	5*
$\varnothing 80$ mm	2	6
$\varnothing 100$ mm	3	10
$\varnothing 125$ mm	5	11
$\varnothing 160$ mm	8	16
$\varnothing 200$ mm	13	18
$\varnothing 250$ mm	20	27
Lindab $\varnothing 100$ mm ventilation service column	4	2.8
Lindab $\varnothing 125$ mm ventilation service column	6	2.8
Manifold box $\varnothing 125$ mm / 4 x $\varnothing 63$ mm	4	0.2 x 0.2 x 0.1
Manifold box $\varnothing 125$ mm / 6 x $\varnothing 63$ mm	6	0.2 x 0.2 x 0.1

* Corresponding to approximately 2 m flexible hose

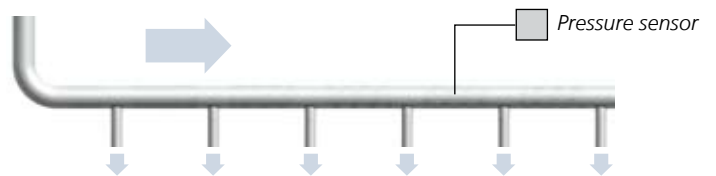
Temperature and Pressure Control

When Personalised Ventilation is utilised, the recommended level for supply air temperature is no lower than approx 18–20°C. It is important to remember that there will usually be an air temperature increase of 2–3°C in the ventilation ducts, which means that the supply air temperature permitted will be approximately 16–18°C.

Duct sizing (described previously) and the size of individual zones are very important when ensuring the correct airflow in all of the ventilation devices. If EXHAUSTO guidelines are followed, the airflow variation from the first to the last device will, under normal circumstances, remain within the range +/- 15%, permitted by DS447.

Pressure controller(s) must be fitted as follows:

- If there is more than 40% variance between the pressure in the distribution duct between the first and last branch, the unit must be subdivided into zones. Each zone must be fitted with its own constant pressure control
- The pressure sensor will most often be positioned 2/3 down the length of the duct system

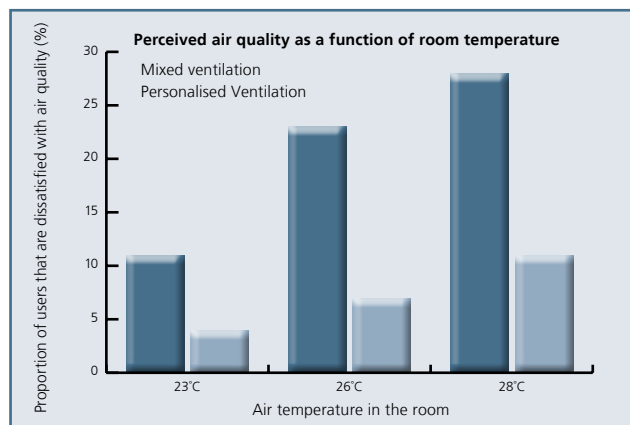


Saving Energy with Personalised Ventilation

Once you have installed Personalised Ventilation, the principle of room temperature not being too high becomes less important. Research carried out at DTU/ICIEE* has indicated that people working at room temperatures of up to 28 °C are no less satisfied with the indoor environment, as long as the supply air temperature to Personalised Ventilation is at 23°C or lower.

This means that it is possible to save on energy used for cooling as the need to lower room temperature is far less important when there is Personalised Ventilation. The potential savings may be calculated for the individual room, using, for example, simulation software.

Below is a simple calculation of saving, assuming that an increase in the room's CO₂ concentration of 200 ppm is acceptable.



Perceived air quality. People are far more satisfied with Personalised Ventilation than standard ventilation. In the test, the supply air temperature for Personalised Ventilation was 23°C.

Example of airflow reduction/saving with Personalised Ventilation and DCV control

A Call Centre without Personalised Ventilation:

20 people, CO₂ production = 20.4 l/h x person
 CO₂ level in the room = 858 ppm
 Calculated airflow = 223 l/s (803 m³/h)

A Call Centre with Personalised Ventilation:

20 people, CO₂ production = 20.4 l/h x person
 Acceptable CO₂ level in the room = 1,058 ppm
 Calculated airflow = 160 l/s (576 m³/h)

Airflow reduction: 223–160 l/s = 63 l/s (227 m³/h) ~ 28% less airflow.

