Mixing ventilation

In order that the highest possible exchange of supplied air can be produced, a thorough analysis of the conditions is required. The air should be supplied so that the whole locality receives an air exchange without producing an increased air velocity in the occupied zone.

The design work can be split into two parts:

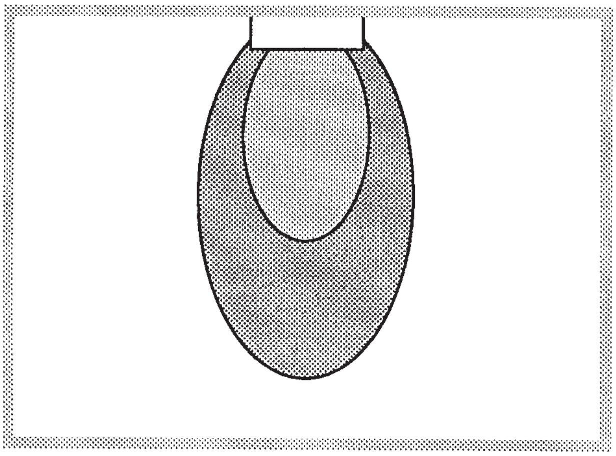
Process analysis

Activity level / Type of occupation

The purpose of indoor ventilation is, in the first place, to provide comfort condition for people. It is therefore important to establish the actual activity level. This gives in turn, the suitable air velocity in relationship to the room temperature in the locality.

Room dimensions

The room dimensions affect the flow patterns and consequently the comfort in the locality. It is important therefore to correct the throw data during planning stages to allow for different room dimentions.



Calculations

Min. flow in accordance with regulations

Ventilation air flow in accordance with regulations is condition which must be included in the calculations.

Energy balance calculations

A calculation where the internal and external loads and als the accumulated energy in the building must lay the grounc for the required cooling load. This together with the comfo demands creates a suitable criteria for choosing suitabl supply air flow.

Resultant air velocity in a room

The devices are selected for a throw with a terminal velocit of 0,3 m/s - 0,6 m/s. For different activities this termin: velocity can be adjusted so that a correct air flow is achieve without creating draught problems in the room. Instructior of how this can be accomplished can be found in this sectioı

Resultant sound level

It is always necessary to carry out a calculation of th resultant sound level of an air device in relation to the actu: sound absorbtion in the room.

Vertical projection

When cooled or heated air is supplied to a locality verticall or with a certain vertical projection angle, the heated ai shortens and the cooled air lengthens the throw dependin on the supply air's density.
This condition can be calculated and a special computer prc gram has been developed for this type of operation. Th flow, the difference between supply air and room air tem perature and the projection angle is given in the program.

Recommended air velocity in occupied zones

Room air velocity should be limited according to room temperature. Graph shows recommended air velocities for different applications. These recommendations are in accordance with DIN 1946 (Deutsche Inductrie Norm) and research carried out by the Swedish National Institute for building research.

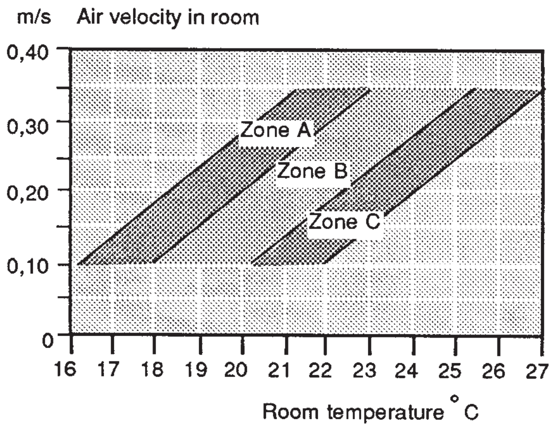
Zone A: Large spaces, people in motion eg. big department stores, hotel, indoor sport activites.

Zone B: Office spare, small shops, schools public buildings.

Zone C: Hospitals, individual hotel rooms.

Example:

For a room temperature of 22°C and rooms in zone C recommended room air velocities are 0.10 - 0.20 m/s (20-40 cfm).



