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Conaire Knowledge Series Papers 17

CHOOSING THE RIGHT AIR OUTLETS

Air diffusing equipment, commonly referred to as Grilles and Diffusers play a vital role in the performance of an HVAC system. Since they form the visible end point in the complex system of supply and exhaust air, aesthetics obviously play an important role. But couched within the aesthetics is the quality of engineering perfection and precision that can make or mar the performance of the overall system. Thus choice of an appropriate grille is important.

Contrary to popular perception a grille is not merely a standard fabrication item, but a product of engineering perfection that determines it's life, performance and aesthetics. Choice of an appropriate grille/diffuser is based on a number of considerations, ranging from air delivery requirements, size and height of the space, sound levels and appearance.

SUPPLY AIR OUTLET

These should be properly sized and located to obtain proper air diffusion and equalise temperature in space.

An opposed blade damper is commonly used with the supply air outlet to regulate the volume of supply air.

Other accessories as required may also be used to control its flow pattern.

EXHAUST AIR INLET

Return and exhaust air is removed from a space through return and exhaust inlets. Proper sizing and location of these outlets too plays an important role in the efficient working of the HVAC system in any building.

AIR JET CLASSIFICATION

Most common of these are as follows:

- Compact air Jet, formed by perforated grille (small aspect ratio).
- Linear air jet, formed by linear grille (large aspect ratio).
- Radial air jet, formed by rectangular/circular ceiling diffuser that directs air horizontally in all directions.
- Conical air jet, formed by rectangular/circular ceiling diffuser which projects air at nearly 120^{0} from the top of outlet.
- Incomplete radial jet, formed by adjustable grille which forces the angle of projection and at distance this jets forms into a compact air jet.

JET EXPANSION ZONE

Zone 1: core, extending to 4 diameter of width of outlet. maximum velocity, temperature of air stream remain unchanged.

Zone 2: transition, length is dependent upon type of outlet, aspect ratio, initial airflow turbulence and so forth.

Zone 3: fully established turbulence flow, extending to 25 to 100 diameter of outlet and width of slot.

Zone 4: In the terminal zone, the maximum velocity decreases rapidly to a value less than 0.25m/sec. with in a distance of a few outlet diameters.

Angle of divergence: usually ranges from 18O to 22O depending upon air jet classification.

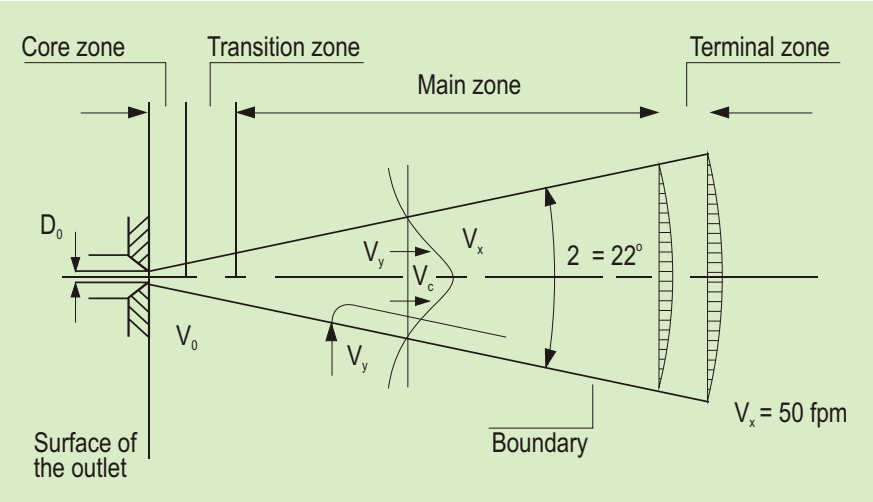


Fig 3. Four zones of a free isothermal axial air jet.

AIR DIFFUSION PERFORMANCE INDEX

- Supply air outlet introduce air into a conditioned space to obtain a desired indoor atmospheric environment from the floor to 1.8 m above the floor level.
- To obtain comfort conditions within the cooling zone (1.8m above the floor) in airconditioned space, standard limits have been established for acceptable effective draft temperature.
- Which combines the effects of air temperature, and air movement in terms of their physiological effects on a human body with humidity and radiation considered as constant. Variation from accepted standards causes occupant discomfort.