It is important to measure exactly how much room temperature increases when the airflow is reduced because room temperature should only briefly exceed 26–27°C

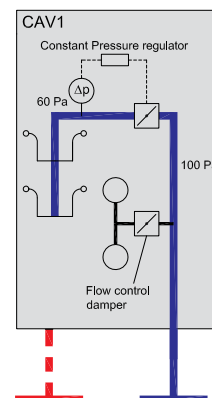
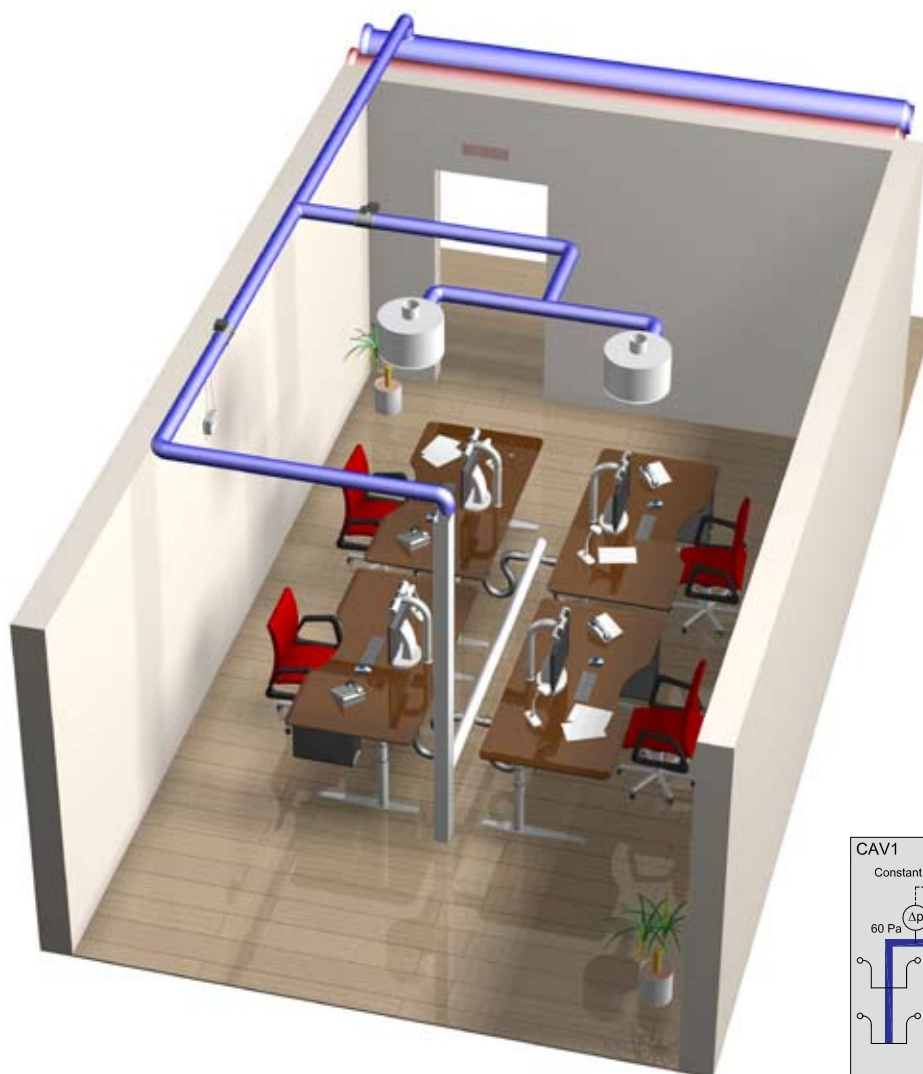
* DTU/ICIEE - International Centre for Indoor Environment and Energy - www.ie.dtu.dk

Ventilation of office facility using Personalised Ventilation – CAV1

The examples shown below illustrate how Personalised Ventilation can be fitted to existing ventilation installations, including air transfer devices, pressure regulators etc. Note that a DCV unit can save energy, because with Personalised Ventilation installed, a higher room temperature/CO₂ level is acceptable.

The supply air is fed to the Personalised Ventilation via a freestanding Lindab \varnothing 100 mm ventilation service column, which can supply max. 4 Personalised Ventilation devices. The room ventilation is achieved using ceiling fittings with fixed airflow.

