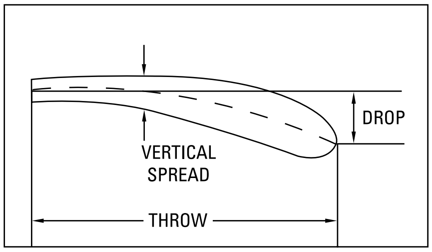
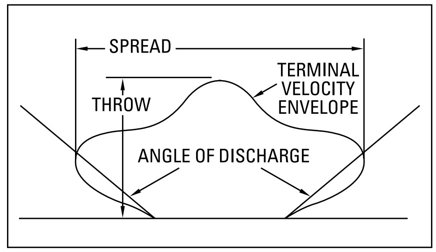
Engineering Guidelines

The purpose of a heating, ventilating, or air conditioning system is to create the proper combination of temperature, humidity and air motion which will provide comfort for the occupants of the conditioned room.





THROW, as defined in the ASHRAE Handbook of Fundamentals (1993), is "the horizontal or vertical axial distance an air stream travels after leaving an air outlet before the maximum stream velocity is reduced to a specified terminal velocity, e.g. 100, 150, 200 fpm..."AirConcepts uses the term PROJECTION interchangeably with Throw, because we think PROJECTION is a better description of the physical characteristics of what is being accomplished by forcing a concentrated column of air through a nozzle-type air distribution device.

DROP is the vertical distance that the lower edge of a horizontally projected air stream drops between the outlet and the end of its throw.

SPREAD is the divergence of the air stream in a horizontal or vertical plane after it leaves the outlet. The natural spread from a jet type outlet is approximately 22° included angle and can be approximated by one foot of spread for every three feet of throw.

The air stream characteristics for projected air flow from a nozzle are illustrated in Figure 1. There are three variables that determine how far the air can be projected and the velocity decay characteristics of the air stream: (1) air volume or mass of air flow, (2) discharge velocity or nozzle velocity, and (3) outlet configuration.

AIR VOLUME

In general, the larger the air volume or air mass, the further it can be projected. A projectile in excess of 100 pounds from a 16" naval gun with a muzzle velocity of 800 fps can travel up to 40 miles, while a rifle bullet which weighs less than one ounce and leaves the barrel at 3200 fps can only travel a mile.

DISCHARGE VELOCITY

When air exits from an opening at a higher velocity that the surrounding air, the surrounding air will be induced, aspirated, or entrained into the moving air stream. This induction of slower moving air results in an interchange of momentum such that the stream grows in mass as it moves forward, and the resultant velocity of the larger mass is decreasing as the air stream moves away from the opening. The greater the differential between the discharge velocity and the surrounding velocity, the greater is the induction; the greater the induction, the greater is the interchange of momentum.

OUTLET CONFIGURATION

The induction of room air into the moving air stream is a function of the discharge velocity, as previously discussed, and the exposed perimeter of the air stream. To project the air the greatest distance, a round nozzle has the least perimeter for any given discharge area.