  è = (tx –tc)–8(Vx –0.15) …… (1)

  where,

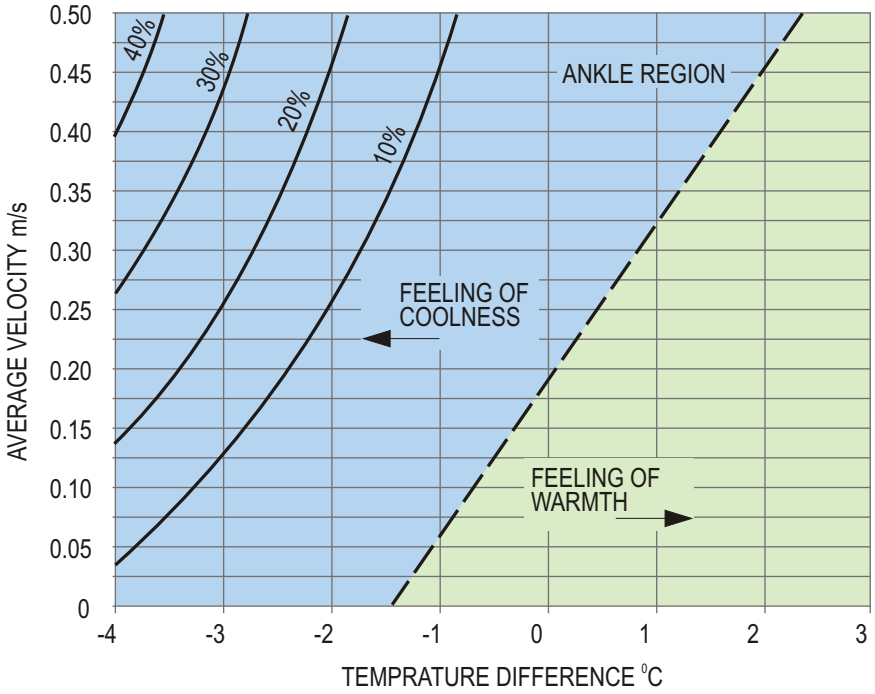
  è = effective draft temperature, K

  x = local airstream dry-bulb temperature, °C

  tc = average (control) room dry-bulb temperature, °C

  Vx = local airstream centreline velocity, m/s

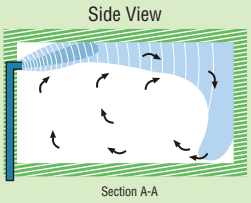
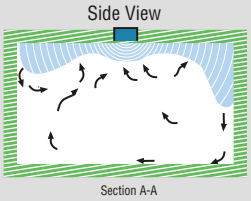
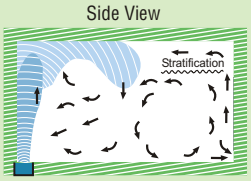
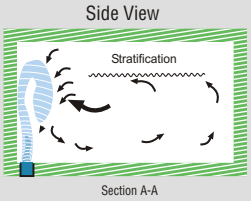
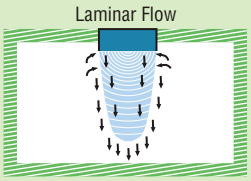
- A high percentage of people are comfortable where the effective draft temperature è, as defined in Equation (1), is between .1.5 and +1 K and the air velocity is less than 0.35 m/s.
- If several measurements of air velocity and air temperature are made throughout the occupied zone of an office, the ADPI is the percentage of locations where measurements were taken that meet these specifications for effective draft temperature and air velocity. If the ADPI is maximum (approaching 100%),the most desirable conditions are achieved.



Percentage of Occupants Objecting to Drafts in Air-Conditioned Rooms

COOLING ZONE DESIGN CRITERIA

- Jet throw, the throw of a jet is the distance from the outlet to a point where maximum velocity in the stream cross section has been reduced to selected terminal velocity. To estimate ADPI terminal velocity considered as 0.25 m/s. The throw distance of a jet is denoted by Tv, where subscript V denotes the terminal velocity in m/s for which the throw is given.
- Characteristic room length L is the distance from the diffuser to the nearest boundary wall in the principle horizontal direction of the air- flow. However, where air injected into the room does not impinge on a wall surface but collides with air from a neighbouring diffuser, the characteristic length is one-half the distance between diffusers plus the distance the mixed jet travels downward to reach the occupied zone. Table 1 summaries definitions of characteristic length for various diffusers.
- The recommendations in the table cover cooling loads of up to 250 W per square metre of floor surface.

