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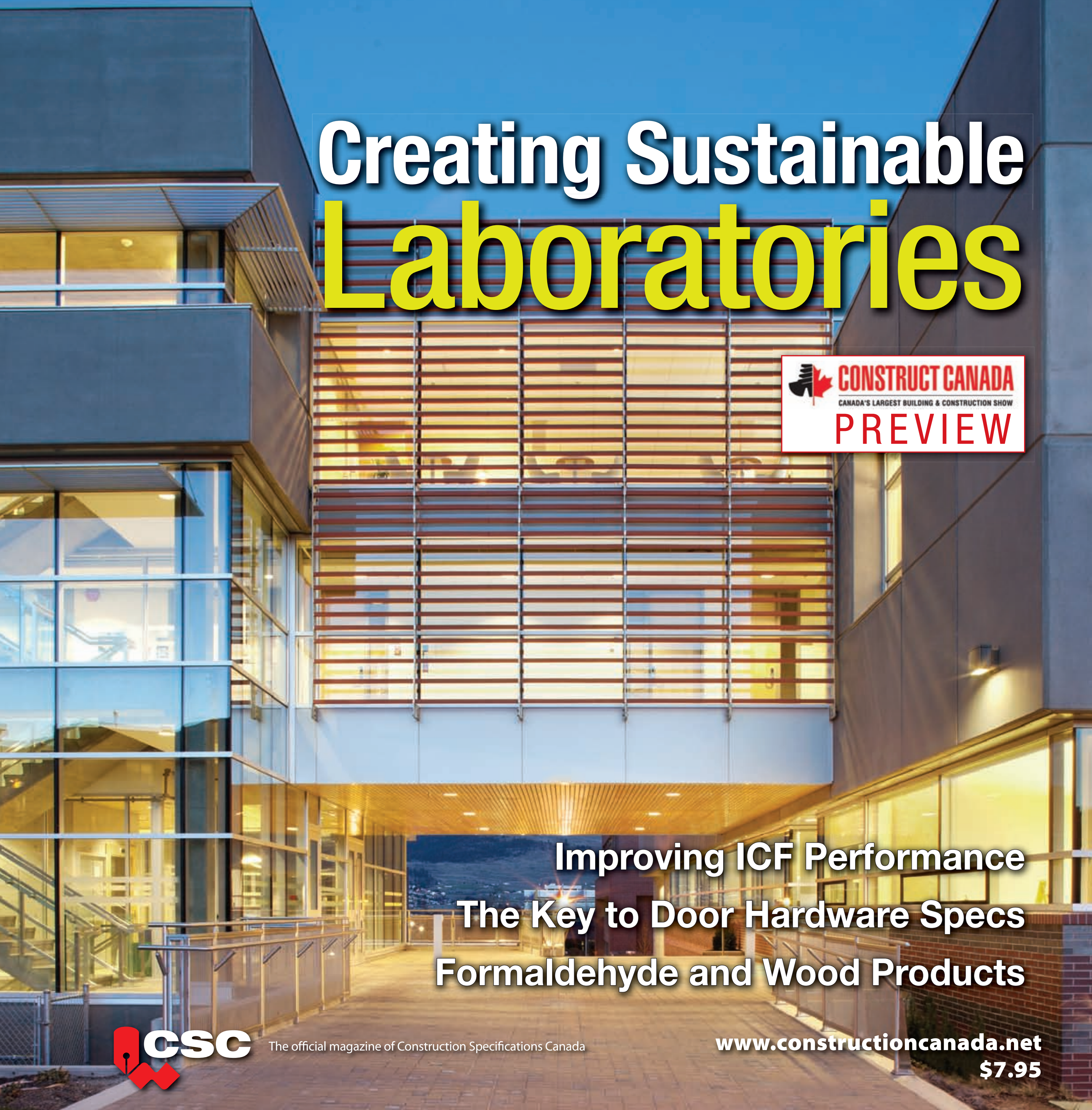

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Mind the Gap

Using sound-masking in closed spaces

By Niklas Moeller, MBA

Closed offices and meeting rooms are built with the intention of providing occupants with both visual and acoustic privacy. While the first goal can easily be achieved, the second often proves elusive because of the many ways in which sound can transfer from one space to another.

