



Mixing ventilation

The target of mixing ventilation applications is to diffuse the supply air draughtlessly into the space so that the thermal conditions and eventual contaminant concentrations are uniform either in the entire space or in a specific zone of the space (e.g., the occupied zone).

The air flow rates are typically defined using heat or humidity balance calculation. Alternatively, the air flow rate is determined on the basis of the dilution of emitted air contaminants in the space via air exchange.

Naturally, the outdoor air ventilation rates specified in the building codes are respected.

Ventilation efficiency is ensured by effective air diffusion throughout the occupied zone and avoiding undesired stagnant zones and flow of the supply air into the exhaust.

- Sufficient supply and exhaust air flow rates



Air diffusion solutions for various applications in commercial buildings and industrial facilities.

- Diffuser and jet type selection adapted to the operation conditions throughout the year
- Adaptable positioning of supply and exhaust units
- Vertical or horizontal zoning when it is useful to limit the air diffusion into part of the space only

Mixing ventilation

Diffuser types and their selection

The air diffusion is dependent on several factors:

- Air flow rate
- Temperature difference between supply and ambient room air
- Diffuser type, jet type and jet direction
- Diffuser location
- Distance from ceiling and walls
- Interaction with other air jets and air currents – e.g., convective currents from warm/cold surfaces
- Location of exhaust; only in some cases – avoid short-circuiting

The diffuser type and number are selected to achieve good ventilation effectiveness, acceptable air velocity conditions and comfortable thermal conditions, with acoustic requirements respected.

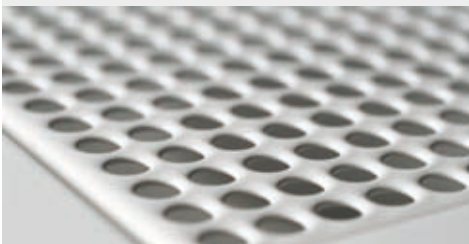
The air diffusion and diffusers have different characteristic features, depending on the application:

- Integrated ceiling installation
- Suspended free installation in the ceiling
- Wall installation
- Floor installation
- Window sill installation

In integrated ceiling and wall installations, jet attachment to the ceiling and the walls is typically utilised, to avoid jet entrainment directly into the occupied zone.

In direct air supply to the occupied zone, the target is to

- Avoid high velocities in cooling applications
- Ensure sufficient jet entrainment to the occupied zone in the heating applications



Perforated diffusers (circular and rectangular)



Jet and multi-nozzle diffusers (circular and rectangular)



Conical diffusers (circular and rectangular)



Swirl diffusers (circular and rectangular)



Linear slot and wall diffusers



Floor diffusers

Jet types

Mixing ventilation applications are realised using the following supply air jet types:



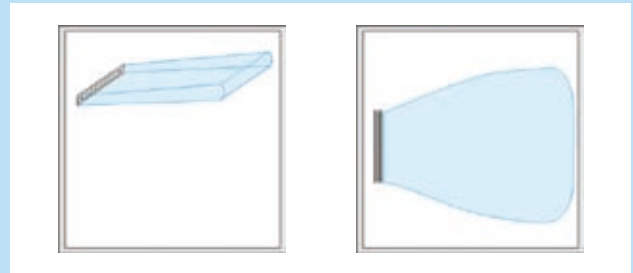
Radial jet



Compact jet



Swirl jet



Plane jet

Jet behaviour varies with

- Jet type
- Horizontal direction of the jet
- Vertical direction of the jet
- Supply air flow rate
- Temperature difference between supply and room air

Other important factors are:

- Interaction with jets from other diffusers
- Interaction with other air flows (convective currents etc.)
- Obstacles in the air flow path

The jet type of certain diffusers can be adapted to the application, such as:

- From radial to compact (swirl diffuser TSA)
- From plane to compact (slot diffuser SLN)

Characteristic values for the air jet

Supply air jet behaviour can be presented using the following design values:

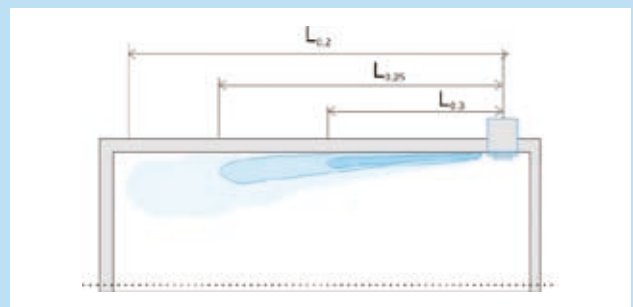
- Throw length $L_{0.2}$
- Distance of jet detachment, L_d
- Minimum distance between diffusers, L_{min}

- Minimum distance to obstacle perturbing the flow, L_{obs}
- Air velocity of the jet entering the occupied zone, v_1 & v_3
- Temperature difference between jet and ambient room air, ΔT_1 , ΔT_3

Throw length $L_{0.2}$

Throw length indicates the distance at which the air velocity of the core of the air jet has reached a specific limit velocity – e.g., 0.2 m/s (other options include 0.4, 0.3 and 0.25 m/s).

Throw length $L_{0.2}$ is normally defined by the diffuser manufacturer in the laboratory setting in isothermal discharge conditions; i.e., supply air temperature is equal to ambient room temperature.



Throw length $L_{0.2}$

Jet directions and jet types

Distance of jet detachment, L_d

The distance of jet detachment (L_d) is the distance from the diffuser centreline at which the air jet detaches from the ceiling and starts to fall downward.

It is useful when cool air is supplied into the space.

Minimum distance between diffusers, L_{min}

The minimum distance between two diffusers, distance, L_{min} , is the minimum distance necessary between diffuser centrelines for achieving air velocities below 0.25 m/s in the occupied zone.

Note that when two jets collide before detaching from the ceiling, they lose their inertial force and the velocity of the jet entering the occupied zone is lower than that of already detached jets.

The following design conditions prevail for L_{min} :

- Room temperature of 24 °C
- Supply air temperature of 18 °C
- Room height of 2.8 m
- Occupied zone height of 1.8 m

Minimum distance between diffuser and flow obstacle

The minimum distance ($L_{obs} \Rightarrow \text{approx. } 0.5 \times L_{min}$) indicates the minimum distance necessary between the diffuser and a flow obstacle deflecting the flow downward in order to achieve air velocities below 0.25 m/s in the occupied zone.

Design conditions as for L_{min} .

The allowed height of an obstacle and distance needed between the obstacle and diffuser in order to avoid critical deflection are dependent on jet type and air flow rate.

Air velocity of the jet entering the occupied zone, v_1 & v_3

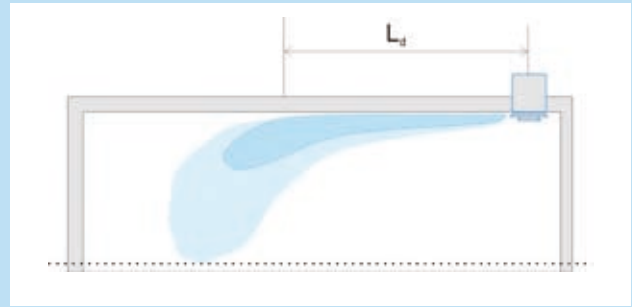
The velocity of the air jet entering the occupied zone, v_1 & v_3 , can be used for estimating the thermal conditions in the occupied zone. The actual design conditions are used, and all critical points can be studied:

- Upper corners of the occupied zone v_{1c} , v_{1b} , v_{3c}
- Jet entering via the top of the occupied zone, v_3

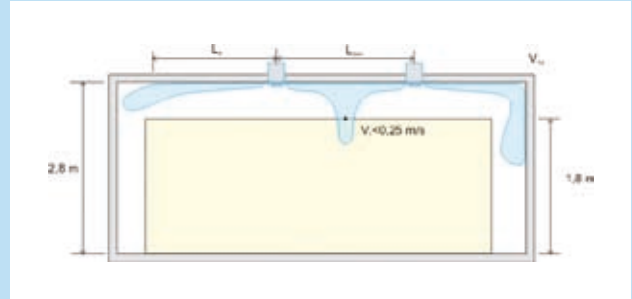
Note that in cases with asymmetrical layout there are eventually several points where the air jets enter the occupied zone.

