FORUM

Floor swirl diffusers: types and applications

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ABSTRACT

Displacement systems offer energy efficiency and indoor air-quality advantages to commercial offices. Traditional displacement air distribution, however, via wall-mounted or free-standing "bollard-type" perforated displacement diffusers, is bulky and difficult to integrate into the architecture.

Floor-mounted displacement diffusers offer a viable alternative in applications with false access floors. They discharge air horizontally, and often use swirl technology to break down discharge velocities and minimise draughts. Such horizontal-discharge floor swirl diffusers are best suited to low heat-load applications.

Vertical-discharge floor swirl diffusers utilise swirl technology not only for draught minimisation, but also to restrict maximum vertical throw to approximately head height of seated occupants. Such diffusers are suitable for moderate to very high thermal loads, and often include the option of airflow rate adjustability by the user, to personalise the local thermal climate. However, this often compromises thermal comfort due to increased vertical temperature gradients when the airflow rate is reduced (cold feet, warm head). The option of motorised VAV diffuser operation suffers from the same shortcoming.

Directionally inclined floor swirl diffusers offer user adjustability of the localised effective temperature while maintaining a largely constant vertical temperature gradient within the occupancy microclimate by allowing user adjustability of localised air motion rather than of airflow rate. These diffusers are not suitable for motorised VAV operation.

Constant-velocity-discharge floor swirl diffusers maximise user adjustability of the localised thermal environment by providing airflow rate adjustability as well as airflow direction/motion adjustability, and generally do so while maintaining a largely constant temperature up to head height of seated occupants. These diffusers also offer optional motorised VAV operation with mixing – throughout the airflow rate range – largely to head height of seated occupants to prevent "cold feet, warm head", and with user adjustability of air direction/motion for thermal comfort personalisation.

Key words: Underfloor air distribution, UAD, mixed flow, thermal displacement, occupancy microclimate, floor register, air grille, twist outlet, floor swirl diffuser, displacement diffuser, horizontal discharge, vertical discharge, constant velocity discharge, low aspiration, high induction, draught, draft, task/ambient conditioning, TAC, thermal comfort, indoor air quality, IAQ, floor plenum, energy efficiency, free cooling, economiser cycle, raised floor, access floor, HVAC.

1.0 INTRODUCTION

Displacement air distribution has, for many years, been one of the preferred means of cooling and providing fresh air to the occupants of sustainable buildings. This is because the principles of displacement air distribution – of effectively cocooning occupants in freshness – bring with them a host of energy efficiency and indoor climate advantages. However, traditional perforated displacement diffusers are usually difficult to accommodate into typical commercial offices, because they are bulky, and are free-standing (like bollards) or need to be integrated into walls – usually at a low level.

The introduction of false access floors into many commercial offices made it possible to supply displacement air through a less bulky alternative – through floor diffusers fed from the underfloor plenum. This made displacement airflow more viable for commercial offices. Many floor diffusers have been developed for this purpose. Of these, floor swirl diffusers have been the most successful in the office environment.

This article explores the pros and cons of four key floor swirl diffuser technologies and recommends applications for each.

2.0 DISPLACEMENT AIRFLOW

The principles of displacement airflow traditionally involve the supply of air that is slightly cooler than room temperature and of high indoor air quality. This supply air oozes from low-level perforated diffusers with large discharge surfaces, to then gently flood the floor of the occupancy space in a lake of cool, fresh air, which is drawn towards heat sources by rising heat.

The heat sources are enveloped in coolness and freshness as the air rises in plumes of natural convection to then accumulate in high-level stratified layers of heat and contaminants, where it is removed from the space. Occupants are effectively cocooned in a microclimate of approximately 23°C, with the supply air being only marginally lower in temperature, typically about 20 °C. Despite this relatively elevated supply-air temperature (compared to mixed-flow systems) the supply-to-return temperature differential ranges from – 6K for standard commercial ceiling heights of 2.7m to more than -12K in higher spaces. As a result, the fan energy penalty due to the higher supply air temperature is moderate for standard office applications, and in fact turns into a saving when ceilings are high. This is because the vast void beneath high ceilings acts as a thermal reservoir, allowing the stratified layers floating above the occupancy microclimate to capture even more heat, thereby elevating both the air temperature in the void and the supply-to-return air temperature differential.

From the above, the key benefits of displacement air distribution, relative to mixed-flow, can be described as follows:

1. Occupant indoor air quality (IAQ) is enhanced, achieving ventilation effectiveness values of up to 2.0 for seated occupants in typical commercial office applications, which well exceed the values of 0.9 to 1.0 typical for mixed-flow systems[1].
2. Energy savings can be achieved by reducing outdoor airflow rates without compromising indoor air quality.
3. The elevated supply-air temperature provides potential for chillers to operate with increased coefficients of performance (COP).
4. The elevated supply-air temperature enhances free-cooling potential and associated energy savings (there are more days in the year where free cooling at 20°C or less is likely to be available than for, say, 13°C or less, as for a mixed-flow system).