Terminal Device		Characteristic Length L	Load (W/m_2)	$T_{0.25/L}$ for Maximum ADPI	Maximum ADPI
High Sidewall Grille		Distance to wall perpendicular to jet	250	1.8	68
			190	1.8	72
			125	1.6	78
			65	1.5	85
Circular Ceiling Diffuser		Distance to closest wall or intersecting air jet	250	0.8	76
			190	0.8	83
			125	0.8	88
			65	0.8	93
Sill Grille, Straight Vanes		Length of room in direction of jet flow	250	1.7	61
			190	1.7	72
			125	1.3	86
			65	0.9	95
Sill Grille, Spread Vanes		Length of room in direction of jet flow	250	0.7	94
			190	0.7	94
			125	0.7	94
			65	0.7	94
Perforated, louvered ceiling diffusers		Distance to wall or midplane between outlets	35-160	2.0	96

Inlet *Isothermal region at 100 fpm* *Isothermal region at 50 fpm* → *Natural convection current*

SELECTION OF SUPPLY OUTLETS

Shape, size and ceiling height of the building: For buildings with limited ceiling height, ceiling and slot diffusers are often the best choice. For large buildings with high ceiling, high side outlets mounted at high levels to form stratified induced recirculating flow patterns are recommended. In a perimeter zone, an overhead two way slot diffuser projected down toward the window and horizontally projected to the room, a ceiling diffuser with a throw to the inner surface of the window glass, or a sill outlet should be used.

Surface effect : A good surface effect is of especially important to the VAV system because it allows the supply volume flow rate to be reduced to half or even 30 percent of the design flow.

Air loading of floor space : Side wall outlets are limited to a lower air loading of floor space because of the higher air velocity in the occupied zone, the slot diffuser has a narrower slot width and can only project in one or two directions. Therefore, the air loading of floor space for a slot diffuser is smaller than that of a ceiling diffuser.

Type of Outlet	Air Loading of Floor Space Max. L/s per m^2	Approx. Max. Air Changes per Hour for 3 m Ceiling
Grille	3 to 6	7
Slot	4 to 10	12
Perforated panel	5 to 15	18
Ceiling diffuser	5 to 30	30

Appearance: The shape and configuration of out lets and inlets are closely related to the interior appearance of the building, and should be coordinated with inlets and lighting troffer

Sound Level: The sound level from an outlet is a function of its discharge velocity and the transmission of system noise. For a given air capacity, a larger outlet has a lower discharge velocity and corresponding lower generated sound. A larger outlet also allows a higher level of sound to pass through the outlet, which may appear as outlet generated sound. High-frequency sound can be the result of excessive outlet velocity but may also be generated in the duct by the moving airstream.

Low-pitched sounds are generally mechanical equipment sound and/or terminal box or balancing damper sound transmitted through the duct and outlet to the room. The cause of the sound can usually be pinpointed as outlet or system sounds by removing the outlet core during operation.

If the sound remains essentially unchanged, the system is at fault. If the sound is significantly reduced, it may be caused by a highly irregular velocity profile at the entrance to the diffuser. The velocity profile should be measured. If the velocity varies less than 10% in the air outlet entrance neck, the outlet is causing the noise. If the velocity profile at the entrance indicates peak velocities significantly higher than average, check the manufacturer's data for the sound at the peak velocity. If this rating approximates the observed sound, the velocity profile in the duct must be corrected to achieve design performance. Note that a high-velocity free stream jet does not cause a high sound level until the jet impinges against an interfering surface or edge.

Smudging: It is the deposition of dirt particles on the air outlet or surface that is contiguous with the outlet. Dirt particles may be either in the room air that is entrained in the discharge or in the air supply to the outlet. Smudging is more prevalent with ceiling diffusers and linear diffusers that discharge the air parallel to the mounting surface than with grilles that discharge air perpendicular to the surface. Dirt from room air is deposited most frequently at the edge of the stream, where the entrained air comes in contact with the surface, rather than at the centre of the stream, which tends to wipe the surface with clean supply air. Edges of the stream occur at interruptions in the discharge stream, such as at a blank section of a linear diffuser or at the corner of a directional rectangular diffuser.

SELECTION OF RETURN AND EXHAUST OPENINGS

Velocity in the occupied zone near the openings: Air handled by the opening approaches the opening from all directions, and its velocity decreases rapidly as the distance from the opening increases. Therefore, drafty conditions rarely occur near return openings. Table shows recommended return opening face velocities.

Permissible pressure drop: It depends on the choice of the designer. Proper pressure drop allowances should be made for control or directive devices.

Noise: The problem of noise in return openings is the same as that in supply outlets. In computing room noise levels resulting from the operation of an airconditioning system, the return opening must be included as part of the total grille area.

Inlet Location	Velocity Across Gross Area, m/s
Above occupied zone	4.0
Within occupied zone, not near seats	3.0 to 4.0
Within occupied zone, near seats	2.0 to 3.0
Door or wall louvers	1.0 to 1.5
Through undercut area of doors	1.0 to 1.5