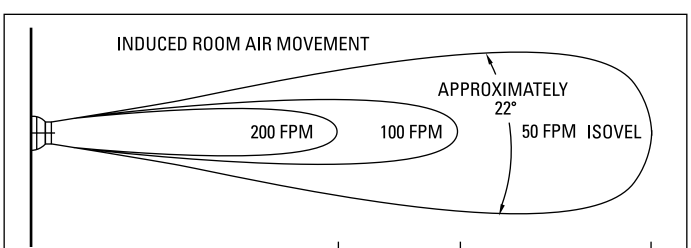


FIGURE 1

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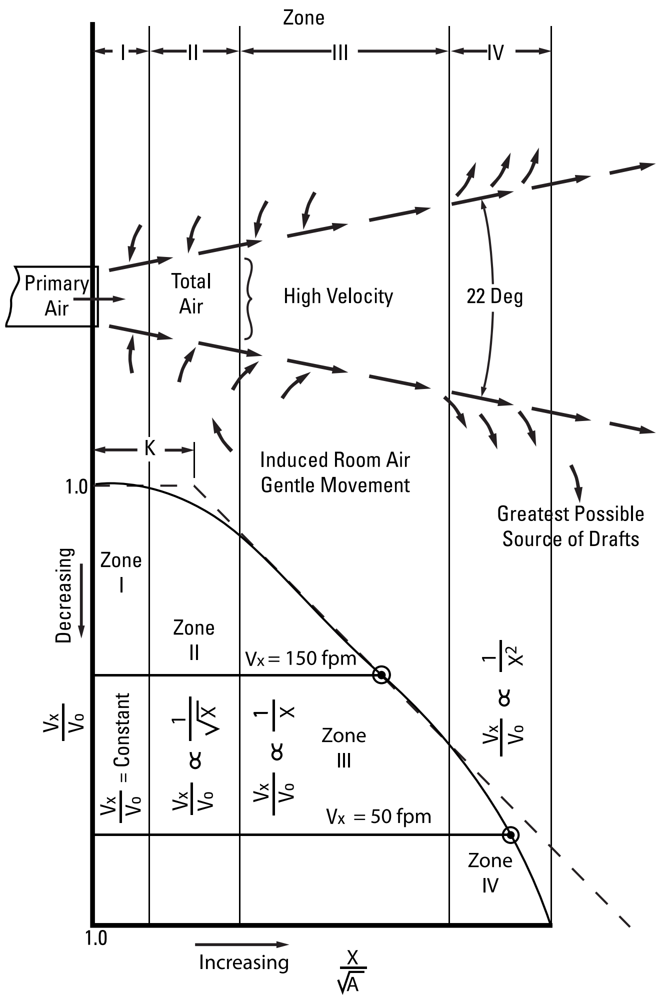
The zones of expansion for an isothermal jet can be described as follows, based on numerous observations and measurements by many investigators:



ZONE 1 A short zone, extending about four diameters from the outlet face (or vena contracta for orifice discharge), in which the maximum velocity of the air stream or the center line velocity remains practically unchanged.

ZONE 2 A transition zone, extending to about eight diameters for round outlets, or for rectangular outlets of small aspect ratio, over which maximum velocities vary inversely as the square root of the distance from the outlet. For rectangular outlets of large aspect ratio, this zone is elongated and extends from about four widths to a distance approximately equal to the width multiplied by four times the aspect ratio.

ZONE 3 A long zone, of major engineering importance, in which the maximum velocities vary inversely as the distance from the outlet. This zone is often called the zone of fully established turbulent flow and may be 25 to 100 diameter long, depending on the shape and area of the outlet, the initial velocity, and the dimensions of the space into which the outlet discharges.

ZONE 4 A terminal zone in which, in the case of confined spaces, the maximum velocity decreases at an increasing rate or, in the case of large spaces free from wall effects, the maximum velocity decreases rapidly, in a few diameters, to a velocity below 50 fpm.

ADPI

Using this draft temperature as our criteria, the comfort level of a space can be determined based on the Air Diffusion Performance Index (ADPI). ADPI is defined as the percentage of locations in the occupied space which meet the comfort criteria based on velocity and temperature measurements taken at a given number of uniformly distributed points. This ADPI value has proven to be a valid single number rating of an air diffusion system.