Key disadvantages, however, of traditional displacement, via perforated wall-mounted or free-standing diffusers, are:

1. The supply-to-return temperature differential is relatively low for standard ceiling heights. Increased airflow rates are therefore required, which result in increased duct and fan sizes, as well as increased fan-energy consumption.
2. The perforated displacement diffusers are bulky, typically with about 10 times the face area of comparable mixed-flow diffusers.
3. The cool, dense air oozing from the displacement diffusers creates a waterfall effect once it enters the space, cascading down and accelerating before spreading across the floor. Occupants generally need to be seated well more than 1m away from the diffusers, so as not to be exposed to ankle air velocities in excess of about 0.18m/s, which would result in draughts[1].
4. Low supply-air temperatures may not be used even when heat loads are high, as ankle air temperature may not drop below 21°C in order to prevent the sensation of cold feet[2].
5. A vertical temperature gradient in excess of 2K/m (e.g. a differential greater than 21°C ankle temperature / 23°C face temperature) creates thermal discomfort[1] (the sensation of “cold feet, warm head”) and is a primary limiting factor for the amount of heat that can be removed by displacement airflow.

3.0 FLOOR SWIRL DIFFUSERS FOR COMMERCIAL OFFICES

As the age of computers dawned, so the introduction of false access floors – to accommodate the cabling requirements of computer rooms – provided a path for cool supply air that would satisfy the significant computer cooling demands by complementing natural convection with cool airflow from below and heat removal from above.

Consequently, many varieties of floor-mounted diffusers were developed over the years. Most of the earliest designs were simple, low-aspiration registers that produced strong air motion and draughts. This was acceptable in computer rooms, but by the late ’70s demand in Germany was shifting for underfloor air distribution to also be used in offices[3].

This was so as to meld the draught-free comfort, enhanced indoor air quality and energy-efficiency advantages of traditional perforated displacement systems with underfloor air. Additionally, increased flexibility and reduced life-cycle costs are achievable through the use of raised access floor systems[4].

However, the vigorous, penetrating air streams produced by simple floor grilles created draughts and agitated high-level heat, mixing heat and contaminants back into the occupancy space. This destroyed not only the elevated temperature differential between supply and return air that is required to maximise heat removal with minimal fan energy, but also the cocooned occupancy microclimate that ensures superior indoor air quality.

These systems were plagued with complaints about discomfort and draughts, and it was not until diffusers were properly engineered – using swirl technology to address these problems – that underfloor airflow for offices came into its own.

3.1 Horizontal-discharge floor swirl diffusers

Over the years, a number of floor-displacement diffuser designs have come to the market, the most popular of which typically discharge a gentle, horizontal swirl pattern of up to 30L/s from a 200mm diameter face (Figure 1). The swirl discharge achieves rapid discharge velocity decay, so as to minimise the threat of draughts for nearby occupants. The gentle, horizontal discharge ensures minimal mixing of the supply air with high-level heat and contaminants, thereby maximising indoor air quality, typically achieving a ventilation effectiveness of 1.3 to 2.0 for seated occupants[1].

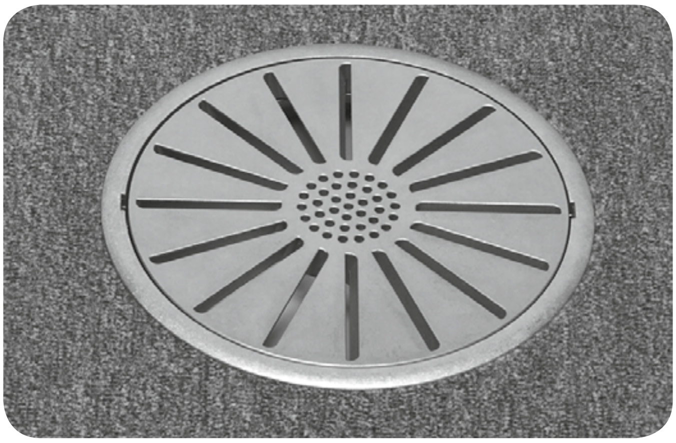
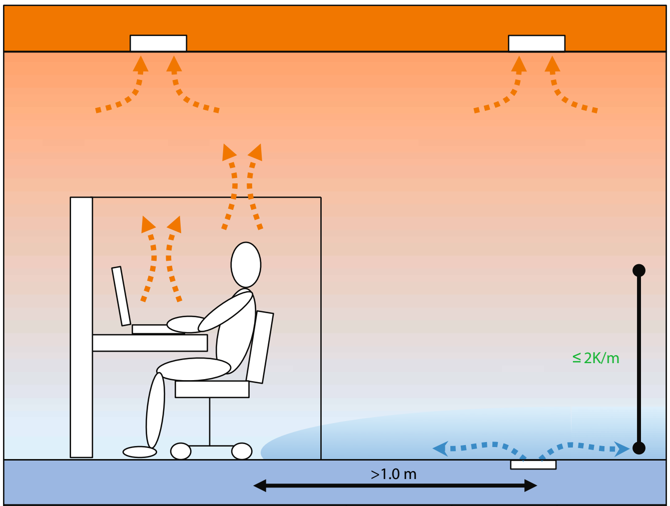


