# SONĀRE

*The Environmental Acoustics Magazine*

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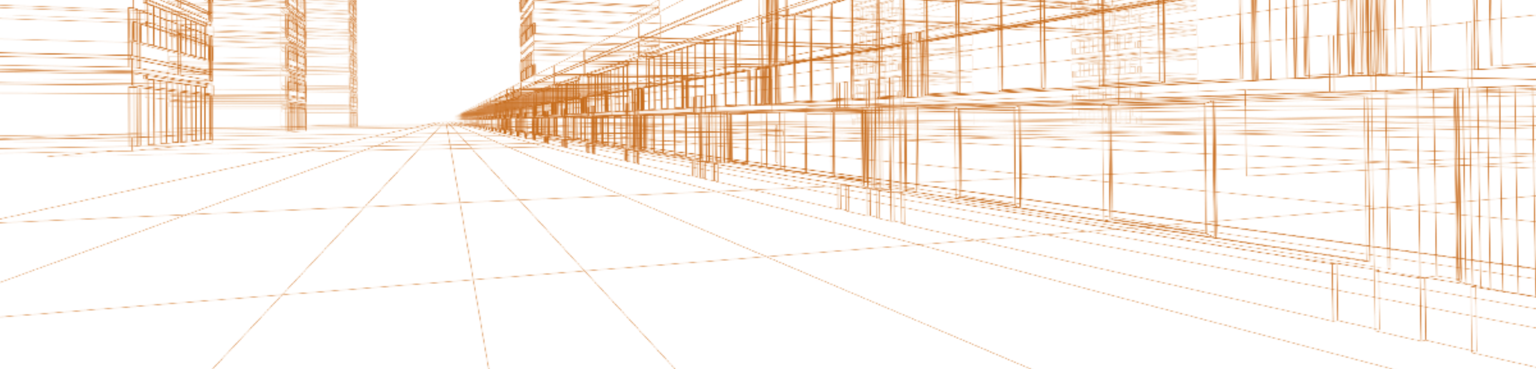
*Premiere Issue*

# A NEW APPROACH TO ACOUSTICS

## USING SOUND MASKING AS A DESIGN PLATFORM

WITH MOUNTING RECOGNITION OF THE NEED TO SUPPORT FOCUSED WORK AND PROMOTE WELLNESS, ORGANIZATIONS ARE LOOKING TO PROVIDE BUILDING OCCUPANTS WITH IMPROVED SPEECH PRIVACY, NOISE CONTROL AND ACOUSTIC COMFORT.

BACKGROUND SOUND IS KEY TO ACHIEVING THESE GOALS. INDEED, ALL ACOUSTIC DESIGN CONSIDERS THIS FACTOR WHEN DETERMINING SOUND TRANSMISSION CLASS (STC), ARTICULATION INDEX, OR SIGNAL-TO-NOISE RATIO. HOWEVER, BUILDING PROFESSIONALS OFTEN NEGLECT TO USE THE ONLY ACCURATE MEANS OF CONTROLLING THE MINIMUM BACKGROUND LEVEL – A SOUND MASKING SYSTEM – AS A DESIGN TOOL.



BY TURNING THE TRADITIONAL THREE-TIERED APPROACH OF ABSORB, BLOCK AND COVER – COLLECTIVELY KNOWN AS THE 'ABC RULE' – ON ITS HEAD AND USING SOUND MASKING AS THE STARTING POINT FOR INTERIOR PLANNING, BUILDING PROFESSIONALS CAN SET THE BASE LEVEL OF BACKGROUND SOUND THROUGHOUT A FACILITY AND, HENCE, MORE ACCURATELY SPECIFY THE BLOCKING AND ABSORPTIVE ELEMENTS USED IN THEIR DESIGN, ALLOWING IT TO BE DELIVERED IN A MORE COST-EFFECTIVE MANNER, AND WITH GREATER ASSURANCE OF ACHIEVING THE INTENDED RESULTS.