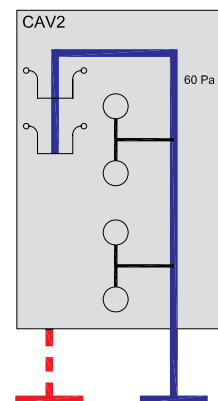
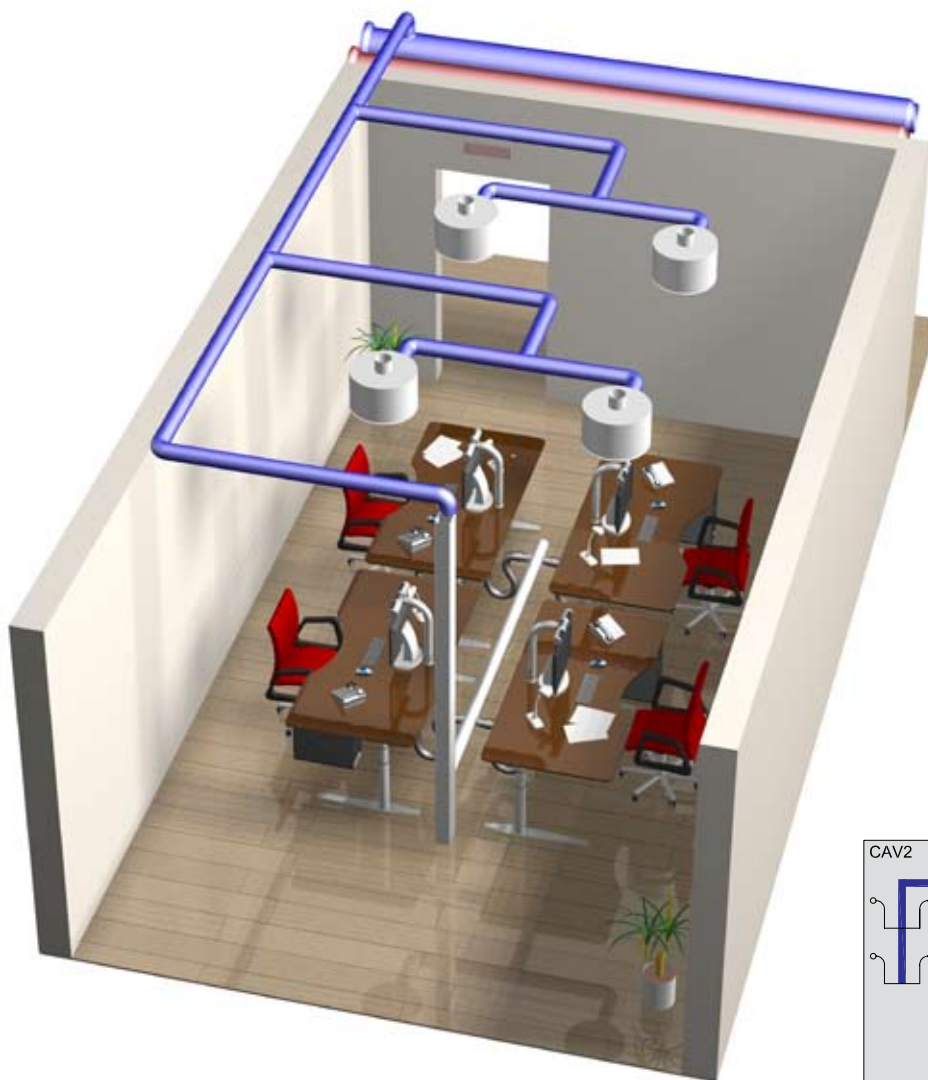
There is a relatively high pressure in the distribution duct (100 Pa). There is a regulating damper on the room air branch. The Personalised Ventilation is connected to the existing duct system via constant pressure control.