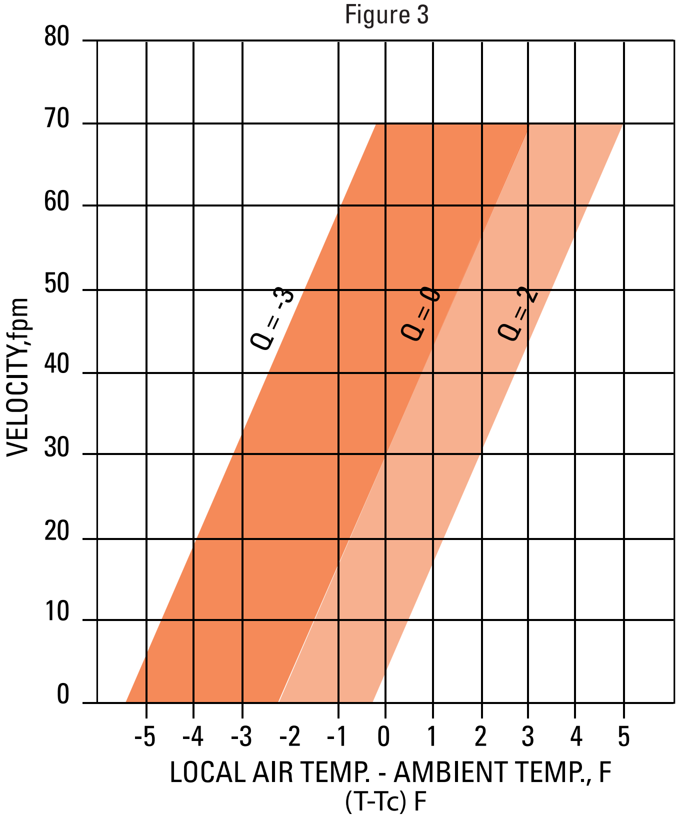
The ADPI rating of an air diffusion system depends on a number of factors:

- Outlet type
- Room dimensions and diffuser layout
- Room load
- Outlet throw

COMFORT CRITERIA

The true measure of the performance of any environmental system is that it maintains comfort of the occupants of the space it serves. Provided the total amount of heated or cooled air required to thermally satisfy the requirements of the space is available, the comfort level within the space becomes totally dependent upon the space air distribution. In general, comfort when related to anatomy can be described as the condition that exists when the heat generated by the body is balanced by some of the metabolic heat transfers through convection, the air, wall surfaces and other heat transfer mechanisms in the space.

Figure 3



Research indicates that a high percentage of people are comfortable where the effective draft temperature difference is between -3°F and +2°F. This comfort zone is illustrated as the shaded area in the figure 3 shown to the left.

ELEVATED AIR SPEED This standard ASHRAE 55 allows elevated air speed to be used to increase the maximum temperature for acceptability if the affected occupants are able to control the air speed. The amount that the temperature may be increased is shown in figure 2. The combinations of air speed and temperature defined by the lines in this figure result in the same heat loss from the skin. The reference point for these curves is the upper temperature limit of the comfort zone (PMV = +0.5) and 0.20 m/s (40 fpm) of air speed. This figure applies to a lightly clothed person (with clothing insulation between 0.5 clo and 0.7 clo) who is engaged in near sedentary physical activity (with metabolic rates between 1.0 met and 1.3 met).

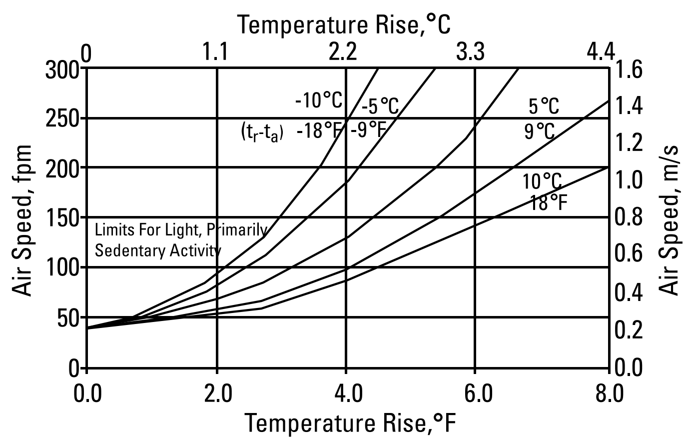


Figure 2 Air speed requied to offset increased temperature.

