Attaining Speech Privacy

with Acoustical Ceiling Panels

Armstrong®
World Industries

Office Acoustics

The message is loud and clear: office employees have long considered the intrusion of unwanted noise as one of the leading sources of workplace dissatisfaction.

Over the years, study after study has measured employees' satisfaction with their workplace environment and the results have continued to point to noise as a major cause of reduced effectiveness, higher stress, and declining job satisfaction.

The studies also indicate the majority of acoustical complaints in offices relate to speech privacy – overhearing an unwanted conversation or feeling that they are being overheard.

The Center for the Built Environment (CBE) at the University of California at Berkley surveyed 23,450 respondents from 142 buildings on building satisfaction. More than 50% of cubicle occupants and 30% of those in private offices say acoustics interfere with their ability to get their job done. In fact, in indoor environmental quality, poor acoustics causes the most dissatisfaction – even more than thermal comfort, lighting and air quality.

In addition, the Gensler 2013 US Workplace Survey examines "What Factors Drive Workforce Performance?" The company commissioned a nationwide survey of 2,035 professionals to examine the design factors that create an effective workplace. They found that U.S. workers are struggling to work effectively and overall work performance has dropped 6% since the last Gensler study in 2008. Time spent focusing has increased 13% since the 2008 study, while time spent collaborating has decreased 20% during the same time period.

Increased Noise Classes

Contributing factors:

- Increased workstation densities and benching arrangements, which means more employees are working in closer proximity to each other than ever before.
- Creation of "collaboration" areas that increase noise classes as a result of interactive conversations required in this type of environment.
- More widespread use of speakerphones and the tendency of employees to speak more loudly when using them.
- A growth in the architectural trend toward exposed structure roof deck designs and the reverberation problems that accompany them.

As a result of trends like these, architects, interior designers, building owners, and facility managers all need to be more aware of speech privacy. Speech privacy is quickly becoming a concern in a variety of buildings ranging from healthcare facilities, where physician-patient confidentiality is critical, to owner-occupied and for-lease office buildings, where privacy is needed in meeting rooms and board rooms as well as in closed offices.

Speech Privacy

In order to attain an appropriate speech privacy performance for a particular architectural space, it is important to be familiar with the acoustical performance parameters that influence it. The term speech privacy itself, refers to how well an overheard conversation is understood by an unintended listener. The commonly recognized categories of speech privacy are:

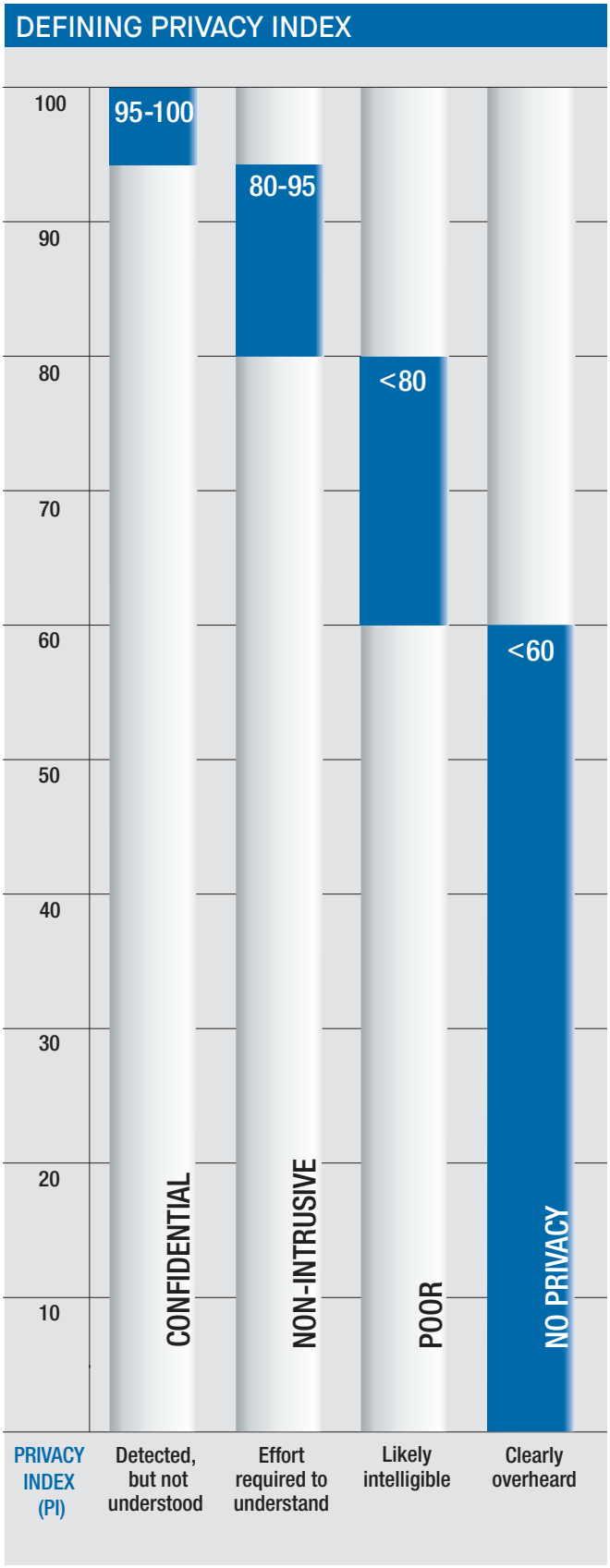
Confidential – Represents a Privacy Index (PI) of 95 to 100. Nearby conversations may be partially audible, but definitely not understood. Co-workers may hear muffled sounds but the meaning of spoken words is not intelligible, and they are not distracted from their work.