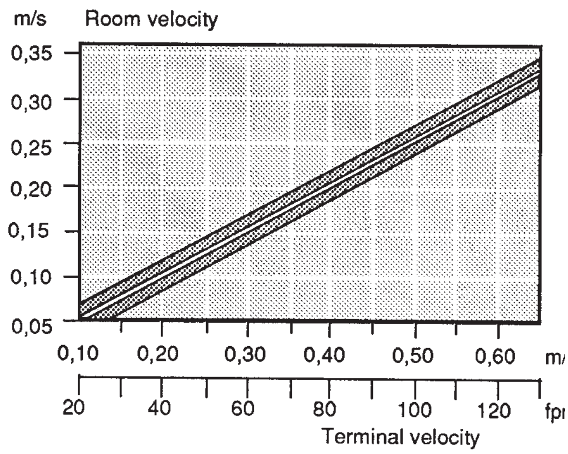
Quick reference to recommended velocities in occupied zones.

Terminal velocities related to velocity in occupied zones

The relationship between the terminal velocity given and velocity in occupied zone can be expressed in a graph. The graph is applicable for cooling differentials up to 12°C and ceiling height of 2.7 m depending on type of diffuser or grille.

Example:

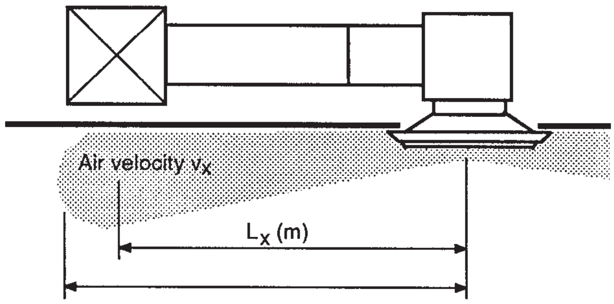
For a terminal velocity of 0.60 m/s (120 fpm) there will be a velocity in occupied zone less than 0.30 m/s (60 fpm).



Calculation of other terminal velocities

The throw L_x at different terminal velocities within a limited zone of the jet core can be calculated as shown.

$$L_x = L0.30 \times \frac{0.30}{v_x}$$



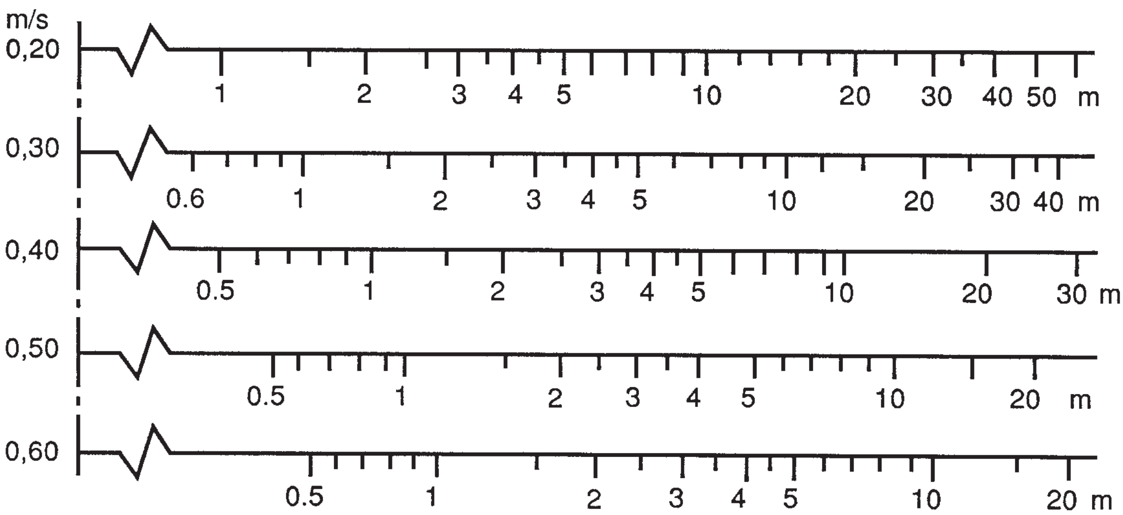
L throw for a terminal velocity of 0,30 m/s (60 fpm)

Example:

An air throw of 5 m with a terminal velocity of 0.30 m/s gives an airthrow of 3.75 m at a terminal velocity of 0.40 m/s ($L0{,}4 = 5 \times \frac{0.30}{0.40} = 3.75$ m)

Nomogram for quick calculation of throws to different terminal velocities.

Throw in m. to a specified terminal velocity.