## VARIABLE VS. PREDICTABLE SOUND

Both ASTM E1130, *Test Method for Objective Measurement of Speech Privacy in Open-plan Spaces Using Articulation Index,* and ASTM E2638*, Standard Test Method for Objective Measurement of the Speech Privacy Provided by a Closed Room*, consider background sound when calculating speech privacy.

However, ASTM E2638 also reminds readers speech privacy class is only valid at the time it is measured because the background level is presumed to be provided by HVAC. Even if well-designed, this equipment's output is only governed in that it is not to exceed maximums defined by the American Society of Heating, Refrigerating, and Air-conditioning Engineers (ASHRAE) in the *2013 ASHRAE Handbook—Fundamentals*. It cannot control the minimum background sound level.

HVAC output often varies by 15 dBA or more, according to zone, time of day, and season as well as the type of equipment used. Whenever and wherever the background level falls below the assumed minimum of 30 dBA on which wall choices are typically based, occupants can no longer rely on the partition assembly for speech privacy. Furthermore, HVAC doesn't generate a spectrum conducive to speech privacy.

Speech privacy levels fluctuate from wall assembly to wall assembly, depending on their real-world performance, as well as the inconsistent noise level and spectrum generated by HVAC—not to mention sound leaks through various flanking paths. If privacy is achieved, it's largely due to good luck or overbuilding. If it isn't, a sound masking vendor is contacted. In this scenario, the technology is consigned to Band-Aid status.

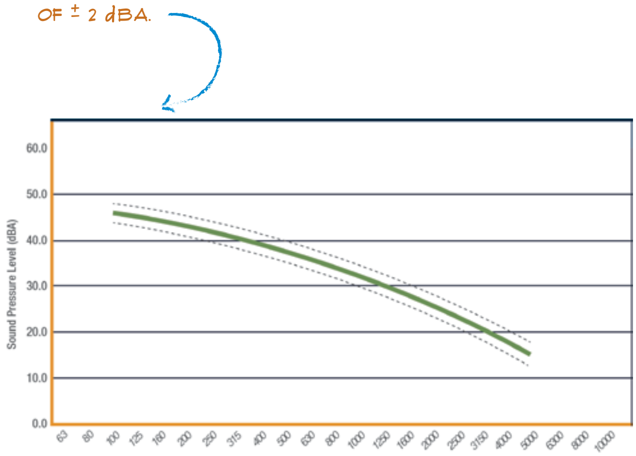
## SOUND MASKING

A sound masking system uses a series of electronic components and loudspeakers to distribute a sound most people compare to softly blowing air. However, unlike HVAC, the sound is continuous and precisely controllable.

Though this technology is often referred to by the term 'white noise,' modern systems don't utilize a particular color of sound. Rather, they're engineered so their output can be tuned post-occupancy in order to provide a spectrum or 'curve' specifically designed to balance acoustic control and comfort.

The advent of localized computer tuning—whereby software adjusts the system's output in order to meet the masking curve throughout all treated areas—means a minimum background sound level is now a readily deliverable component of architectural acoustic design. Building professionals can use this predictable, controlled level as the foundation for the remainder of their acoustical plan.

THE NATIONAL RESEARCH COUNCIL'S (NRC) OPTIMUM MASKING SPECTRUM SHOWN AT A LEVEL OF 45 dBA, AS WELL AS ONE-THIRD OCTAVE BAND TOLERANCES OF ± 2 dBA.