Figure 1

While maximising indoor air quality, horizontal-discharge floor swirl diffusers suffer from the following limitations (Figure 2):

1. A distance of at least 1m from the diffuser to the nearest seat is typically recommended to avoid the threat of ankle draughts caused by the radial spread of the horizontally discharged supply air stream. It is often difficult to realise this minimum distance, especially in confined or multipurpose spaces, such as work stations, meeting rooms or areas for task groups.
2. The low air motion at head height, which results from the airflow pattern being gently directed across the floor, is not suitable for the comfort preferences of all occupants. This is because many individuals prefer perceptible, or even increased localised air motion, and complain about stuffiness when this is not present. This is especially true for the tropics and the Asia-Pacific region as a whole.



Airflow Rate *(% of Constant Velocity Discharge Floor Swirl Diffuser @ Maximum)*	30%	70%	100%
Air Stream Motion – Barely Perceptible			
Air Stream Motion – Gentle			

Figure 2

3. The lake of cool supply air flooding the floor results in the air temperature at the ankles (0.1m height) being less than that at head height of seated occupants (1.1m height). For a standard ceiling height of 2.7m, these systems are typically limited to a maximum specific sensible heat load of about 50 W/m^2 so as to prevent the vertical temperature gradient from exceeding 2K/m, thereby averting the sensation of "cold feet, warm head".

Horizontal-discharge floor swirl diffusers maximise indoor air quality and are well suited to applications with low equipment heat-loads or high ceilings, or centre zones with low occupancy densities. However, the higher equipment heat loads and increased occupancy densities typical of most offices, combined with ceiling heights generally no higher than 2.7m, severely limit the applications where such diffusers may be used.

These diffusers, however, perform better than their upward discharge counterparts when low heat-loads, such as in libraries, require diffusers to be spaced far apart. This is because horizontal-discharge floor swirl diffusers flood the floor with cool air, which then migrates across considerable distances to heat sources that draw this up by natural convection.

3.2 Vertical-discharge floor swirl diffusers

About 30 years ago, the floor swirl diffuser with vertical discharge was invented for the underwriters' area of the iconic Lloyds building at 1 Lime St in the City of London [5, 6], to remove the extremely high heat loads in this space without subjecting occupants to an excessive vertical temperature gradient, and to realise enhanced indoor air quality (typically, vertical discharge floor swirl achieves a ventilation effectiveness of 1.3 to 2.0 for seated occupants[1]).

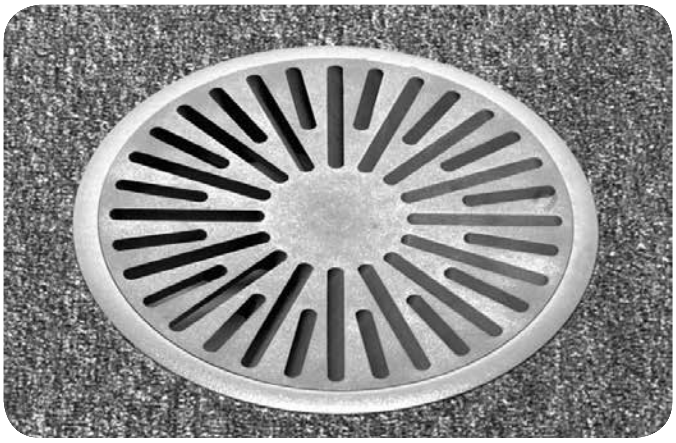


Figure 3

Floor swirl diffusers with a 200mm diameter face (Figure 3) were designed to provide intensely inductive upward discharge, creating mixing up to head height of seated occupants without disturbing the layers of heat and contaminants that stratify above this level. This is because the vertical-discharge floor swirl diffuser brings about rapid discharge velocity decay and quick temperature equalisation of the supply-air stream with the occupancy microclimate air.

Compared to horizontal-discharge swirl diffusers, both substantially higher airflow rates (up to 50L/s) and larger supply-to-return temperature differentials (typically up to – 10 K for 2.7m ceiling height) are achieved. It is possible to remove up to 200 W/sq m in offices with 2.7 to 3.0m high ceilings.