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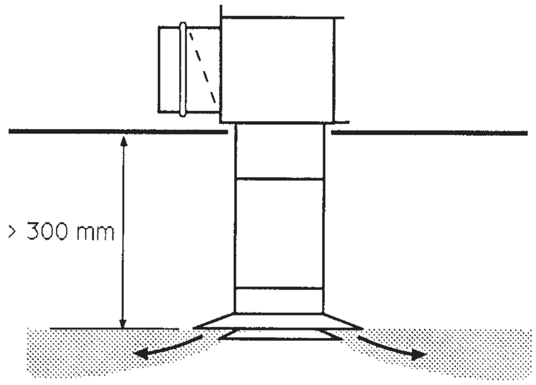
Non standard mounting

The throw data for slot diffusers, cone diffusers and design diffusers are for ceiling mounting. If the diffusers are installed in a freely suspended position, i.e. more than 300 mm from the ceiling, and the jet is directed so that it does not cling to the ceiling. The throw is then reduced because entrainment takes place on both sides of the inlet air jet. The following formula applies:

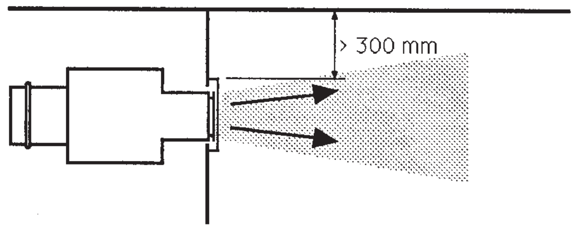
L0.30 suspended = 0.7 x L0.30



Suspended diffuser

The data for grilles is very often for free mounting. If the grille is installed closer to the ceiling than 300 mm, or the jet is directed upwards towards the ceiling, entrainment is not possible on the upper surface of the jet. This extends the flow according to the following formula:

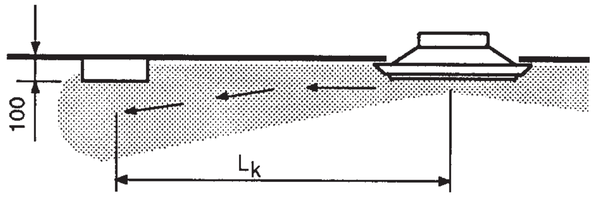
L0.30 to ceiling = 1.25 x L0.30



Free-mounted grille

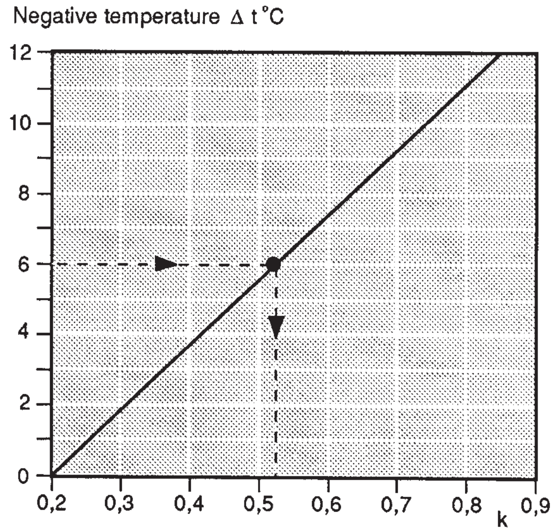
Obstructions in the air jet

Hanging obstructions such as light fittings should not be placed near the supply air device. If however due to architectural reasons the supply air device must be placed near a luminaire, the following relationship applies:



$L_k = k \times l_{03}$

L_k = The smallest distance to obstruction
K = A correction factor depending on the negative temperature.



Example:
A supply air device has a throw $l_{0,3} = 5$ m. With isothermal supply air ($\Delta t \approx 0$°C) a minimum distance to the nearest obstruction of $L_k = 0{,}2 \times 5 = 1{,}0$ m is obtained.

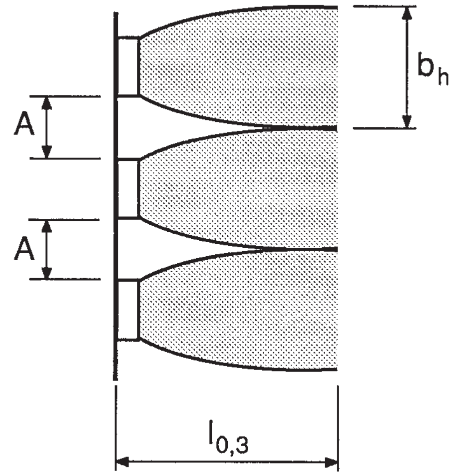
With negative temperature at $\Delta t = 6$°C. The minimum distance to the nearest obstruction is $k \approx 0{,}5 \times 5 = 2{,}5$ m.