| | 63 | 80 | 100 | 125 | 160 | 200 | 250 | 315 | 400 | 500 | 630 | 800 | 1000 | 1250 | 1600 | 2000 | 2500 | 3150 | 4000 | 5000 | 6300 | 8000 | 10000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Spectrum* | | | 46.9 | 45.9 | 44.7 | 43.9 | 42.7 | 41.4 | 40.4 | 38.9 | 37.4 | 35.4 | 33.7 | 31.4 | 29.4 | 27.4 | 24.9 | 22.4 | 19.4 | 16.4 | | | |
| *Max Tolerance* | | | 48.9 | 47.9 | 46.7 | 45.9 | 44.7 | 43.4 | 42.4 | 40.9 | 39.4 | 37.4 | 35.7 | 33.4 | 31.4 | 29.4 | 26.9 | 24.4 | 21.4 | 18.4 | | | |
| *Min Tolerance* | | | 44.9 | 43.9 | 42.7 | 41.9 | 40.7 | 39.4 | 38.4 | 36.9 | 35.4 | 33.4 | 31.7 | 29.4 | 27.4 | 25.4 | 22.9 | 20.4 | 17.4 | 14.4 | | | |

One-Third Octave Frequency Bands (Hz)

## FORMULA FOR SUCCESS

When preparing "Sound & Vibration 2.0: Design Guidelines for Health Care Facilities"—the companion document to the Facility Guidelines Institute's (FGI) *2014 Guidelines for Design and Construction of Hospitals and Outpatient Facilities*—acousticians developed a formula providing a predictive model for this approach. Basically, to "achieve confidential speech privacy the sum of the composite STC and the A-weighted background noise level shall be at least 75," or $STC_c + dBA \geq 75$. Some refer to this formula as Speech Privacy Potential (SPP).

Because dBA is assumed to be 30, $STC_c$ must be at least 45 to achieve the combined total of 75. Using masking to apply a continuous level of 30 dBA eliminates the variability of the source, and speech privacy is more reliably achieved with the stated $STC_c$. The curve generated by a professionally-tuned masking system is also precise. Therefore, the speech privacy it provides is greater than the typically erratic spectrum produced by HVAC, even at the same volume.

While the need for speech privacy is obvious to organizations that consistently deal with sensitive information—such as hospitals and law offices—most people expect conversations occurring within closed rooms to remain private, making SPP broadly applicable.

## VALUE-ENGINEERING RESULTS

In this scenario, the masking sound is set to a level far below the one used in traditional applications. It's barely audible and yet provides the minimum necessary to accurately plan the remaining design elements. However, there are significant opportunities for further value engineering because the predictable overall volume and spectrum allows one to reduce the specifications for the room's physical shell.

If speech privacy equals $STC_c + 30\ dBA \geq 75$, then, for every 1 dBA increase in the background sound level, it is possible to reduce $STC_c$ by one point and achieve the equivalent level of speech privacy. Were the background sound to be increased from 30 dBA to 35 dBA, for instance, construction costs for partition types would start to drop significantly because the $STC_c$ could be reduced by five points.

Again, 30 dBA—and, indeed, even 35 dBA—is well below typical masking levels in closed rooms. Usually, they are set between 40 and 43 dBA in such spaces. Depending on various factors, including occupant comfort, they may be

## OPEN PLAN

### WITHOUT MASKING

UNCONTROLLED AND UNPREDICTABLE BACKGROUND SOUND LEVELS EXPOSE OCCUPANTS TO THE NOISE AND CONVERSATION GENERATED WITHIN THE OPEN PLAN, AND ALSO ALLOW THEM TO HEAR WHAT'S HAPPENING INSIDE ADJACENT CLOSED ROOMS.