Put differently, in typical office environments, vertical-discharge floor swirl diffusers are able to provide more than three-to-five times the maximum sensible cooling capacity of comparable horizontal discharge (i.e. floor swirl or perforated wall-mounted) displacement systems without subjecting occupants to draughts or to an excessive vertical temperature gradient[1].

The enormous success of the vertical-discharge floor swirl diffuser in this, and other, applications heralded a new era in displacement air diffusion for offices.

Demand for personalised comfort brought in the addition of airflow rate adjustability for the user. The requirement for individual diffuser control, called task/ambient conditioning (TAC), escalated following studies by such leading researchers as Bauman [7], who strongly advocated these systems.

This was especially after investigations by the Buildings Owners and Managers Association (BOMA) [8] in which 1,829 office tenants in the US and Canada were surveyed.

Bauman concluded from this survey: "The only feature to show up on both the list of most important features (96%) and the list of items where tenants are least satisfied (65%) [is the] "tenants' ability to control the temperature".

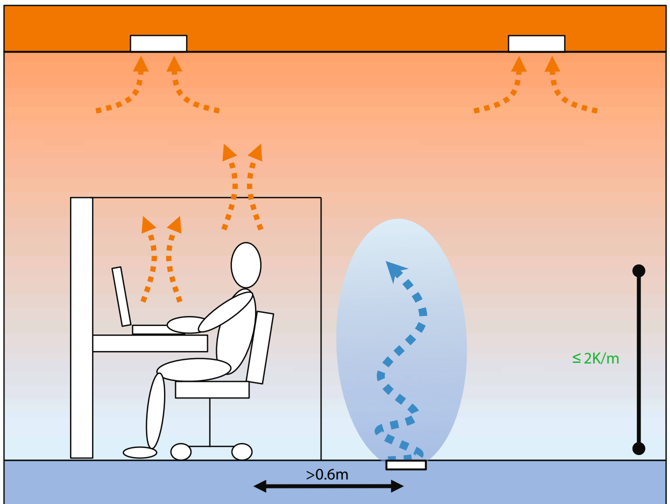
Bauman went on to quote de Deer's [9] findings that building occupants who have no individual control capabilities are twice as sensitive to changes in temperature compared to occupants who do have individual thermal control.

Webster [4] states that underfloor air-distribution systems with user control "offer improved employee satisfaction and productivity by giving employees greater control over their local environment and by improving the quality of indoor environments".

Webster, however, goes on to show that an excessive vertical temperature gradient (i.e. discomfort due to "cold feet, warm head") results if the airflow rate through vertical discharge floor swirl diffusers drops too low. This is because the mixing height of the swirl plume drops to a level substantially lower than head height of seated occupants, thereby subjecting occupants' facial area to the higher temperatures of the stratified zone. This can be caused by user control of diffusers, if users throttle the dampers of vertical-discharge floor swirl diffusers substantially.

Today's vertical-discharge floor swirl diffusers, by various manufacturers, supply highly inductive airflow vertically, and typically offer personalised user adjustability of the airflow rate via manual rotation of the diffuser face (clockwise to throttle the damper; counter-clockwise to open it) thereby satisfying Green Star requirements for user-adjustable credits.

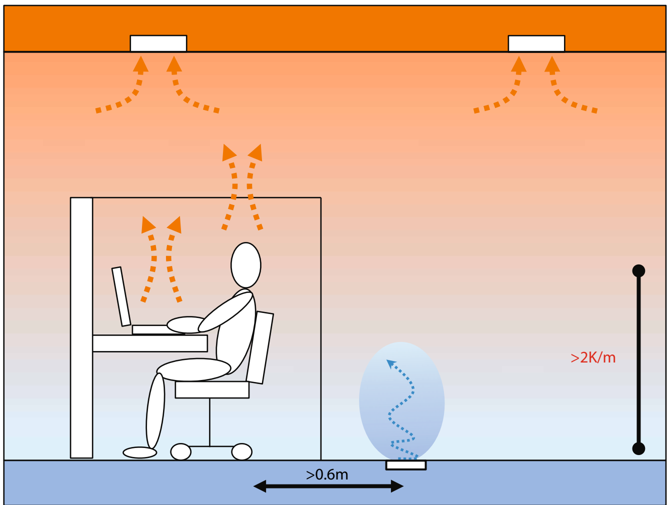
Nevertheless, these diffusers suffer from the following limitations (Figure 4):



Airflow Rate *(% of Constant Velocity Discharge Floor Swirl Diffuser @ Maximum)*	30%	70%	100%
Air Stream Motion – Barely Perceptible			
Air Stream Motion – Gentle			