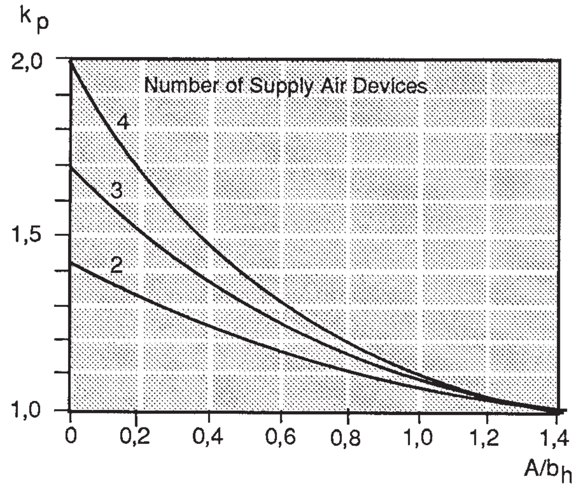
Combining of supply air jets

When two or more supply air devices are installed so close together that their jets merge, the throw is lengthened. This lengthening factor kp, is given in the fig. and is dependent on the supply air device's jet spread (b_h). The jet spread varies for each supply air device and is stated under the heading "Air pattern".

$$b_h = f \times l_{0,3}$$
$$l_p = k_p \times l_{0,3}$$

l_p = resultant throw





Negative temperature supply air

A supply air devices' ability to supply negative temperature air is completely dependent on its' induction ability. That is to say its' ability to mix negative temperature air and room air.

To calculate the cooling capacity (P) with a given air flow (q) use the relationship :

$$P = 1{,}2 \times q \times \Delta t$$

To calculate the air flow (q) with given cooling (P) use the relationship:

$$q = \frac{P}{1{,}2 \times \Delta t}$$

Cooling capacity per surface unit (PA) can be calculated in accordance to relationship :

$$PA = \frac{1{,}2 \times q \times \Delta t}{A}$$

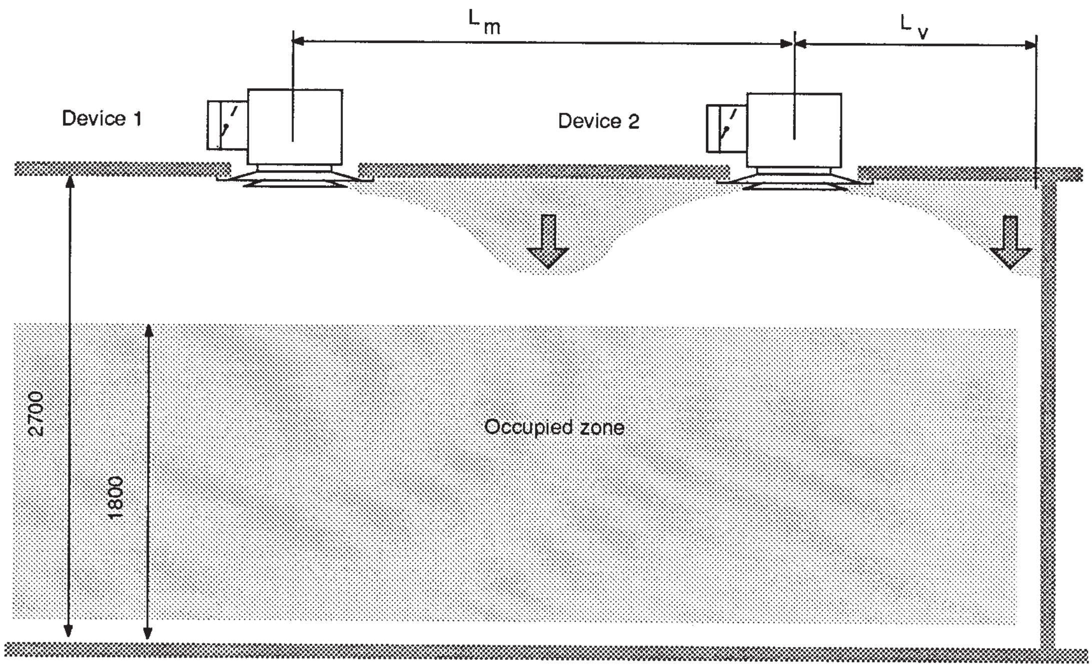
In the above formula:

P = cooling capacity (watt)
q = air flow (l/s)
A = floor area (m²)
Δt = temperature difference (°C) (exh.- sup.)
P_A = cooling capacity per surface unit (W/m²)
1,2 = product of air heating capacity cp (kJ/kg) and air density ρ (kg/m³).