Per ANSI / ASHRAE STANDARD 55-2004

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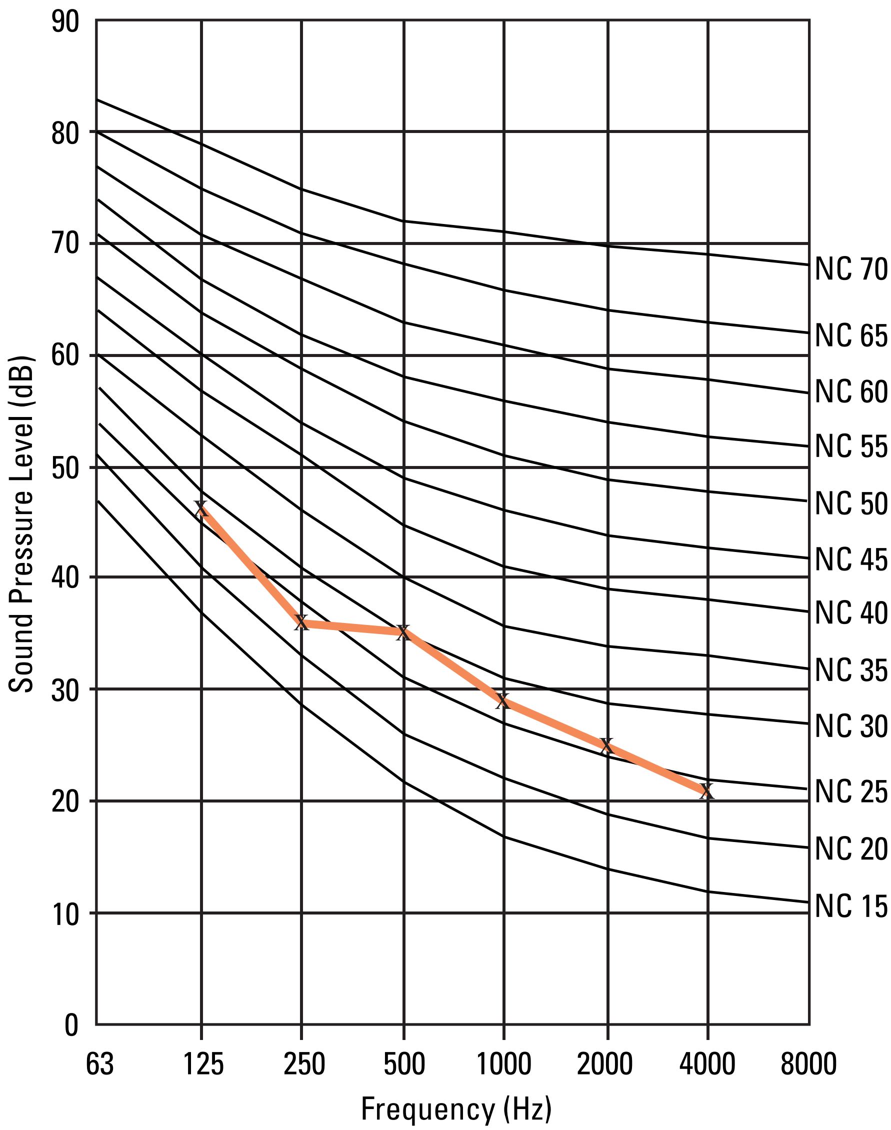
NOISE CRITERIA

Noise Criteria - NC - were established in U.S. for rating indoor noise, noise from air-conditioning equipment etc. In Europe it is common to use Noise Rating Curves - NR.

The method consists of a set of criteria curves extending from 63 to 8000 Hz, and a tangency rating procedure. The criteria curves define the limits of octave band spectra that must not be exceeded to meet occupant acceptance in certain spaces.

The NC rating can be obtained by plotting the octave band levels for a given noise spectrum - the NC curves. The noise spectrum is specified as having a NC rating same as the lowest NC curve which is not exceeded by the spectrum.



AirConcepts NC's are determined by ploting octave band 2-7 Sound poWer Levels minus a Room Absorption of 10dB.

Model	Nozzle Velocity	CFM		125	250	500	1K	2K	4K	Noise Criteria
APL-08	3000	313	SWL	57	47	45	39	35	31	30
			RA	-10	-10	-10	-10	-10	-10	
			SPL	47	37	35	29	25	21	