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Workplace Acoustical Performance: Designing for Privacy

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Abstract

Privacy, and the ability to concentrate, are essential for individual focus work as well as private collaboration. People need to be able to hear what they want to hear, when they want to hear it. They also need to know that confidential conversations are protected. Yet, knowledge workers continue to identify noise and the lack of speech privacy as leading sources of dissatisfaction in the workplace.

Tackling noise and poor privacy requires an understanding of 1) speech intelligibility, 2) ways to address unwanted speech and noise, and 3) how construction elements work together for optimal acoustical performance in the workplace.

Keywords

- Absorption
- Acoustical Performance
- Acoustics
- Confidentiality
- Distraction
- Focus
- Intelligibility
- Masking
- Privacy
- Productivity
- Reverberation
- Sound Masking
- Sound Transmission
- Speech Privacy

Takeaways

The workplace remains relevant. The reasons we go to a workplace, the activities that take place there, and the way we use a workplace may shift. But, people still need to work together, and we do this most easily when we are in the same place.

As long as people gather in a common workplace, acoustical performance and the principles that govern it will remain important. More than ever, especially now that we're realizing working from anywhere is more possible, workplaces need to get acoustical performance right.

As workplace landscapes change, approach acoustical performance by leveraging the ABCDs: absorption, blocking, covering, and diffusion.

The global pandemic has accelerated the evolution of the workplace. Returning to the workplace, employers and employees have embarked on a new paradigm that is making working from anywhere the norm.

Knowledge workers no longer need to come to work just to "get work done." Technology has enabled work to be done anywhere, anytime. And yet, while people can choose from a wide variety of spaces in which to do their best work, research from Gensler and Leesman affirms that the office remains the preferred option.[1,2]

Why?

One reason: people want to connect face-to-face. Non-verbal cues and body language can be difficult to discern when communicating virtually. Additionally, through both the Gensler and Leesman research studies, employees reported that they prefer the office for social connections, impromptu learning, collaborating on focus work, and professional development or mentoring.

> "While many employees believe they are productive at home ... they struggle with finding the right balance with work/ life, physical activity, and connection to both their organization and to colleagues."
>
> Leesman, 2020

A New Normal

The new workplace experience involves 6-foot distancing, mask wearing, reduced occupancy, and the increased use of technology to accommodate distributed team members. This creates an acoustical conundrum.

How do we maintain workplace guidelines that help people be healthy, support the ability to hear and understand one another, and maintain speech privacy?

Another challenge we face is that while we are in the workplace, we also need to do work that requires focus or concentration. We still need to work with minimal disruptions.

74% say the people are what they miss most about the office.

In either instance, we need to be able to manage what we want to hear, and what we don't want to hear. To comprehend what is important, we must first hear it clearly, while also being able to both maintain the required level of speech privacy and minimize the distracting effect of unwanted, irrelevant sounds, or noise.

Because different activities require different ways of managing acoustical information, we seek out a variety of workspaces, each with specific characteristics that support the work we're doing at the time.[3]

Historically, employers who understand and address this need for varying workspaces are more successful.[4] And these needs still exist in today's workplaces.

Numerous studies have measured employee satisfaction with their workplace environments, and have pointed to noise as a major cause of reduced effectiveness, higher stress, and decreased job satisfaction. In one landmark study, evaluations from more than 50,000 workers in 351 buildings confirmed that the lack of speech privacy was the single greatest source of dissatisfaction.[5,6] Additionally, almost 30% of those in private offices said that acoustics interfered with their ability to do their jobs.[7] This hurts innovation.

To foster innovation...

77% of employees have a preference for quiet when focus is needed.

However...

69% are dissatisfied with the noise level at their primary workspace.[8]

Strategies to improve collaboration are ineffective if the ability to focus is not also considered. Simply stated, providing employees with both the opportunity and the space to do focus work is a primary driver of organizational effectiveness.

Why is this?

1. Gensler, 2020.
2. Leesman, 2020.
3. Gensler, 2016.
4. Gensler, 2013.
5. Kim & de Dear, 2013.
6. Frontczak, et al., 2012.
7. Jensen & Arens, 2005.
8. Gensler, 2013.

Connecting and conversing requires that we hear and understand each other, through intelligible language. High-focus work takes effort, and irrelevant, unwanted sounds draw resources away from our ability to do more difficult work—whether we're doing it individually or collaboratively.[9]

Think about two people that must collaborate on a more difficult, high-focus task. They will have the same requirements for blocking irrelevant acoustical information, while needing to understand each other. To make matters more complex, sometimes what we have to say to each other needs to be private, and must not be overheard by people outside of our conversation.

