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Background Sound Level and Uniformity Preferences in the Open Office

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Background Sound Level and Uniformity Preferences in the Open Office

Acoustical comfort is an important goal of modern office design. But what factors actually contribute to the perception of acoustical comfort?

Research and experience with the design of open offices over the last 40 years has established the factors that are most important in the users' judgement of their acoustical environment. One of the principal factors is achieving adequate speech privacy, generally agreed to require a Privacy Index (PI) of 80% or an Articulation Index (AI) of 0.2., or better. Electronic background sound systems are normally necessary to achieve this goal. Not so well known are the factors related to the design of the background sound system that also affect users' perception of adequate acoustical comfort.

It should be obvious that adequate speech privacy can be obtained if the background sound level is high enough. If one user is seated under a particularly noisy return air grill he may well not be aware of intruding speech from a colleague, and therefore clearly has adequate speech privacy even if he is annoyed by the excessive noise. Similarly, a background sound system can be turned up very loud until everyone in the office has sufficient speech privacy, but with many such systems this also results in annoyance caused by the excessive background sound itself. Nevertheless, it is clearly possible to design such systems so that both requirements are met – adequate speech privacy and freedom from annoyance. What factors contribute to a sense of acoustical comfort, given that a background sound system is operating?

The first requirement is that the tonal quality or balance of frequencies in the background sound is proper. See CSM Technical Bulletin 10 for a discussion of this issue. A second requirement is that the background sound level should not exceed approximately 45 dBA, as demonstrated by recent research studies[1] carried out by the Canadian Research Council. The latter fact is not well known: many installed background sound systems are adjusted for levels well above 45 dBA. This is probably because a majority of the population tolerates higher levels without serious complaint, even though an important minority is clearly annoyed. Finally, the sound must be spatially uniform, in both tonality and sound level, at the listener's ear elevation so that his normal moving about in the office does not result in drastic changes in the sound.

The importance of this last requirement, spatial uniformity, is not well understood even by some vendors of background sound systems. It is unusual to find systems that achieve uniformity of better than 4 or 5 dB in the important speech frequencies. This is despite the fact that this amount of variability results in dramatic changes in speech privacy throughout the office, if the system is properly adjusted so that the highest levels do not exceed 45 dBA. The result is that most above ceiling systems are adjusted for average levels of about 48 dBA and maximum levels of 50 dBA or even more at many locations, causing annoyance to a significant percentage of users. Alternatively, the system is adjusted to a lower average level, compromising the speech privacy for a substantial percentage of the users. These factors unfortunately have contributed to opinion among some users that background sound systems are either too loud or not very effective.