Ventilation of office facility using Personalised Ventilation – CAV2

The supply air is fed to the Personalised Ventilation via a freestanding Lindab $\varnothing 125$ mm ventilation service column, which can supply max. 6 Personalised Ventilation devices. The room ventilation is achieved using ceiling fittings with fixed airflow. There is a large rate of air replacement in this room. The Personalised Ventilation takes up less than 10% of the room air. The pressure in the duct system is more than sufficient for pressure requirements (approx. 60 Pa) across the Personalised

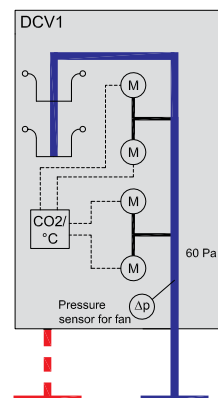
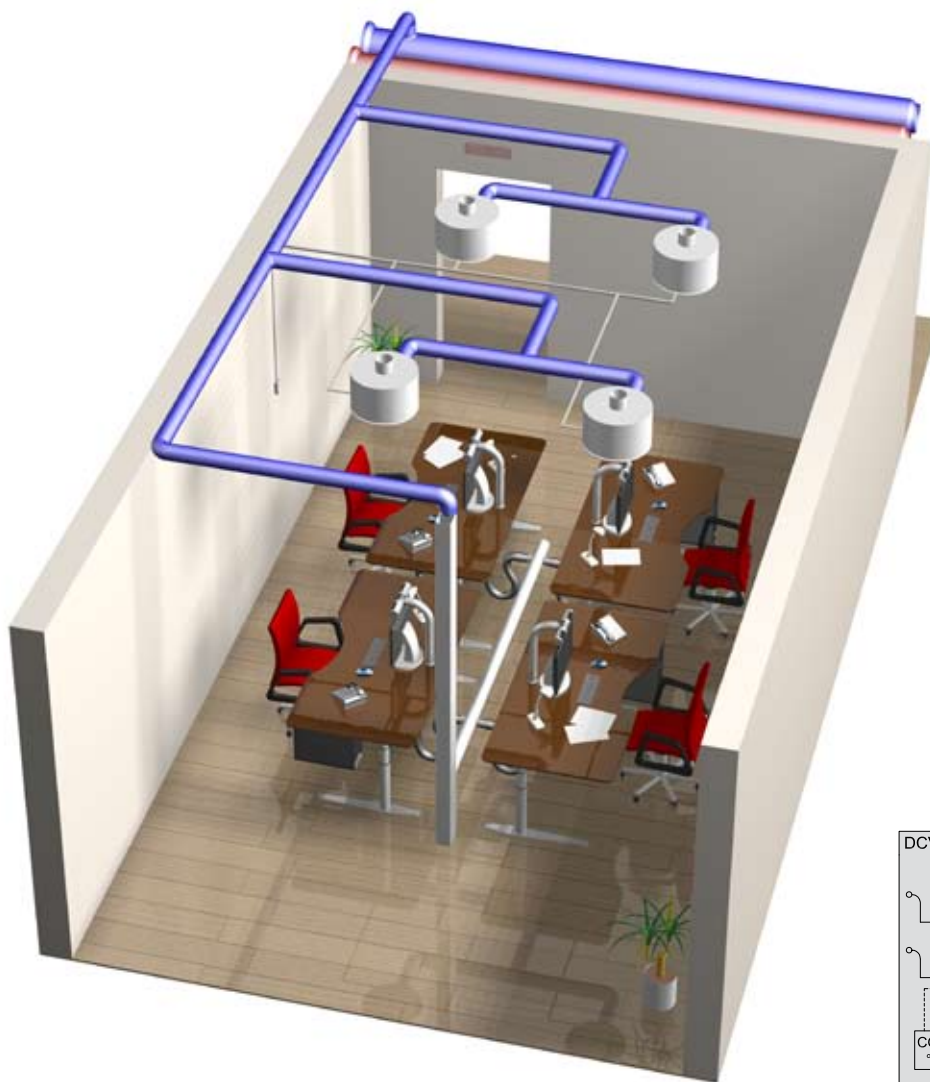
Ventilation. So the Personalised Ventilation is directly connected to the existing duct system. If all of the Personalised Ventilation devices are closed (an airflow of approx. 1 l/s continues), the pressure in the duct system will increase, as will the airflow across the ceiling fittings. The sound level across the ceiling fittings should be checked to make sure that the level is acceptable, approx. 70 Pa.