Figure 4

1. A distance of at least 0.6m from the diffuser to the nearest seat is generally recommended to prevent the radially spreading, vertically discharged supply air plume from clashing with seated occupants. It is often difficult to realise this minimum distance, especially in offices with high occupancy densities or with the flexibility of "plug-and-play" work spaces.
2. The barely perceptible air motion produced by the highly inductive vertical discharge is not suitable for the comfort preferences of all occupants, many of whom prefer noticeable or somewhat increased localised air motion.
3. In order to be effective, substantial airflow rate adjustability is required to personalise the user's local climate via airflow rate adjustment alone, which brings about the following problems (Figure 5):
   a. Substantial throttling of the diffuser airflow rate may result in more air being discharged by other diffusers connected to the same plenum, thereby increasing the likelihood of these diffusers, in turn, also being throttled by occupants who are otherwise likely to suffer from localised overcooling. In other words, a snowball effect of closing diffusers may take place, largely resulting in loss of thermostatic control to the zone due to the system being unable to deliver sufficient air to properly respond to changing thermal loads.



Airflow Rate *(% of Constant Velocity Discharge Floor Swirl Diffuser @ Maximum)*	30%	70%	100%
Air Stream Motion – Barely Perceptible			
Air Stream Motion – Gentle			

Figure 5

   b. The snowball effect of throttling diffusers is detrimental to indoor air quality, as it often causes insufficient fresh air supply to the space.
   c. As the airflow rate through the floor swirl diffuser reduces, so too does its throw height, which ideally should be to head height of seated occupants, so as to prevent an excessive vertical temperature gradient. Substantially reduced airflow rates result in insufficient vertical throw. Consequently, the interface to the layer of high-level stratified heat drops to encroach upon the heads of occupants, creating thermal discomfort ("cold feet, warm head") and a sense of stuffiness (stagnant face-level air).
4. Optional motorised VAV damper operation in the diffuser – often used as a secondary form of thermostatic control for the highly fluctuating loads in meeting rooms – frequently also causes occupant discomfort described in 3c.

Vertical-discharge floor swirl diffusers work well in moderate to very high heat-load spaces in which they are not located directly next to seats. They should preferably be restricted to no more than only a small range of user controlled airflow rate adjustability, especially in applications with strongly fluctuating loads, such as perimeter zones. These diffusers are particularly well suited to transient spaces or to zones with unusually high thermal loads.

3.3 Directionally-inclined-discharge floor swirl diffusers

In order to prevent overall system cooling performance and indoor air quality from being compromised by user control, floor swirl diffusers with directionally inclined discharge were invented (Figure 6) to allow climate personalisation via discharge direction adjustment. These diffusers produce strongly inductive swirl discharge along an inclined axis. Due to the swirl discharge, supply air velocity decay is rapid, as is equalisation of the supply air temperature with room air temperature. The air motion of the inclined air stream is gentle. User adjustability of the airflow direction is offered via rotation of the diffuser face, thereby satisfying Green Star requirements for user adjustable credits.

Figure 6

In comparison to vertical swirl discharge, directionally inclined floor swirl discharge offers the following advantages (Figures 7 and 8):

1. While it is preferable to locate the diffuser at least 0.4m from seats for optimum directional control, the ability to rotate the directional airflow pattern away makes it possible to locate the diffuser directly next to seats without the threat of causing draughts.
2. The higher user localised air motion created by directing the diffuser supply air stream towards a user overcomes issues associated with the sensation of stuffiness for those users who prefer increased air motion. For decreased air motion, the user simply rotates the diffuser face to direct the air stream away.
3. By replacing airflow rate adjustment with air direction adjustment, to achieve personalised effective temperature adjustability, directionally inclined swirl discharge achieves the following:

   a. Indoor air quality cannot be compromised, as the diffuser airflow rate cannot be throttled by occupants.

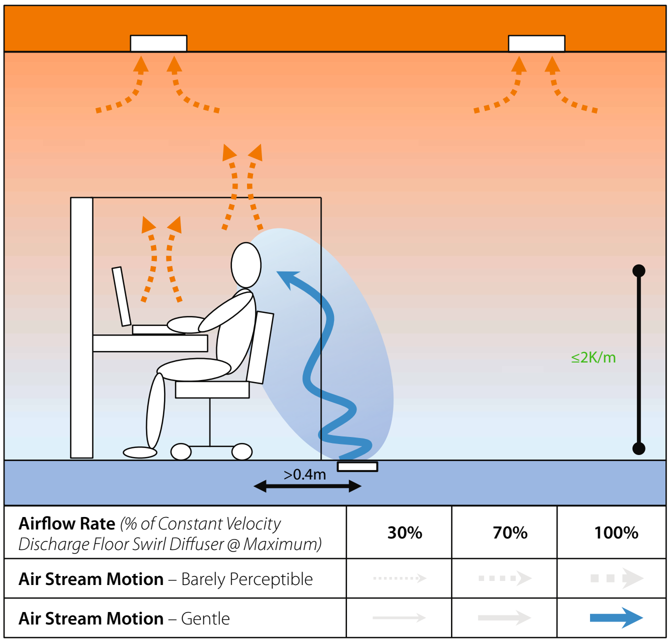


Figure 7

   b. Thermostatic control cannot be compromised, as the diffuser airflow rate cannot be throttled by occupants.

   c. Throw height remains largely constant, thereby eliminating the sensation of stuffiness and "cold feet, warm head" regardless of the user-adjustable setting.