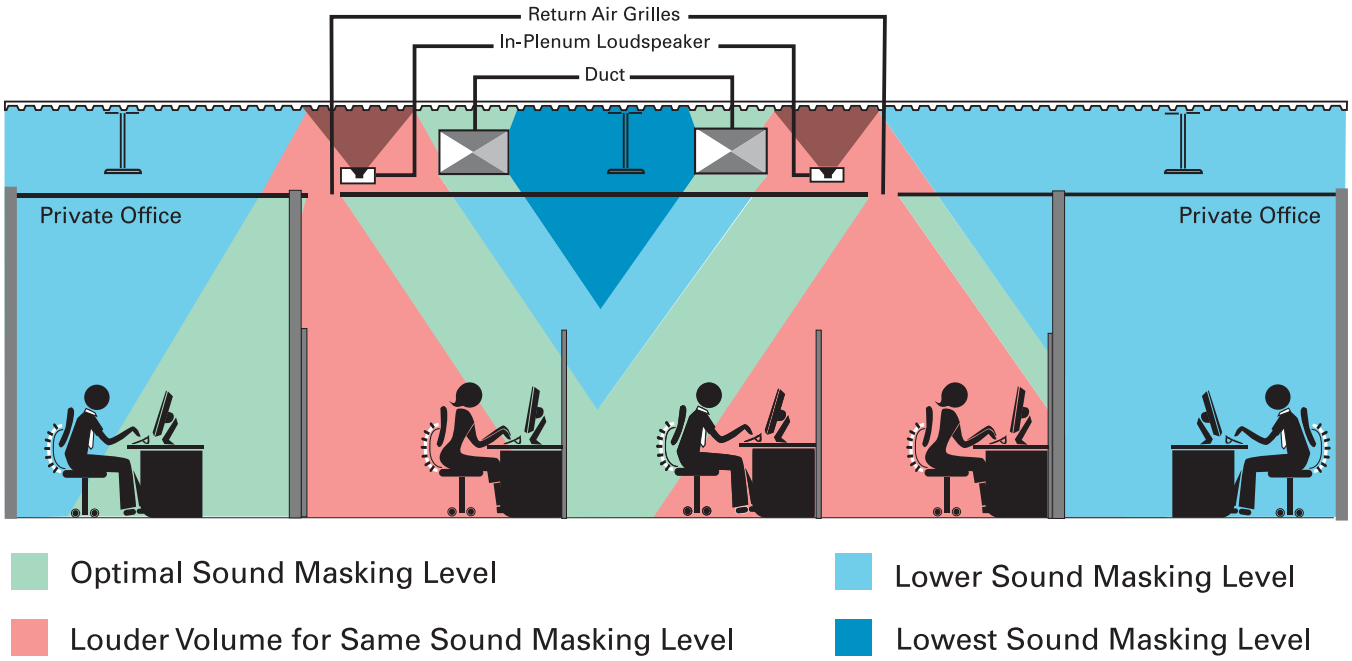

Figure 1. Typical plenum and acoustical ceiling acoustical variations cause nonuniformity in the background sound below. Ductwork and building beams compartmentalize the sound, acoustically absorbent fireproofing in some areas and not in others causes non-uniformity above, and openings for return air in the ceiling or light fixtures further deteriorate uniformity below. Typical variability below is 4 or 5 decibels.

Figure 1 illustrates the difficulty in achieving good uniformity with an above-ceiling system. The conventional wisdom is that the ceiling will "spread out" the sound in the plenum, improving the uniformity. What actually happens is that the plenum typically causes lack of uniformity. Practical plenums hide large structural elements, such as HVAC ductwork or structural beams, which effectively compartmentalize the sound. Even if the plenum is atypical and contains no large elements, openings in the ceiling or lighting fixtures permit proportionately more sound to be emitted below them.

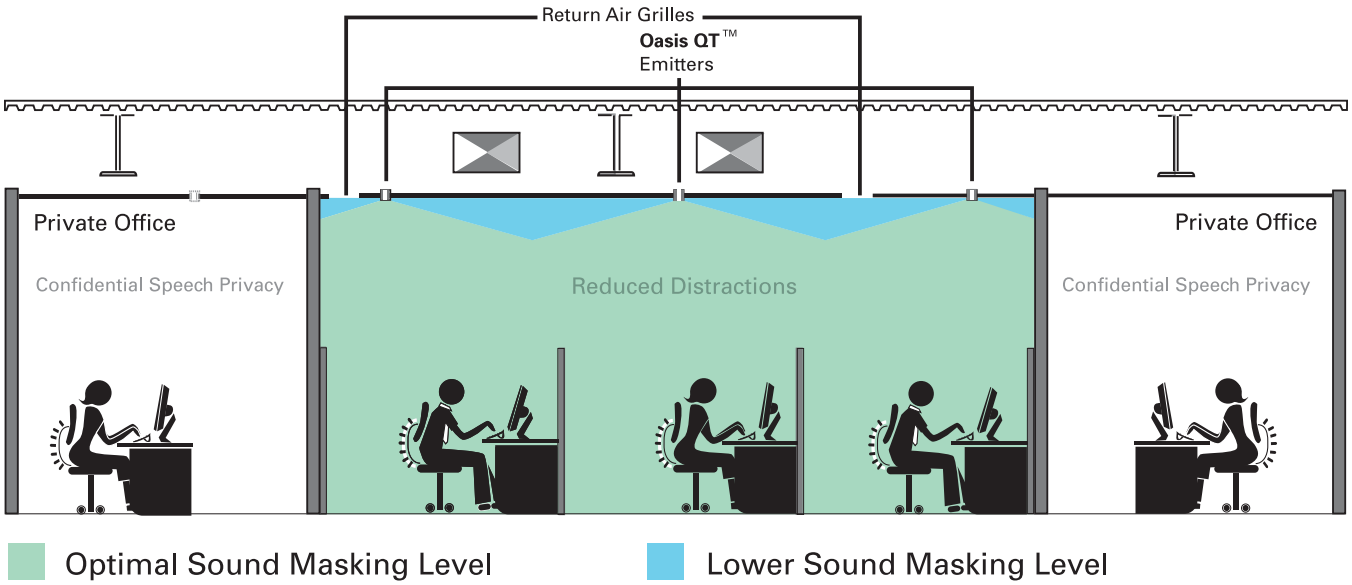

Figure 2. Use of ultra-wide dispersion transducers radiating directly into the listening space below results in spatial variability of only 1 decibel throughout the office.

By contrast with an above-ceiling system, the uniform gray in Figure 2 illustrates the good uniformity possible with an in-ceiling background sound system. If the emitters or speakers are properly chosen for wide dispersion (like an Oasis emitter), the background sound is very uniform at the listener's ear elevation. Typical uniformity is within +/- [1] decibel even at 4000 Hz, the highest voice frequency of interest, and even better at lower frequencies. Typical acoustical variations in the plenum and ceiling are of little consequence.

1. Acoustical Design Guide for Open Offices, Warnock, A.C.C., National Research Council of Canada, IRC-RR-163, March 2004