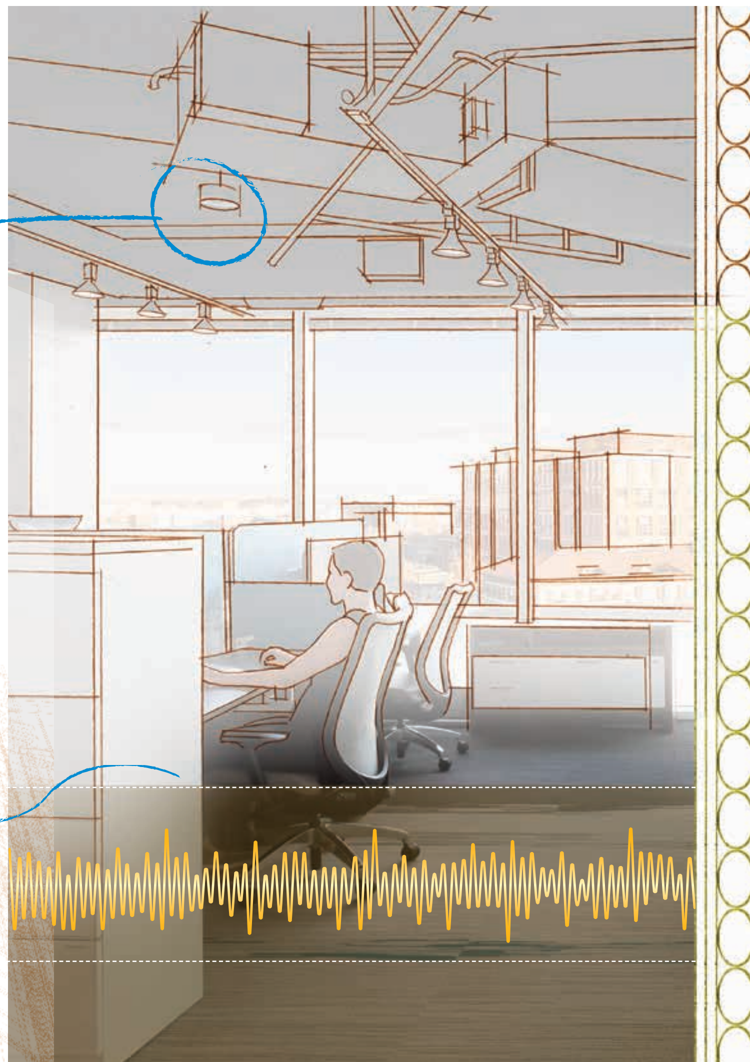
### WITH MASKING

PROVIDES OPEN PLAN OCCUPANTS WITH IMPROVED SPEECH PRIVACY, NOISE CONTROL AND ACOUSTIC COMFORT, WHILE PRESERVING THE PRIVACY OF THOSE IN CLOSED OFFICES AND MEETING ROOMS.

ALTHOUGH ENCLOSED ROOMS OFFER THE OPTION OF USING ONLY THE MINIMUM MASKING LEVEL REQUIRED TO ACHIEVE THE DESIRED SPP, OPEN PLANS DON'T HAVE THE SAME DEGREE OF PHYSICAL ISOLATION AND, THEREFORE, THE LEVEL IS DRIVEN BY DIFFERENT NEEDS. HERE, THEY'RE TYPICALLY IN THE NEIGHBORHOOD OF 47 TO 48 dBA.

USING MASKING THROUGHOUT BOTH OPEN AND CLOSED SPACES ALSO MAINTAINS A CONSISTENT ACOUSTIC EXPERIENCE THROUGHOUT THE SPACE.

AVERAGE UNMASKED BACKGROUND SOUND LEVEL



set higher. Therefore, although 30 dBA can be used as a design benchmark, the lowest STC$_c$ rating possible to achieve an SPP of 75 is actually determined by the highest comfortable level of continuous minimum background sound.

With a suitable design of sound masking, walls, and ceilings, it's also possible to achieve privacy with walls built to the suspended ceiling rather than to the structure. In one example, a major American healthcare provider changed its construction standards for medical office buildings away from deck-to-deck construction. After significant testing of mock-up 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 of just over 30,000 ft$^2$ (2787 m$^2$).