Floor swirl diffusers with directionally inclined swirl discharge, however, suffer from a variety of shortcomings:

1. By offering climate adjustment to the user through only one (i.e. air direction) of two potential means of adjustment (i.e. air direction and airflow rate), the full range of user personalised comfort is not maximised.
2. By not offering the option of intensely inductive vertical discharge with rapid discharge velocity decay, applications

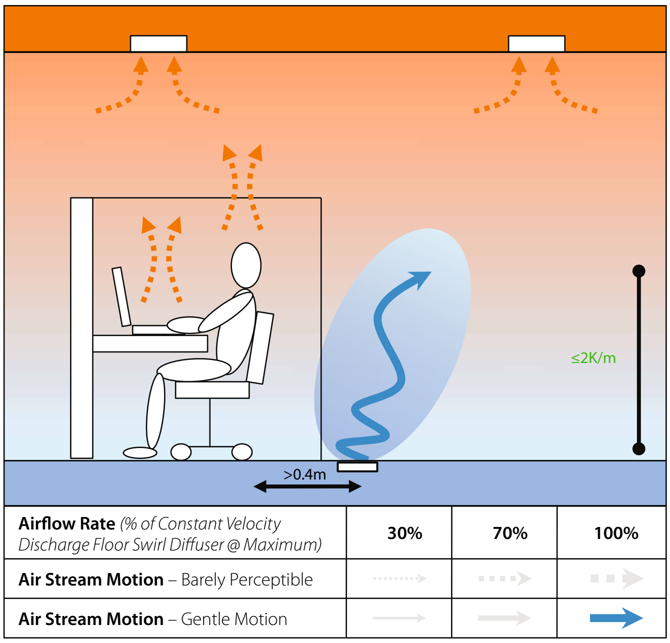


Figure 8

in which such an air pattern, with its resultant minimal air motion, are not catered for.

3. Optional motorised diffuser VAV damper operation is not available, as it would result in fluctuating throw, which would compromise both the minimal vertical temperature gradient for occupants and user adjustability of air motion.

Directionally-inclined-discharge floor swirl diffusers work well in moderate to high heat-load spaces where user adjustability of the personalised climate is desired, and achieve such adjustability without compromising the vertical temperature gradient for occupants. These diffusers do not offer the option of motorised VAV operation, as their primary advantage – mixing to head height of seated occupants regardless of the user adjustment setting – would then be lost.

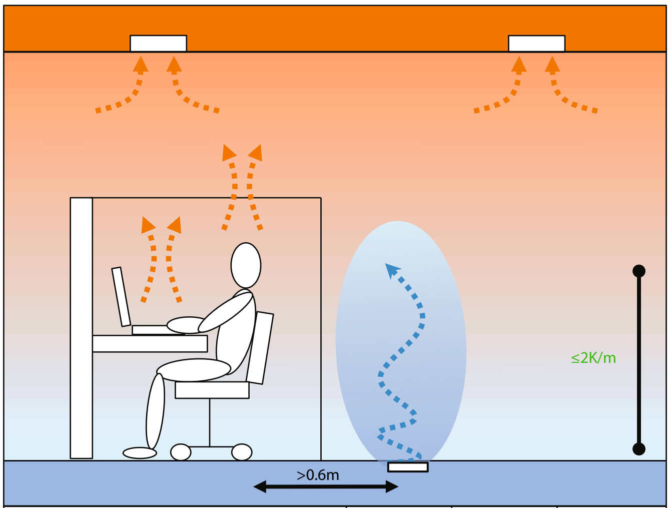
3.4 Constant-velocity-discharge floor swirl diffusers

Constant velocity discharge makes it possible to achieve a largely constant throw to head height of seated occupants even when airflow rates are adjusted. Consequently, the user may adjust the diffuser airflow to a reduced setting without creating an excessive vertical temperature gradient in the occupancy space.

Combining such largely constant throw airflow rate adjustability with a directionally inclined airstream further increases the potential for the user's local thermal environment to be personalised, as this allows the increased or decreased airflow rate to be directed towards or away from the user.