Air temperature of the jet entering the occupied zone, ΔT_1 & ΔT_3

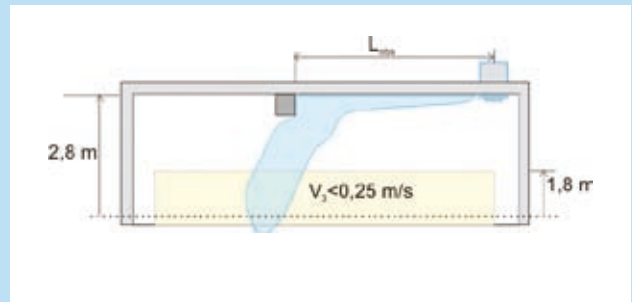
These figures indicate the temperature difference between jet and ambient room air, respectively, at the critical point where the supply air jet enters the occupied zone.



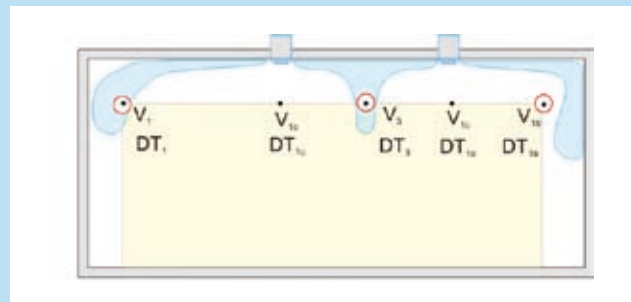
Distance of jet detachment, L_d



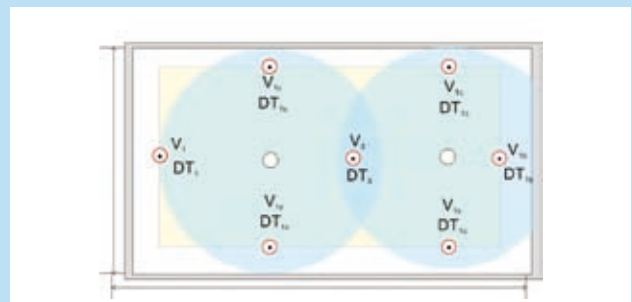
Minimum distance between diffusers, L_{min}



Minimum distance between diffuser and flow obstacle



Air velocity of the jet entering the occupied zone, v_1 & v_3



Air temperature of the jet entering the occupied zone, ΔT_1 & ΔT_3

Quick selection

The quick-selection tables present the following characteristics:

- Throw length $L_{0,2}$
- Distance of jet detachment, L_d
- Minimum distance between diffusers, L_{min}

Throw Length 0,2

The diffuser size is typically selected such that throw length $L_{0,2}$ is 0.9...1.4 times the distance between the diffuser and the wall, depending on the application.

Minimum distance between diffusers, L_{min}

The positioning of diffusers is determined so that the minimum distance between diffuser centrelines, L_{min} , is respected.