In an attempt to create sufficient speech privacy, walls with high sound transmission class (STC) ratings may be specified. However, these ratings are lab-tested and frequently overstate real-world performance by a minimum of five to 10 points. Site-tested field STC or noise isolation class (NIC) ratings are better gauges, but unfortunately only testable after the fact.

A common tactic used to improve speech privacy in a closed space is to construct full-height walls that extend from the concrete floor all the way to the deck above (*i.e.* deck-to-deck or slab-to-slab construction). The aim is to completely seal the room. While this approach increases effectiveness, it also raises costs and reduces flexibility. Vigilance must be maintained during design, construction, maintenance, and renovation to ensure penetrations in the wall's structure are controlled. Even minor ones can substantially reduce acoustic performance.

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Any penetrations, including outlets and controls, can impact sound attenuation.

These challenges raise the question as to whether there are alternate and preferable methods of achieving high levels of speech privacy in closed spaces—such as adding sound-masking technology to closed rooms with walls built only to the suspended ceiling.

Cracks in the armour

Each crack in a wall's armour facilitates the transmission of sound to and from neighbouring spaces. For example, wall performance is very sensitive to gaps along the perimeter, such as those occurring along window mullions or the floor. If light can pass through, so can sound—often well enough to substantially reduce the wall's impact. The wall's sound-isolating performance is weakened by other 'imperfections,' such as HVAC elements that pass between closed spaces, and even back-to-back electrical switches and outlets. Interior windows may also contribute to sound transfer.

Photo © iStockphoto/Pgiam

Sealing a wall to the deck is challenging given both obstructions and the prospect of an uneven deck surface.

In the case of full-height walls, the seal between the top of the wall and the deck must be maintained, which can be quite difficult if the surface is irregular (*e.g.* a corrugated steel deck). The sound isolation performance of the barrier above the ceiling may also be compromised by penetrations. Openings can exist from the first day of construction or be introduced during servicing or upgrades. Any gaps due to building structure, pipes, conduit, cables, and raceways must be carefully managed to ensure wall integrity. This level of care can be challenging to sustain throughout the space's life.

Moreover, a closed space only offers acoustic isolation when the door is closed. Once open, the barrier provided by the wall is compromised. For example, an STC 40-rated wall with an open door that represents 10 per cent of the wall's area reduces its effective STC to 10. The same is true for STC 45 and 50 walls. If the door is 20 per cent of the wall area—the case for a standard 0.9-m (3-ft) door in a 3 x 3-m (10 x 10-ft) wall—then the effective STC is only 7.

To avoid making the door the weak link, even when it is closed, the fenestration mustat least match the wall's STC rating. Any improper seals present will provide a convenient route for sound to escape (or enter) the room.

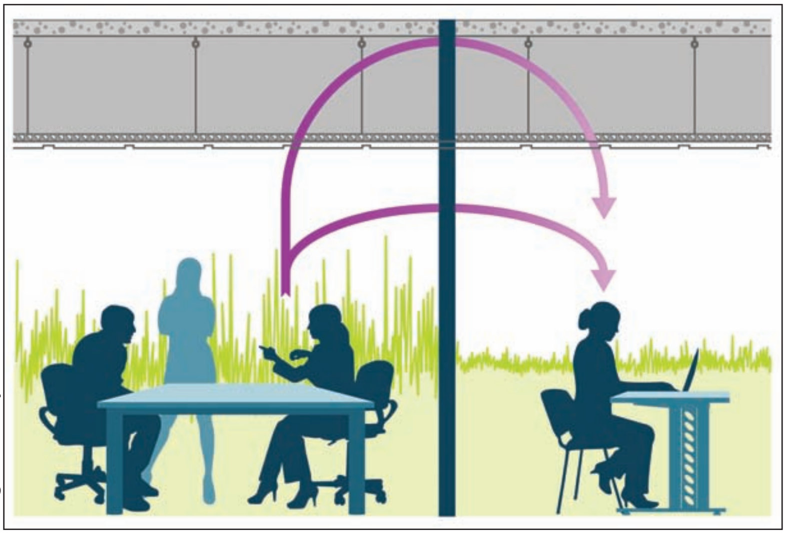
Cost and flexibility

Full-height walls also present financial challenges. Compared to a wall built from the floor to the suspended ceiling, the additional costs of materials and labour are obvious. However, there are other ways deck-to-deck construction can substantially add to the initial budget. Each time a wall is built above the suspended ceiling, the ceiling grid must be restarted—a time-consuming process. The separated plenum space requires separate return air ducts and may necessitate additional HVAC control zones. Return ducts must be treated to prevent sound transfer along their length from one location to another.