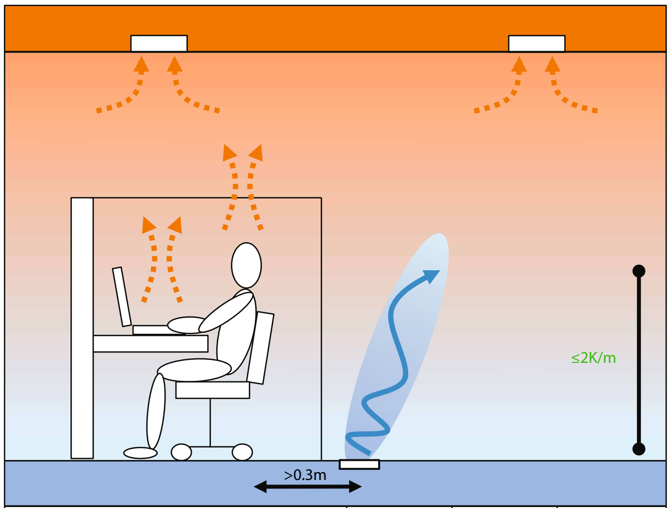
Figure 9

The thermal comfort advantage of such a wide range of user adjustability is especially important in areas where loads fluctuate strongly, such as in perimeter zones, which typically require the greatest range of user-specific personalisation.



Airflow Rate *(% of Constant Velocity Discharge Floor Swirl Diffuser @ Maximum)*	30%	70%	100%
Air Stream Motion – Barely Perceptible			
Air Stream Motion – Gentle Motion			

Figure 10



Airflow Rate *(% of Constant Velocity Discharge Floor Swirl Diffuser @ Maximum)*	30%	70%	100%
Air Stream Motion – Barely Perceptible			
Air Stream Motion – Gentle Motion			

Figure 11

A widely used constant-velocity-discharge floor swirl diffuser in the Asia-Pacific market (Figure 9) allows assembly of the

diffuser components into any one of three configurations by virtue of two adjustable dampers (however, only two of these configurations offer largely "constant velocity" discharge):

1 User-adjustable discharge inclination, rotation and airflow rate (discharge is largely "constant velocity").

2 Inclined discharge with user-adjustable rotation and airflow rate (discharge is largely "constant velocity").

3 Vertical discharge with user-adjustable airflow rate (discharge is of variable velocity).

All three of the above configurations satisfy Green Star requirements for user adjustable credits.

Configuration 1 offers user adjustability of the airflow rate (limited via adjustable stops) and of the direction (via rotation of the directionally inclined discharge pattern) and of the inclination (providing minimal airstream motion when vertical).

This configuration maximises the range of thermal comfort adjustability: counter-clockwise rotation of the diffuser face produces a directionally inclined air stream of increased airflow rate with gentle air motion that may be directed towards the user (Figure 7); clockwise rotation of the diffuser face produces a reduced airflow rate, vertically directed away from the user, with barely perceptible air motion (Figure 10). Throw height is largely constant.

This is the most typical configuration for reconfigurable offices, especially in draught-sensitive applications.

Configuration 2 offers the user adjustable airflow rate (limited via adjustable stops) and adjustable direction (via rotation of the directionally inclined discharge pattern).

This configuration provides gentle air motion in the space regardless of the airflow rate setting: counter-clockwise rotation of the diffuser face produces a directionally inclined airstream of increased airflow rate with gentle air motion that may be directed towards the user (Figure 7); clockwise rotation of the diffuser face produces a directionally inclined air stream of reduced airflow rate with gentle air motion that may be directed away from the user (Figure 11). Throw height is largely constant.

This is the most typical configuration for offices and workstations in the tropics and many parts of the Asia-Pacific region, as gentle air motion is realised even at reduced airflow rates.

Configuration 3 discharges vertically and offers the user airflow rate adjustability (limited via adjustable stops). Intense discharge velocity decay occurs regardless of the airflow rate setting, bringing about barely perceptible air motion in the space (Figures 4 & 5). Throw height varies with airflow rate.

This configuration is most typically used in transient spaces or zones with very high thermal loads.

Specifically, the constant-velocity-discharge floor swirl diffuser achieves the following advantages:

1. In Configurations 1 and 2 it is possible to locate the diffuser directly next to seats without the risk of causing draughts (though at least 0.4m is preferable for optimum air motion control).
2. In Configurations 1 and 2 user airflow rate adjustment is achieved while largely maintaining mixing to head height of seated occupants. This eliminates the threat of stuffiness and "cold feet, warm head" despite airflow rate adjustability.
3. In Configurations 1 and 2, counter-clockwise face rotation increases the airflow rate of a gentle, directionally inclined airstream, which may be directed towards the user to maximise the personalised cooling effect.
4. In Configuration 1, clockwise face rotation reduces the airflow rate and produces intensely inductive, vertically directed discharge, creating barely perceptible air motion, to provide minimal personalised cooling; whereas, in Configuration 2, clockwise face rotation reduces the airflow rate of an inclined, rotatable airstream, creating gentle face-level air motion, which may be directed by rotation.