Distance of jet detachment, L_d

The diffuser size and design parameters are selected so that

- The jet does not detach from the ceiling and fall directly into the occupied zone

Typically $L_d > 0.8$ times the distance between the diffuser and the wall, depending on the application

Quick selection example

- Room dimensions: 10 x 6 x 2.8 m
- Airflow rate : 160 l/s = 2,7 l/s m²
- Room temperature: 24 °C
- Supply air temperature: 18 °C
- Sound level requirement: <35 dB(A)
- Room attenuation: 4 dB

DKR-200-450 (R4)

- Sound power level: 30 dB(A) >> two diffusers 33 dB(A)
- Static pressure drop: 10 Pa
- Total pressure drop: 13 Pa
- $L_d = 3$ m OK; Distance from diffuser to occupied zone limit = 3.3 m, 2.9 m 2.2 m
- $L_{min} = 2.8$ m OK; distance between diffusers 3.8 m
- $L_{0,2} = 4$ m OK; on both sides of the room (distance to walls: 3.8 and 2.7 m)

qv	Pa	240	360	480	600	720	960	1200	1440	1680	1920	2400	3000
	l/s	20	30	40	50	60	80	100	120	140	160	200	250
	m ³ /h	72	108	144	180	216	288	360	432	504	576	720	900
DKR-125-300(R4)	LpA		26	35	42	48							
	ΔPst		10	18	28	41							
	ΔPtot		14	25	38	55							
	Ld		-	-	-	-							
	Lmin		1,0	1,6	2,6	3,6							
	L0,2		2,2	3,0	3,8	4,6							
DKR-160-300(R4)	LpA		21	29	36	42	51						
	ΔPst		10	18	27	40	70						
	ΔPtot		11	20	31	45	80						
	Ld		2,2	3,0	3,4	3,8	4,8						
	Lmin		-	-	-	-	-						
	L0,2		2,3	3,6	4,6	5,4	7,2						
DKR-160-450(R4)	LpA				22	28	38	46					
	ΔPst				4	6	11	18					
	ΔPtot				8	12	21	32					
	Ld				-	-	-	-					
	Lmin				-	-	-	-					
	L0,2				2,4	3,0	3,8	4,8					
DKR-200-450(R4)	LpA					21	30	37	43				
	ΔPst					5	10	15	22				
	ΔPtot					8	13	21	30				
	Ld				2,6	3,0	3,6	4,2					
	Lmin				1,6	2,8	4,0	5,2					
	L0,2				3,0	4,0	5,0	6,0					
DKR-200-600(R4)	LpA						27	34	41	46			
	ΔPst						6	9	13	17			
	ΔPtot						9	15	21	29			

Diffuser selection using HIT Design software

Acceptable selection is studied :

- Check that L_d is sufficiently long in respect of the room width
- Check that the distance between diffusers is greater than L_{min}
- Check that there are no flow obstacles closer than distance $L_{obs} \Rightarrow$ approx. $0.5 \times L_{min}$ from the diffuser
- Check the air velocity of the jet entering the occupied zone, v_1 & v_3
- Check the temperature difference between jet and ambient room air, ΔT_1 , ΔT_3

DKR-200-450 (R4)

- Total sound pressure level: 33 dB(A)
- Total pressure drop: 13 Pa
- $L_d = 3.6$ m OK; distance from diffuser to occupied zone limit = 3.3 m, 2.9 m 2.2 m
- $v_1 = 0,10$ m/s $v_3 = 0,20$ m/s
- $\Delta T_{v1} = 0,1$ °C $\Delta T_{v3} = 0,5$ °C OK; on both sides of the room (distance to walls: 3.8 and 2.7 m)

Note : The limit velocity of the throw pattern plot is 0,15 m/s.

DKR-200-450(R4)					2005.10
Room: A Room A		Supply air flow:		160 l/s (2 x 80 l/s)	
Room size:	10.0 x 6.0 x 2.8 m		Supply air temperature:		18.0 °C
Room air:	24.0 °C / 50 %		Total pressure drop:		13 Pa
Heat gain:	900 W		Total sound pressure level:		33 L _p Are 10m ² sab
Installation height:	2.80 m		Total cooling power:		1140 W (2 x 570 W)
		L_d :		3.6 m	
vmax in occupied zone:	v1		v3		
v	~0.10 m/s		~0.20 m/s		
▲T	0.1 °C		0.5 °C		
					vlim = 0.15 m/s