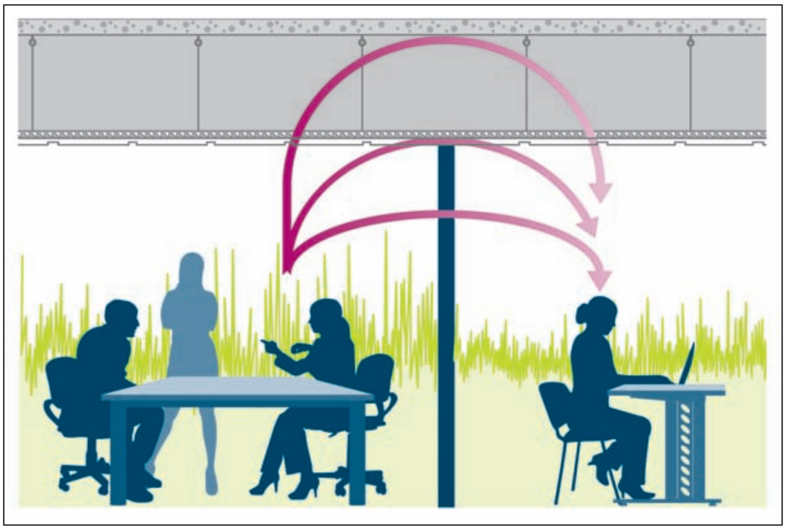
It is also more difficult and costly to renovate, because moving such a wall requires changes to the ceiling grid, tiles, and HVAC returns.

Constructing and moving floor-to-ceiling walls is a much simpler and less costly exercise. Modular wall systems permit even more rapid relocation. However, both open up a further pathway for sound transmission. Typically, the acoustical tile has a lower

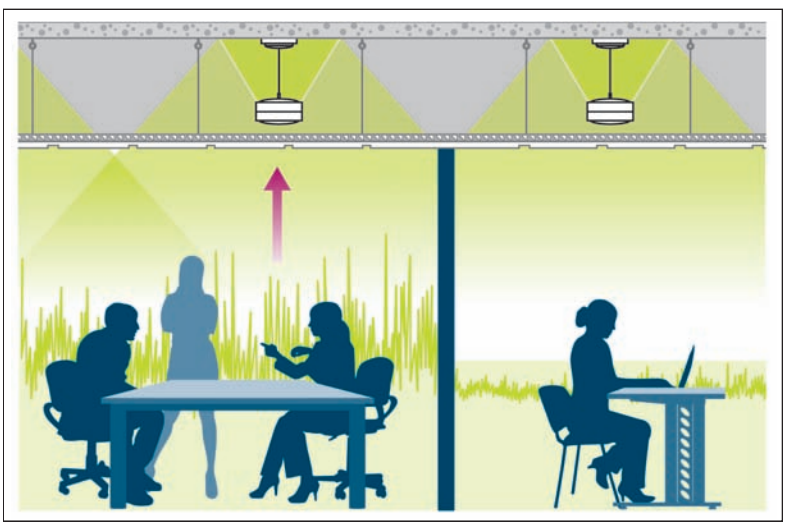
Images courtesy Acoustic Comfort UK



Deck-to-deck construction improves confidentiality, but it also reduces flexibility and increases construction and material costs.



Floor-to-ceiling partitions provide good flexibility, but poor confidentiality.



Installation of sound-masking manages the ambient noise level in a partitioned office, increasing speech privacy while also maintaining the flexibility of floor-to-ceiling partitions.

attenuation rating than the wall. Sounds pass through it, reflecting from the deck above and down into the neighbouring space. In this case, a tile with a ceiling attenuation class (CAC) of 35 to 40 is recommended. It lessens the flanking of sound through the ceiling and plenum, but the room is still subject to the aforementioned acoustic leakages.

The speech privacy equation

Whether built from floor to ceiling or deck to deck, walls only address part of the speech privacy equation. A person's ability to clearly understand a conversation depends on two variables: the volume of the speaker's voice and the volume of the background sound level in the space. The relationship between the two is called the signal-to-noise ratio (SNR).