5. Configuration 1 offers electrical VAV damper operation as an option. This provides personalised air direction and air motion adjustability to the user regardless of the automatically adjusted airflow rate.
6. Configuration 3 (which is not a constant-velocity configuration) offers highly inductive air supply with rapid discharge velocity decay that produces barely perceptible air motion, and offers the user airflow rate adjustability.

The constant-velocity-discharge floor swirl diffuser suffers from the following shortcomings:

1. Configuration 3 does not offer largely constant velocity discharge, and therefore does not maintain a largely constant vertical throw to head height of seated occupants. Throw height varies as a function of the user-adjustable airflow rate (Figures 4 and 5). The sensation of stuffiness and "cold feet, warm head" may occur when substantial user adjustability of the airflow rate is permitted in this configuration.
2. Due to the choice of assembly into any one of three configurations, clearly defined specifications are required from the specifying engineer as to which configuration and damper settings are to be assembled.
3. The inclusion of two adjustable dampers potentially involves more installation complexity.

The constant-velocity-discharge floor swirl diffuser offers the advantage of three configurations: one that maximises the range of airflow rate, air direction and air motion adjustability – this being suitable for most reconfigurable user-adjustable office applications; one that offers airflow rate and direction adjustability while maintaining gentle head height air motion – this generally being suitable for offices and workstations in the tropics and Asia-Pacific; and one that offers only airflow rate adjustability with almost imperceptible air motion, vertically directed – this being suitable for most transient spaces or for very high heat-load applications.

Only the last of these three configurations does not maintain mixing largely to head height of seated occupants regardless of the adjustability settings. Optional motorised VAV damper operation is available for Configuration 1, thereby providing personalised user adjustability of air direction and air motion largely up to head height of seated occupants across the VAV operating range.

4.0 CONCLUSIONS

Apart from the floor swirl diffusers presented above, many designs exist, especially for adjustability. For example, adjustability from horizontal to vertical swirl is available in some models, as is user adjustability of the airflow rate for horizontal-discharge floor swirl diffusers. However, this article has concentrated on the floor swirl diffuser designs that have been most applicable and widely used in the Asia-Pacific region.

In particular, it has shown that horizontal-flow floor swirl diffusers are suitable for low heat-load spaces, such as libraries.

Vertical-flow floor swirl diffusers are most suitable for transient spaces in commercial offices and for very high heat-load applications. These diffusers usually offer the option of user adjustable airflow rate, but this should only ever be applied with a limited adjustability range, and is best only used in zones with relatively low heat-loads and minimal thermal fluctuations, such as centre zones. Optional motorised VAV adjustability may compromise thermal comfort when the airflow rate is turned down due to reduced diffuser throw creating an increased vertical temperature gradient for the user.

Directionally-inclined floor swirl diffusers offer user adjustability of the airflow direction, and thus maintain throw largely to head height of seated occupants regardless of the personalised user setting. They are well-suited to user adjustability in offices, including perimeter zones and spaces with large heat load fluctuations. However, these diffusers do not offer motorised VAV modulation, which is often required for such spaces as meeting rooms.

Constant-velocity-discharge floor swirl diffusers maximise user adjustability of the local thermal environment by offering the user airflow rate, air direction and air motion adjustability at a largely constant throw to head height of seated occupants (with the exception of the vertical-discharge configuration). These diffusers cater for differing user air temperature and air motion preferences. They avert the threat of "cold feet, warm head" even when providing motorised VAV control. Optional motorised VAV control also provides user-personalised air direction and air motion adjustability. Constant-velocity-discharge floor swirl diffusers are best suited to commercial office applications in which user comfort and indoor are quality are to be maximised. ▮

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About the author

Sean Badenhorst BSc(MechEng), MEMgt, M.AIRAH, completed an honours degree in Mechanical Engineering at the University of Cape Town, South Africa, in 1991. Thereafter, Badenhorst worked as a motor vehicle air conditioning research and development engineer at Mercedes-Benz, Germany, before migrating to New Zealand, where his air conditioning career switched to the building sector. After completing his Masters of Engineering Management degree at the University of Auckland, Badenhorst worked briefly as senior mechanical engineer at Connell Wagner in Sydney, before returning to Germany, where he worked for Krantz Komponenten. In 2001, Badenhorst helped establish Krantz Products & Systems Australia (now Krantz Asia-Pacific), of which he is a director. Badenhorst is also the chief technical officer for Asia-Pacific, and since mid-2008 has been based predominantly in China, working on HVAC projects throughout the region.