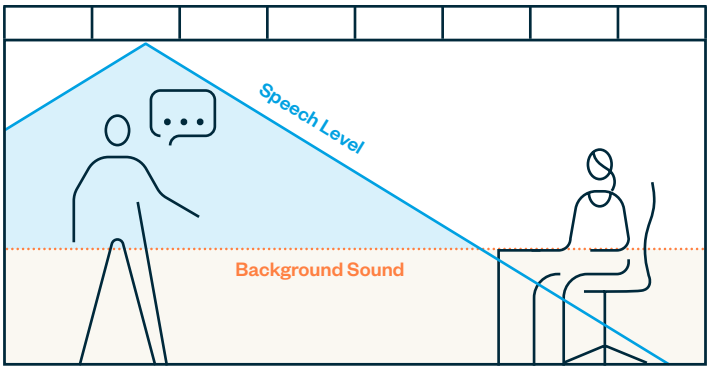
It is critical that architects, designers, facility managers, and building owners be aware of the varying and sometimes complex acoustical needs of the organizations they serve. This is true for environments such as legal offices, where confidentiality is critical; owner-occupied or leased office buildings, where privacy is expected in meeting rooms and closed offices; as well as open-plan administrative offices and call centers. In all types of buildings, and for all types of businesses, freedom from distraction, adequate intelligibility, and privacy are important—and often at the same time!

Measuring Privacy

Speech privacy can be easily understood as the absence of speech intelligibility. Speech intelligibility is based on the audibility of speech sounds as they arrive at a listener's ear, in relation to the background sound levels at the listener's location.

If the speech sounds at the listener's location are well above the background sound level, the speech sounds will be clearly heard and understood, or intelligible. But, if the speech sounds at the listener's ear are well below the background sound level, the speech will not be understood, and communication will not take place. Even when a listener is able to hear the muffled speech sounds of someone talking, privacy still exists because the listener cannot understand what is being said.[10]

This relationship of speech sounds (signal) to background sounds (noise) at the listener's location is called the signal-to-noise ratio, and it is central to the concept of speech privacy. Only where speech is not intelligible (where the intruding speech signal is well below the background sound level) does speech privacy exist.[11]



Therefore, creating a condition of speech privacy requires taking one or both of the following actions for any unintended listeners:

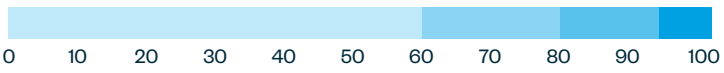
- Reduce the speech sound arriving at the listener's location
- Increase the background sound level at the listener's location

Following this concept, standards have been developed which define levels of speech intelligibility and privacy in terms of a measure called the Privacy Index.[12]

Confidential Privacy Requires a PI ≥ 95

The Privacy Index rating is interpreted based on levels ranging from 0 (least privacy) to 100 (most privacy) validated through extensive research.[13] While the measurement range is broad, confidential privacy is only achieved at the highest numbers on the scale (PI ≥ 95).

Privacy Index (PI)



No Privacy

Non-Intrusive
Overheard speech may be disruptive[14]

Poor
Speech is readily understood

Confidential
Overheard speech is not intelligible

9. Escera and Corral 2007; Sussman, Winkler, and Schröger 2003; Parmentier et al., 2011.
10. Cavanaugh, Farrell, Hirtle, & Watters, 1962.
11. Egan, 1988.
12. ASTM International, 2016.
13. Young, 1965; Pirn, 1971; Bradley & Gover, 2003.
14. Johnson, Goodchild, Burrows and Viator, 2019.

Ensuring the Right Levels of Speech Privacy

Addressing these three factors to create an effective acoustic design in the workplace doesn't have to be complex—it can be as simple as ABCD.

Effective Acoustic Design

Achieving the desired level of speech privacy requires careful assessment and alignment of three key factors:

Functional Needs

Consider the privacy expectations of the primary users of each space, and the likely voice levels, using the Privacy Index shown on the previous page as a guide.

Private Offices, Small Conference Rooms, and Spaces for Intensive Focus Work
Confidential privacy is the common design goal. Users of these spaces generally assume their conversations will not be easily understood by people outside the room. Ideal for difficult focus work that cannot tolerate disruption.