Cooling capacities

The cooling capacities for diffusers and grilles depends on the maximum cooling temperature. The cooling differential is given as max Δt°C for each product.

The minimum distance between supply air devices



The shortest distance between two supply air devices, which have their jets directed at each other, can be shortened due to the cores velocity being higher at the meeting point, without the combined jets velocity in the occupied zone exceeding the required value. This is due to the retarding effect of combining air streams.

$$L_m = k_v\,(l_{03}\,unit_1 + l_{03}\,unit_2)$$

L_m = The smallest distance bewteen air supply units

Example :
Two linear diffusers, each with a throw of 5,0 m and operating with $\Delta t = 6°C$ (Kv = 0.8) $L_m = 0{,}8 \times (5 + 5) = 8$ m.

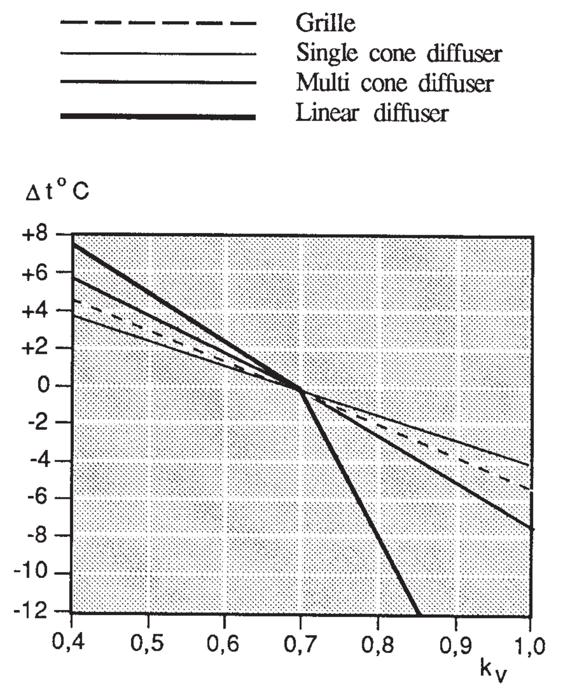


Figure:
The relation between corrections factor k_v and temperature difference for different types of air diffusers.

The minimum distance between supply air devices and a wall

An air jet which strikes a wall is permitted a higher velocity than 0,3 m/s due to the retarding effect and the deflection which occurs.

The following relationship applies:

$$L_v = k_v \times l_{03}$$

Observe that the formula above, does not generally apply for outer walls where convection flow or chilling effect can occur.

Example :
A cone diffuser with a throw of $l_{0,3} = 5,0$ m and $\Delta t = -4°C$ can be placed $L_v = 0,9 \times 5,0 = 4,5$ m from the wall.

Example :
Two linear diffusers each with a throw $l_{0,3} = 5,0$ m and $\Delta t = -6°C$ mounted in a ceiling with height 4,5 m for a distance $L_m = (5,0 + 5,0) \times 0,8 = 8$ m. Calculation of distance $L_{mA} = 8 - (4,5 - 2,7) = 6,2$ m, that is to say the devices can be mounted with a mutual distance of 6,2 m.

The minimum distance between supply air devices with increased ceiling height

The stated throw relates to grilles mounted in a ceiling with 2,7m height. In the case of higher ceiling, the distance between the ceiling and the occupied zone can be considered as a retardation distance for the air jet. The fig. states the relation for the distance between two supply air devices and the distance to the occupied zone.

$$L_m = k_v (l_{03} \text{ unit1} + l_{03} \text{ unit 2})$$

$$L_{mA} = L_m - A$$

where:
$L_{mA} \geq 1,0$ m with $\Delta t \approx 0°C$
$L_{mA} \geq 2,0$ m with $\Delta t = -10°C$

The fig. states relation for the distance between supply air device and a wall which also, can be corrected due to the jet's longer retardation distance.

$$L_v = k_v \times l_{03}$$
$$L_{VA} = L_V - A$$

where:
$L_{VA} \geq 1,0$ m with $\Delta t \approx 0°C$
$L_{VA} \geq 2,0$ m with $\Delta t = -10°C$