#### WITHOUT MASKING

RELYING ON HVAC TO PROVIDE AN ASSUMED MINIMUM BACKGROUND SOUND LEVEL LEADS TO OVER-SPECIFICATION OF THE ROOM'S PHYSICAL STRUCTURE WHILE LEAVING ITS ACTUAL ACOUSTIC PERFORMANCE UP TO CHANCE.

ASSUMPTION 45 STC$_c$ + 30 dBA = 75 SPP

REALITY 45 STC$_c$ + ? dBA = ?

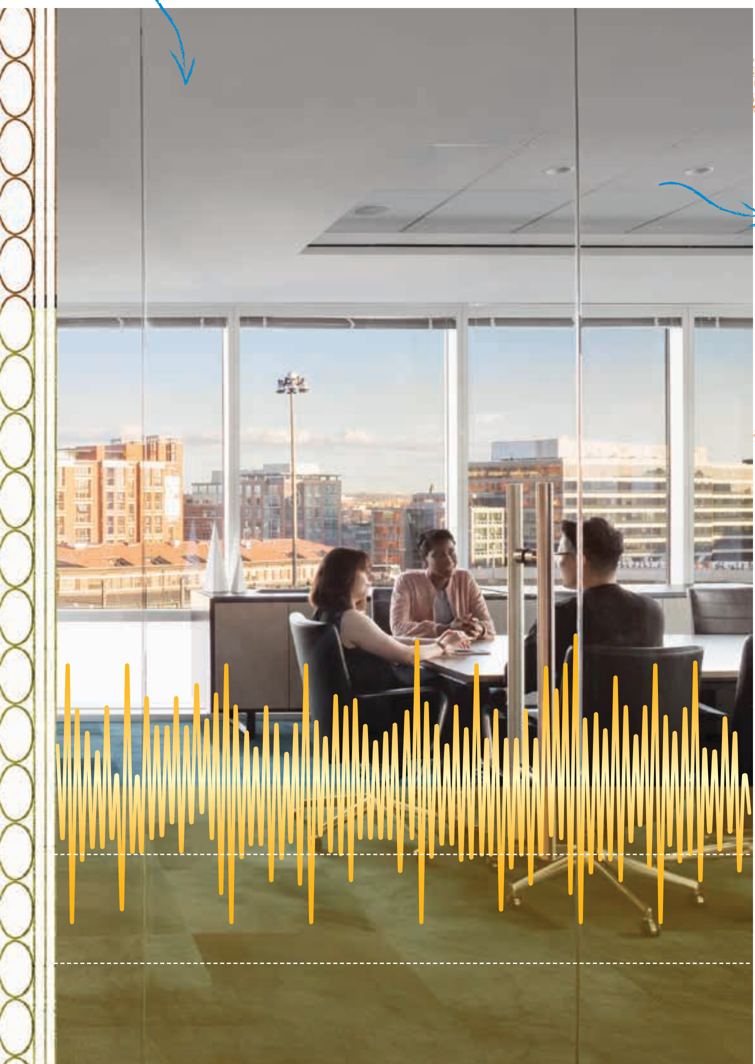


PHOTO | DEVON BANKS

## PERFORMANCE SPECIFICATIONS

It's important to note this type of integrated acoustic design is only viable when the minimum background level is precisely generated and consistently delivered by the sound masking system. Once constructed, the acoustical properties of walls and ceilings cannot be easily changed, and when engineered and installed, neither can the sound masking system's architecture.

ASTM E1111, *Standard Test Method for Measuring the Interzone Attenuation of Open Office Components*, acknowledges variations as small as 2 dBA can significantly influence speech privacy, while other studies indicate even a single dBA affects comprehension by up to 10 percent and, in almost every situation, impacts articulation index by 0.0333. Variations in spectral quality can have similarly negative effects.

Therefore, it's incumbent on those responsible for acoustic planning to ensure the sound masking system is designed and implemented with due consideration for these stringent requirements. A poorly designed or improperly tuned system can allow as much as 4 to 6 dBA variation, meaning the system's effectiveness is halved in unpredictable areas within the facility.