Larger Conference Rooms and Social Spaces
In these larger spaces, it is important to ensure that speech is intelligible for all intended listeners, but blocked from adjacent spaces.

Individual Workstations, Retreats, and Spaces for Light Focus Work
Suitable for less intense focus work and restorative activities that can tolerate some acoustical disruption. Non-intrusive privacy is a common design goal.

Collaboration Spaces and Project Rooms
Disruption from outside the space should be minimized to support the collaborative focus work of the team. Likewise, voice levels of the collaborative team need to be contained, so as not to distract people in adjacent spaces.

Cafés and Lobbies
While open, these spaces are intended to be welcoming and inviting. Small groups should be able to have semi-private conversations without excessive reverberation and sound transmission beyond the intended listener(s).

Ambient Environment & Background Sound

The background sound which exists in the space must be controlled to ensure a non-intrusive background sound, at the right level.[13] Most important of these factors are:

HVAC Noise
New buildings, with high-efficiency air conditioning systems, tend to have extremely low inherent background noise levels. Conversely, older buildings may have loud HVAC systems, but they may be emitting lots of sound at frequencies ineffective for masking speech.

Urban Environments
Urban environments may have high levels of traffic noise.

Walls, Ceilings, & Absorption

Introduce the structures and materials necessary to block and absorb sound between and within spaces. The manner in which these are deployed will have a direct effect on both speech privacy and speech intelligibility. It is necessary to consider both room acoustics and building acoustics:

- When the listener and the sound source are in the same room, absorption mitigates excessive reverberation or echo that can make understating speech very difficult.
- When the sound source and the listener are in separate rooms, sounds transmitted to adjacent rooms can be disruptive. In these cases, walls and ceilings are the primary tools used to block sound. Absorption can also be added to the receiving room, further reducing the legibility of speech sounds.

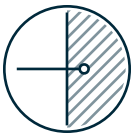
15. Cavanaugh, Farrell, Hirtle, & Watters, 1962.

Acoustic Design Fundamentals: A to D

Speech privacy can be effectively delivered through appropriate application of four primary acoustic design tools, described as "ABCD":

(A) Absorb

Absorb sounds within the space

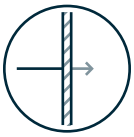


Highly absorptive ceilings and carpeted floors

- Reduce sound levels within rooms
- Minimize undesirable reflections
- Performance indicated by NRC or SAA rating

(B) Block

Block sounds between the spaces



Physical construction using demountable or unitized wall systems and suspended ceiling tiles

- Block sound transmission between rooms
- Wall sound blocking indicated by STC ratings
- Ceiling sound blocking indicated by CAC ratings

(C) Cover

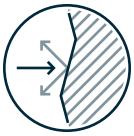
Cover intruding sounds with background sound

Electronic sound masking system

- Carefully tuned in frequency and level to meet desired functional and privacy needs of different areas throughout the space
- Indicated by the sound level, measured in dBA

(D) Diffuse

Spread sound energy evenly in a space



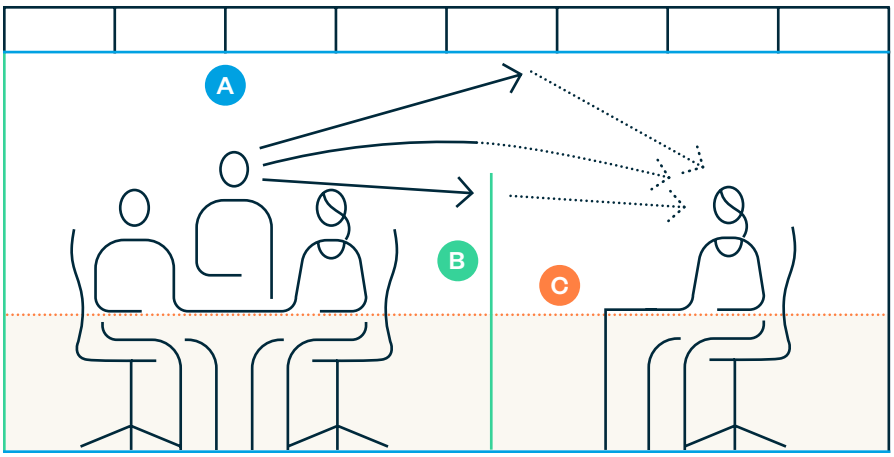
In larger spaces, physical construction using sound diffusers placed on the walls or ceiling

- Diffuse, or scatter desired sounds throughout the room to ensure intelligibility
- Keep desired sounds from being absorbed and degraded before reaching listeners

Putting It Together

As in all good design, multiple factors need to be kept in balance with each other, in a way that serves functional needs. Likewise, achieving an effective acoustic environment requires using each of the building blocks appropriately, and in balance with the other elements. Haworth's extensive knowledge developed through our own research and experience with our customers, provides valuable insight to the ratings, as well as combinations which yield the desired results.