Ventilation of office facility using Personalised Ventilation – DCV1

The supply air is fed to the Personalised Ventilation via a freestanding Lindab $\varnothing 125$ mm ventilation service column, which can supply max. 6 Personalised Ventilation devices. Ceiling fittings with adjustable airflow cool the room, and are regulated by the CO₂/temperature sensor. A large rate of air replacement in this room is required to achieve sufficient cooling during the summer.

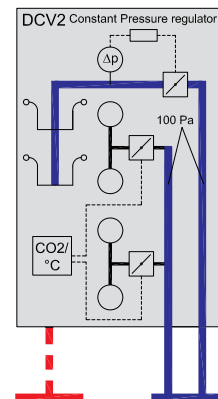
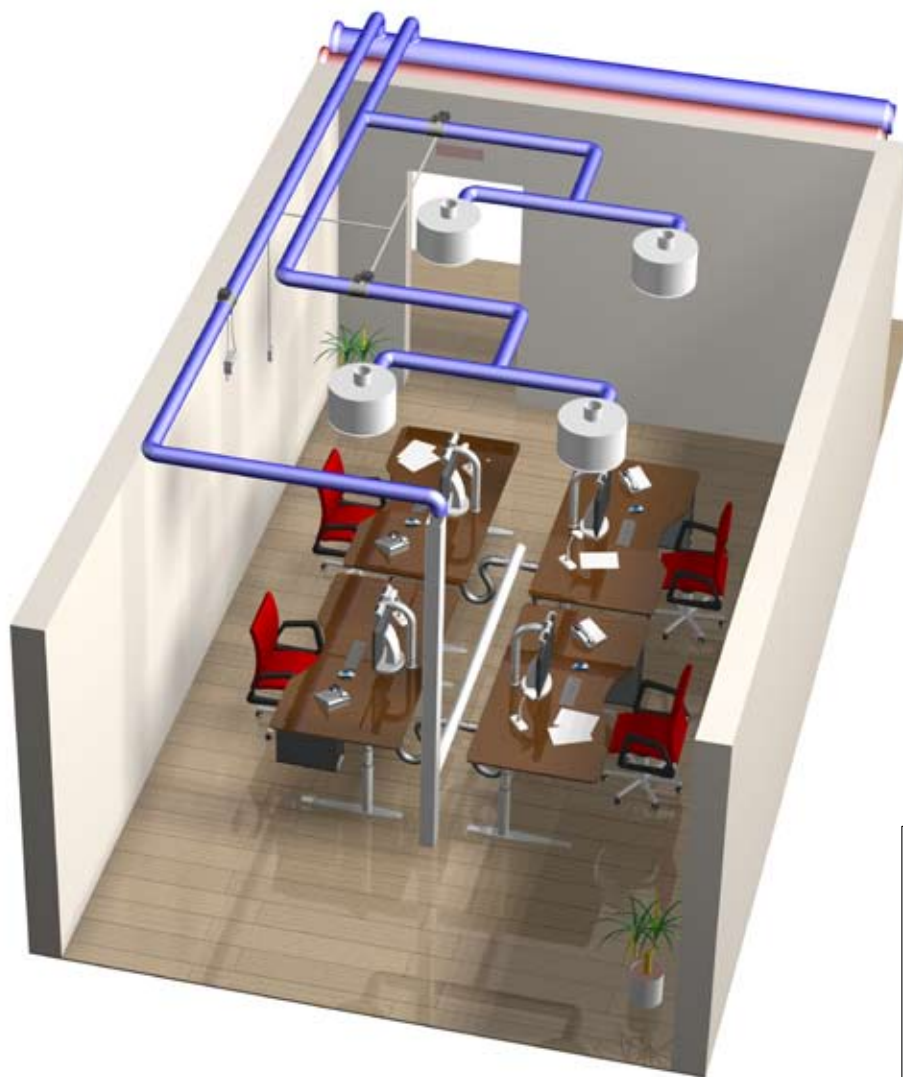
The pressure in the duct system is more than sufficient for pressure requirements (approx. 60 Pa) across the Personalised Ventilation. So the Personalised Ventilation is directly connected to the existing duct system.



Ventilation of office facility using Personalised Ventilation – DCV2

The supply air is fed to the Personalised Ventilation via a freestanding Lindab $\varnothing 125$ mm ventilation service column, which can supply max. 6 Personalised Ventilation devices. Ceiling fittings with adjustable airflow cool the room, and are regulated by the CO₂/temperature sensor. A large rate of air replacement in this room is required to achieve sufficient cooling during the summer.