Traditional closed-room construction attempts to provide privacy by simply reducing the signal. Even if a deck-to-deck wall is well-designed and constructed (*i.e.* all penetrations are addressed), it still may not provide the sought-after speech privacy level. If the background sound level in the adjoining space is lower than the sound passing through the wall (as is often the case), noises and conversations will still be heard and be potentially intelligible.

Sound-masking technology is available to provide an effective background level throughout the space. This type of system consists of a series of loudspeakers that distribute an engineered sound. Though most often compared to softly blowing air, this sound is designed to mask the frequencies in human speech. It also covers up incidental noises that would otherwise impact comfort and concentration.

Calculating the benefits

Sound-masking technology can be used in combination with walls built to the suspended ceiling or demountable partitions to provide a cost-effective and more flexible alternative to deck-to-deck construction.

Budget-wise, sound-masking may represent \$11 to \$22/m^2 (\$1 to 2/sf)of space, but it offsets much more than that in terms of construction above the ceiling. The ability to provide private rooms with walls to the ceiling also increases the ease and cost-effectiveness of relocating them to suit future needs. However, is an equal or greater privacy level achievable using this alternative?

The most objective method to resolve the speech privacy question is to quantify the effects of increased attenuation and sound-masking on intelligibility. This exercise can be done using ASTM E1130-08, *Standard Test Method for Objective Measurement of Speech Privacy in Open-plan Spaces Using Articulation Index*, for calculating the articulation index (AI)—a metric of speech intelligibility taking both factors into account. While ASTM E1130 references an open-plan

Photos © Zahid Ghafoor

Sound-masking systems offer in-room occupant control using rotary volume knobs or programmable keypads, allowing users to adjust the masking as needed.

Photo © iStockphoto/Abel Mitja Varela

Increasing speech privacy and reducing the number of noise disruptions experienced by employees is key to both comfort and concentration.

Photo © iStockphoto/Dragan Trifunovic

Walls that only partially extend above the ceiling grid incur additional costs and limit flexibility like deck-to-deck construction, while also permitting sound to flank through both the ceiling and plenum like floor-to-ceiling walls.

configuration, it is generally agreed this method can also be applied to closed spaces, with slight modification to the test equipment used.

AI calculation is based on several measurements taken in the space in question, as well as a standardized normal voice level. Onsite testing determines the amount by which a voice level decreases between the source room and the listener location. This is subtracted from the standardized voice level to give the volume in the listener location. That volume is compared to the background sound level in that location. The difference between the volume of the voice relative to the volume of the background in each of the third-octave frequency bands (200 to 5000 Hz) provides the SNR in the listener location. The articulation index method assigns a specific weighting formula to determine an AI contribution within each frequency band. These are summed to arrive at the AI value.

Using this method, the impact of raising the wall attenuation and the masking level can be quantified, allowing one to compare the two strategies. As wall attenuation increases, for each decibel there is a growth in speech privacy levels. Mathematically, the same can be achieved by raising the background sound level by a decibel. To understand why, one needs only to look to the step in the above AI calculation that determines the SNR. If a wall decreases the intrusion of voice into the room by a decibel, then the SNR drops by a decibel. An identical drop occurs when the masking volume is raised by one decibel.

Depending on many factors—including mechanical system noise—the background sound level in closed rooms without sound-masking usually ranges from the low 30s to 40 dBA. Levels for sound-masking in closed rooms range from approximately 40 to 45 dBA, depending on the room's size and other conditions. In other words, sound-masking typically adds approximately 5 to 12 dBA of ambient volume. This is the reason one sometimes hears that including sound-masking adds 10 STC points to walls.

Since ceiling tile in closed spaces already attenuates sound

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When meeting room occupants find masking interferes with their ability to clearly hear one another or their use of teleconferencing equipment (if the volume is higher than 42 dBA), an in-room control allows them to turn it down or off as needed.

Photo © iStockphoto/Don Bayley

An open door virtually eliminates the sound-attenuating effect of even the most acoustically superior wall.

transmission to neighbouring areas, in most cases it is unlikely extending the wall above the ceiling will produce a greater increase in attenuation. This is particularly true when the space's design follows the recommendation for tiles with a CAC of 35 to 40. Of course, if wall and ceiling specifications are low, then benefits may be found by upgrading those elements while also controlling the background sound levels.