Spaces for Focus Work



We seek these spaces to minimize noisy distractions.

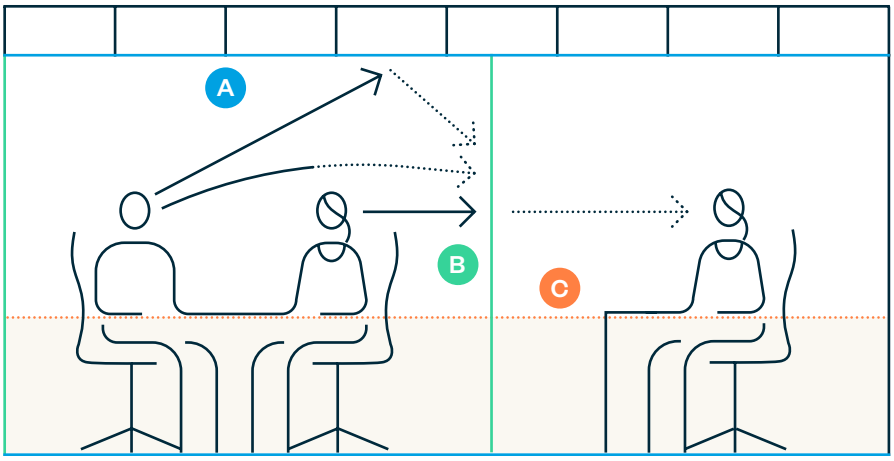
PI > 80: Non-Intrusive

(A) Materials with NRC/SAA of 0.60 or better on ceilings and suspended baffles

(B) Walls or other separations may be needed

(C) Background sound levels of 46–48 dBA

Private Offices and Small Meeting Rooms



We seek these spaces to minimize noisy distractions.

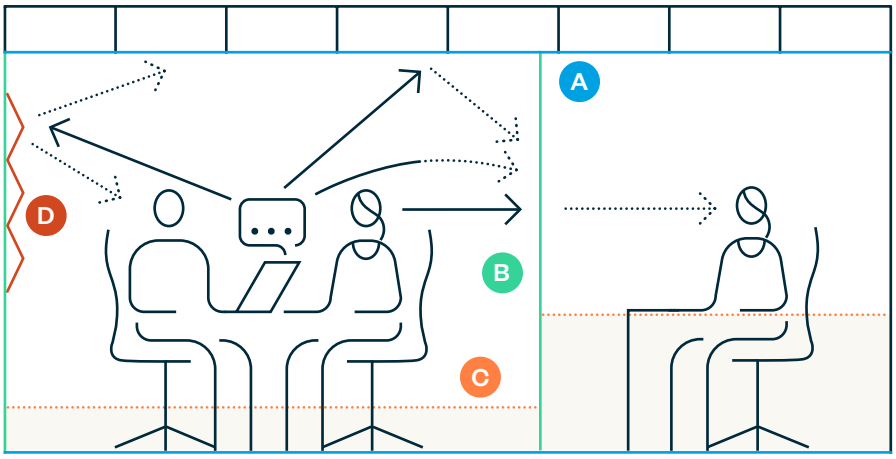
PI ≥ 95: Confidential

(A) NRC/SAA of 0.60 is adequate

(B) Walls to ceiling with STC in high 30s, and CAC ceiling in the high 30s with minimized penetrations

(C) Background sound levels of 42 dBA (may be reduced with higher STC and CAC)

Large Meeting/Teleconferencing Rooms



These rooms are typically expected to ensure confidentiality, but teleconference equipment requires greater absorption.

PI ≥ 95: Confidential

(A) NRC/SAA of 0.70 or greater

(B) Walls with STC of 42 and ceiling with CAC of 42

(C) Background sound in meeting rooms is limited to aid intelligibility, but higher in adjacent rooms to ensure privacy

(D) Diffusion on perpendicular surfaces to evenly distribute sound throughout the room

Conclusion

The investment in facilities is significant for any organization. Ultimately, facilities serve the organization and its people. With noise and speech privacy as leading causes for concern in the workplace, appropriately addressing acoustical performance benefits both the organization and its employees. When construction elements work together to accurately control levels of speech intelligibility and honor privacy, people hear what they need to hear, when they need to hear it. Investing in the right acoustical workplace designs for each area, based on function and use, creates the necessary environment for focus, productivity, and innovation.