## CLOSED ROOMS

#### WITH MASKING

**KNOWN SPP**

USING MASKING TO ESTABLISH A KNOWN MINIMUM BACKGROUND SOUND LEVEL–EVEN AS LOW AS 30 dBA–THAT ALSO FOLLOWS A 'CURVE' DESIGNED FOR SPEECH PRIVACY ALLOWS ACOUSTIC GOALS TO BE MORE RELIABLY ACHIEVED WITH THE STATED STC$_c$.

REALITY 45 STC$_c$ + 30 dBA = 75 SPP

**LOWER STC$_c$ REQUIREMENTS**

SET THE BACKGROUND SOUND LEVEL A BIT HIGHER–FOR INSTANCE, TO 35 dBA, RATHER THAN 30 dBA–AND LOWER STC$_c$ TO 40. OR USE A STILL-MODERATE LEVEL OF 40 dBA, PERMITTING STC$_c$ AS LOW AS 35, EVEN WHILE MAINTAINING AN SPP OF 75.

40 STC$_c$ + 35 dBA = 75 SPP

OR EVEN 35 STC$_c$ + 40 dBA = 75 SPP

FLOOR-TO-CEILING WALLS

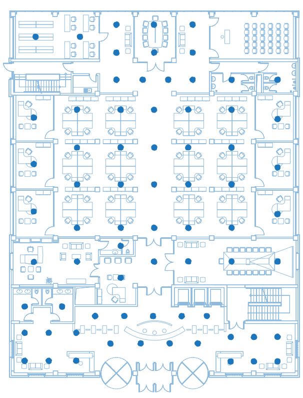
ACHIEVE FURTHER VALUE ENGINEERING AND SITE FLEXIBILITY BY ONLY BUILDING WALLS TO THE SUSPENDED CEILING. WITH STC$_c$ AT 35 AND THE MASKING LEVEL RELIABLY SET TO 40 DBA, SPP IS 75. IF THE STC$_c$ IS INCREASED TO 40 AND THE MASKING LEVEL IS RAISED TO 44 DBA, SPP IS 84.

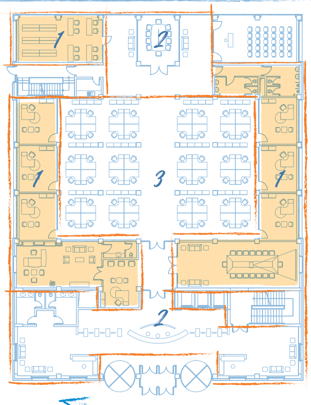
35 STC$_c$ + 40 dBA = 75 SPP

OR, FOR GREATER PRIVACY....

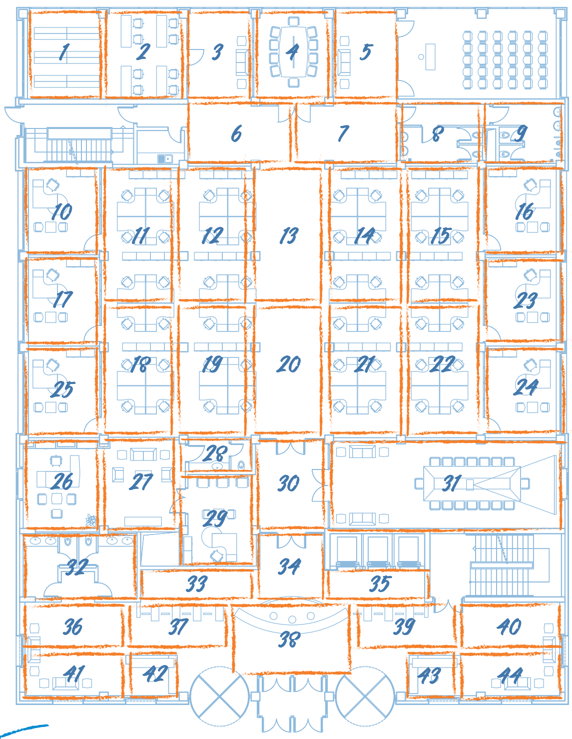
40 STC$_c$ + 44 dBA = 84 SPP

THIS ILLUSTRATION SHOWS THE PLACEMENT OF SOUND MASKING LOUDSPEAKERS (BLUE DOTS) REGARDLESS OF WHAT TYPE OF ZONING IS USED.