In most situations, sound-masking provides not only the cost and flexibility advantages, but also as good or better speech privacy. Masking also offers a measure of increased speech privacy with the door open.

Success stories

In practice, organizations designing with ceiling-height walls and sound-masking have realized both their anticipated speech privacy and cost savings.

In one example, the University of Southern California (USC) was struggling with how to achieve privacy between medical exam rooms in a healthcare consultation centre. With an open plenum, they attempted numerous successive design interventions to improve speech privacy. The addition of plenum barriers—effectively extending the walls to the deck above—did little to address the problem. According to Curtis Williams, vice-president of Capital Construction, it was the addition of masking that reduced the intelligibility of conversations between the exam rooms. This allowed patients and doctors to talk knowing their discussions could not be understood in adjacent rooms.

A major healthcare provider also recently changed its construction standards for medical office buildings away from deck-to-deck construction for similar reasons. After significant testing of mockup facilities, the company determined they achieved as good or better speech privacy with ceiling-height walls and sound-masking. They reported cost savings of hundreds of thousands of dollars for a project a little larger than 2787 m^2 (30,000 sf).

Special considerations

There are cases where one may want to implement both deck-to-deck construction and sound-masking; for example, in spaces where it is likely raised voices or high volume media will be used (*e.g.* during video or teleconferencing activities), as well as in areas with high security needs (*e.g.* requiring confidential speech privacy). Additionally, if the facility features an open ceiling, full-height walls are recommended to ensure some degree of inter-zone isolation.

It is also important to note each closed space is its own environment. Therefore, the sound-masking system should allow for localized control of the masking frequencies and volume in each of these areas. If it does not, and several offices are bundled together into a single adjustment zone, compromises may need to be made in terms of the settings—risking performance and occupant comfort. Current technologies are easily able to offer control for each individual space.

In contrast to the fixed performance provided by room construction, contemporary sound-masking technologies also offer occupants personal control over the masking volume in their own office or other rooms. Various wall controls are available; some allow users to adjust only the masking volume, while others enable muting of the masking and/or paging, and control of the paging channel, depending on the permissions set by the system's administrator. This way, occupants can control noise intrusion, but not their own speech privacy level unless the in-room control is designed to raise the sound-masking volume outside their space.

If a meeting or training room is large enough to allow the masking sound to impact occupants' ability to communicate (*e.g.* over long distances), an in-room control also allows users to adjust the masking volume to a low enough level that voice clarity is restored, but overall sound quality is maintained. Though such occurrences are rare, they are not out of the question. Low levels of masking sound (*e.g.* 42 dBA) typically have no impact on audio-visual (AV) system performance.

Sound-masking should be implemented as a facility-wide solution. If it is used as a spot treatment, the transition in ambient sound quality will be readily apparent to occupants. Additionally, if it is only employed in open areas, the lower ambient level within closed rooms exposes those occupants to the disruptions caused by conversations and activities occurring outside their space. These interruptions force the office occupant to either close the door (which can be interpreted as anti-social) or endure the noise.

Conclusion

Building cost-effective and flexible closed spaces for true speech privacy can be challenging. Nevertheless, combining physical barriers with sound-masking can ensure effective results while helping to control the cost of initial construction and future changes.

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Meet Robert.

He's in the middle of a presentation that's just been interrupted for the third time by a nearby conversation. In a moment, he'll have to ask the client to wait while he tells his colleagues to keep it down.

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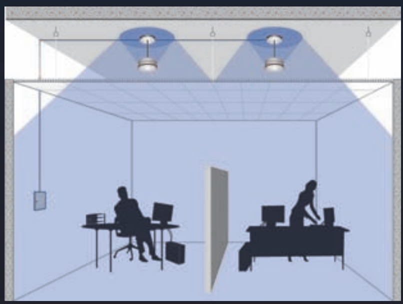
Our networked sound masking technology uses a series of loudspeakers to distribute a comfortable background sound throughout your facility. Though this sound is often compared to that of softly blowing air, it's specifically engineered to mask the frequencies in speech, increasing privacy. It also covers up intermittent noises, improving concentration and overall acoustic comfort.



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