Learn More

For more information on creating environments to support workflow and encourage productivity, read these white papers:

- Designing for Focus Work
- Movable Walls & Raised Floors: Optimizing Adaptable Workplaces to Meet Changing Business Needs
- Optimizing the Workplace for Innovation: Using Brain Science for Smart Design

Acoustic Terminology

Understand some important terms commonly used in acoustic design.

A-Weighted Decibel (dBA)
Measure of a sound level averaged across multiple frequencies, and weighted to reflect the sensitivity of human hearing to different frequencies. The A-weighted scale gives relatively less importance to high and low frequencies.[14]

Ceiling Attenuation Class (CAC)
Single-number rating of the transmission loss (TL) of a ceiling suspended over a partition separating two rooms with a common ceiling plenum.[15] A higher number indicates more sound will be blocked. Like STC, CAC is measured only in a laboratory, and describes the performance only where the ceilings cover both rooms.

Decibel (dB)
Standard measure of sound pressure level at a specific frequency. Though pressure is normally measured in Pascals or psi, the decibel is used for sound pressure measurement because the range of values of sound pressure vary greatly from the threshold of hearing (0 dB) to the threshold of pain (above 120 dB), and because the human ear responds to varying pressure levels logarithmically.[16]

Hertz (Hz)
Measure of the frequency of the sound wave, or the number of times the wave cycles, each second. In music, specific frequencies correspond to specific notes on a musical scale (e.g.: middle-C corresponds to 261.6 Hz). The frequency range of human speech extends from about 160 Hz to nearly 5,000 Hz.[17]

Noise Isolation Class (NIC)
Single-number rating indicating the sound isolation between two adjacent rooms or spaces in a building.[18] A higher number indicates more sound will be blocked. Unlike STC or CAC, NIC is a measure of the actual constructed space, not just a wall, and includes the effect of all construction elements and materials together.

Noise Reduction Coefficient (NRC)
A measure of the ability of a surface material to absorb sound in mid-frequency ranges. It is the average of the absorption at four frequencies from 250 to 2000 Hz, expressed as a number from 0.00 to 1.00, rounded to the nearest 0.05. A higher number indicates more sound is absorbed.[19] Testing for NRC will use one of several different mounting methods, denoted by a letter code, sometimes also followed by a number (e.g.: E400). NRC values for different materials should be compared only for like mounting methods.

Privacy Index (PI)
Degree of privacy between two spaces. It is expressed as a number from 0 to 100 (though it is not an indication of the percentage or fraction of speech that will be overheard). It takes into account the acoustical performance of all construction elements, the background sound level, and the voice level and spectrum of the talker. PI values greater than 80 indicate some degree of privacy is to be expected.[20]

Sound Absorption Average (SAA)
A measure of the ability of a surface to absorb sound, intended to replace NRC. It is the average of the absorption at 12 frequencies from 200 to 2,500 Hz, and is expressed as a number from 0.00 to 1.00, rounded to the nearest 0.01. A higher number indicates more sound is absorbed. Testing for SAA follows the same method as for NRC.[21]

Sound Transmission Class (STC)
A single-number rating of the sound transmission loss of a partition. A higher number indicates more sound will be blocked.[22] Differences of less than 2 points are generally indistinguishable by the human ear (e.g.: walls rated STC 44 and 46 will likely sound about the same). STC is only measured in an acoustical laboratory; similar field measurements will be termed ASTC (Apparent Sound Transmission Class), and will be lower.

16. Cavanaugh, and Wilkes, 1999.
17. ASTM International, 2016.
18. Cavanaugh, and Wilkes, 1999.
19. Cavanaugh, and Wilkes, 1999.
20. ASTM International, 2013.
21. Egan, 1988.
22. ASTM International, 2016.
23. ASTM International, 2013.
24. Egan, 1988.

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Beck Johnson holds a B.S. in Scientific and Technical Communication and an M.A. in Communication. With 15+ years of experience in social science research methodologies and as a Senior Research Specialist at Haworth, she conducts primary and secondary research at the intersection of human and organizational performance in the workplace.

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