THIS ILLUSTRATION SHOWS A SOUND MASKING DESIGN UTILIZING LARGE ZONES. IT ASSIGNS AREAS TO SIMPLE CATEGORIES SUCH AS OPEN PLAN, CLOSED ROOM, CORRIDOR, AND RECEPTION, BASED ON THE ASSUMPTION THEY HAVE THE SAME OR VERY SIMILAR ACOUSTIC CHARACTERISTICS. NOTE THAT VOLUME AND EQUALIZATION SETTINGS FOR ZONE 1 (HIGHLIGHTED IN YELLOW) ARE APPLIED TO THREE DIFFERENT AREAS WITHIN THE FACILITY, ENCOMPASSING SEVEN PRIVATE OFFICES, THREE BATHROOMS, A BOARDROOM, A WAITING AREA, AND A MIXED-USE ROOM.



THIS ILLUSTRATION SHOWS A SOUND MASKING DESIGN UTILIZING 44 ZONES WITHIN THE SAME FACILITY. MOVING SOUND GENERATION, AS WELL AS VOLUME AND FREQUENCY ADJUSTMENT INTO SMALL CONTROL ZONES ADDRESSES THE TUNING CHALLENGES POSED BY LARGE ONES. THE TECHNICIAN CAN ADJUST THE SOUND ACCORDING TO LOCAL CONDITIONS, ALLOWING THE SPECIFIED CURVE TO BE MET ACROSS THE ENTIRE TREATED SPACE.

To maximize control over the sound, each closed room should be provided with its own loudspeaker(s) allocated to its own control zone, and each zone within open plan should not exceed three loudspeakers or 675 $ft^2$ (63 $m^2$). They should offer precise output adjustments for both volume (i.e. 0.5-dBA increments) and equalization (i.e. third-octave over the specified masking spectrum, which is typically from 100 to 5000 Hz or higher). Following installation, the vendor should tune each zone at ear height (i.e. where occupants experience the masking effects) and provide a detailed report of the results.

Although outdated specifications still in circulation might allow for a wide tolerance (e.g. up to 4 dBA), a well-designed and professionally tuned system is able to keep variations in volume to ±0.5 dBA and those in frequency to ±2 dB per third octave, providing dependable coverage throughout an installation.

## IN CONCLUSION

While acoustic professionals have always advocated the 'ABC Rule' of absorbing, blocking, and covering unwanted noise, listing 'C' last reinforces the notion it is a final consideration and perpetuates the misplaced emphasis on isolation and absorption strategies when designing for speech privacy. Instead, the approach should be CBA: cover, block, absorb. By using sound masking to define and, therefore, know exactly what the background sound level will be anywhere in a facility, one can more accurately specify the remaining materials. Further, the volume can be increased at a later date if more acoustic control is needed in order to compensate for deficiencies in partition assemblies—a flexibility uniquely afforded by this technology.

PHOTO | STEVE TSAI

## SOUND MASKING

Sound masking is tuned to follow a spectrum—or 'curve'—that's specially engineered to balance acoustic control and occupant comfort. It's essentially a perfected form of the type of non-informational background sound we experience every day, in all types of settings—whether it's the lapping of waves at the beach, the hum of distant traffic, or the buzz inside a busy restaurant. To one degree or another, this type of sound forms the backdrop to our lives, both indoors and out.

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