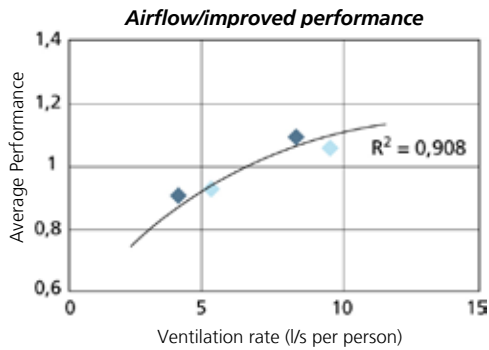
There is a relatively high pressure in the distribution duct (100 Pa). There is a zone damper on the branch for room air, which is regulated by the CO₂/temperature sensor. Personalised Ventilation is connected to an existing duct system via separate constant pressure control.



Why Personalised Ventilation?

Professor Arsen Melikov of the Technical University of Denmark (DTU) International Centre for Indoor Environment and Energy (ICIEE) has researched into Personalised Ventilation for the past ten years.

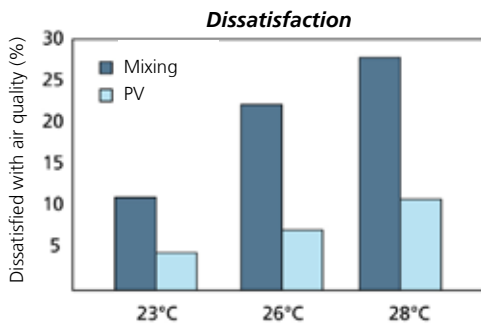
Professor Melikov's research has involved close to 500 students and more than 4,500 hours testing the characteristics of Personalised Ventilation. Some of the professor's results are illustrated below.



Airflow/improved performance curve. Many research projects have produced interesting results about the effects of improving an indoor environment.

Increasing airflow from 5 l/s to 10 l/s per person has been shown to bring an average improvement in performance of more than 20%. Is providing a greater airflow per person an expensive option?

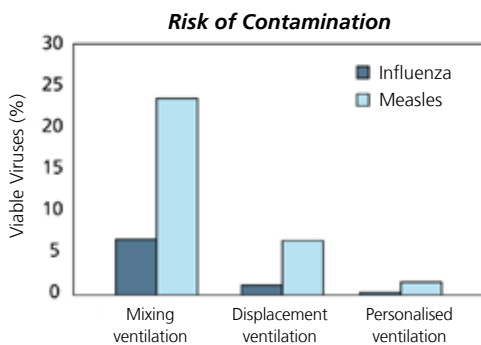
No. Research has shown that the cost of running and maintaining technical installations in a building accounts for less than 1% of the total expenditure per employee and per work station, including salary, amortisation of buildings, etc. In fact, ensuring the correct airflow to employees is an extraordinarily profitable investment.



Personalised Ventilation also makes it possible to save on energy for cooling as room temperature does not have to be maintained at a low level.

At room temperature 23 °C, only approximately 3.5% people with PV are dissatisfied with the indoor environment, whereas approximately 11% people in mixed ventilation are dissatisfied. It's worth mentioning here that thousands of tests have shown that it is simply not possible to create an indoor environment with which more than 95% of people are satisfied. Impossible, that is, until PV was invented.

The light blue columns show that, at room temperature 28 °C, only about 10% will be dissatisfied with an indoor environment with PV, compared to 28% with mixed ventilation.



Viral and bacterial contamination between colleagues in an office depends on a great number of different factors, of which the ventilation system is just one. Here too, tests indicate that Personalised Ventilation has many advantages. The graph shows that, with PV, the spread of vital vira and bacteria between two work stations is significantly reduced.



Source: International Centre for Indoor Environment and Energy
ICIEE - www.ie.dtu.dk



Facts about EXHAUSTO Personalised Ventilation

- Satisfied employees
- Superior job performance
- Sickness absence reduced
- Aesthetically pleasing installation
- Extraordinarily profitable investment
- Airflow at 8–10 l/s per person
- Constant pressure regulated system
- Compatible with VAV and DCV systems
- Recommended PV air temperature 18–23 °C