Non-Intrusive – Represents a PI between 80 and 95. Nearby conversations can be partially overheard, and some words or phrases may be intelligible. Co-workers may hear some of the conversation but the loudness of speech is not distracting, and they can generally continue with their work.

Non-intrusive speech privacy is the most common design goal for most open plan office environments, especially where "knowledge worker" productivity is a key issue. However, it is generally not an adequate design goal in functional environments such as medical facilities, law firms, financial service organizations, or human resource departments, where confidential speech privacy is generally required.

Poor – Represents a PI of 60 to 80. Most nearby conversations can be overheard and are likely intelligible. Co-workers can understand most words and sentences and the loudness of speech may be distracting to them.

No Privacy – Represents a PI of 60 or less. All conversations can be clearly overheard and are fully intelligible. Co-workers can understand all words and sentences and the loudness of speech can be a constant distraction.



Office Acoustics

Balanced Acoustical Design

One of the most effective methods for achieving speech privacy in office environments is the use of an approach called balanced acoustical design. It consists of three key elements, which are often referred to as the "ABCs of Balanced Acoustical Design." If any of the elements are missing or out of balance, speech privacy will be compromised. These elements are:

- Absorb sound within a space by the use of high performance acoustical ceiling and wall treatments that prevent unwanted sound from building up due to reflections and/or intruding into an adjacent space.
- Block sound transmission between spaces with a combination of high performance ceilings and effective partition wall or furniture panel design and layout.
- Cover the remaining intruding sound with an evenly distributed electronic sound masking system that can be adjusted to meet the desired speech privacy.

Acoustical Performance Indicators

To better understand the elements of a balanced acoustical design and other acoustical solutions, it's important to be familiar with the main indicators of acoustical performance.

Noise Reduction Coefficient (NRC) Indicates the ability of a surface, such as a ceiling, to absorb sound from all angles. It is expressed as a number between 0.00 and 1.00, and indicates the average percentage of sound the ceiling absorbs. The higher the number, the better the surface acts as a sound absorber.

Ceiling Attenuation Class (CAC) Indicates the ability of a ceiling to block sound in one room from passing up into the plenum and transmitting back down into an adjacent closed space that shares the same plenum. The higher the number, the better the ceiling acts as a barrier to sound intrusion between closed spaces.

Sound Transmission Class (STC) Indicates the ability of a wall or furniture panel to block the transmission of sound through it and into an adjacent space. The higher the number, the better the construction acts as a barrier to sound transmission.

Privacy Index (PI) Indicates the level of speech privacy between spaces and takes into account the acoustical performance of everything in the space. The higher the number, the better the speech privacy, and the less likely an overheard conversation is understood by an unintended listener.

The attainment of speech privacy is dependent on good acoustical design and the proper selection of interior systems and materials. In that regard, the proper choice of a ceiling can serve to both limit the sound intrusion between spaces and affect the quality of sound within a space. The ceiling is thus a key element in creating an acoustical environment that can maintain speech privacy.

To achieve total acoustic quality, which is the ideal combination of sound blocking and absorption of unwanted sound, acoustical ceiling products should be specified with high performance attributes according to two essential measurements – CAC and NRC.

Ceiling panels with CAC ratings of 35 and higher as well as NRC ratings of 0.60 and higher will help block and absorb unwanted sound in open office spaces used for both collaboration and focus work. These attributes are even more important in closed offices where privacy is key and sound could otherwise travel to adjoining spaces such as other offices and corridors.

Focus Areas – Open Plan

Focus areas are most likely to be in an open plan setting with multiple work stations separated by furniture panels; minimizing noise and distractions within the space are key. It is also important to minimize transfer of sound in all directions.

Suggested solutions to use for this type of area are a high NRC rated panel to reduce distraction within the space and a panel with good CAC properties to reduce the sound from the plenum and reduce sound leakage into the space.

Collaboration Areas – Open Plan

In office building collaboration areas, interaction and teaming activities require open communications within groups. There is also need for two groups to be working on separate tasks in the same collaboration area. These spaces are likely to be open plan in design and speech intelligibility is key.

Acoustic systems with moderate to high NRC and good CAC to contain activity, should be used to preserve and enhance speech clarity. This will allow for group collaboration in these spaces while still having significant acoustic separation for adjacent privacy and focus areas.

Privacy Areas – Closed Plan

Privacy areas are spaces where sensitive conversations such as legal, financial, human resource related, and doctor-patient, can be held in confidentiality. These spaces should be closed plan areas where speech privacy and low background sound are key needs; so it is important to minimize sound transfer in all directions. High NRC and CAC rated ceilings increase speech clarity for those in the room while preserving confidentiality.

Electronic Sound Masking

Speech privacy is a function of the sound isolation between spaces and the ambient background sound within a space. The sound isolation provided by the architecture and the interior finishes (wall construction and ceiling panels) and the background sound can come from either the air delivery system or an electronic sound masking system.

Proper choice of acoustical ceiling and wall treatments will help lower the level of the intruding sound. In the past, background sound contributed by heating, ventilating and air conditioning (HVAC) equipment was generally sufficient to assure adequate speech privacy. However, with the advent of quieter HVAC equipment, particularly variable air volume (VAV) systems and underfloor air distribution systems, this is no longer the case.

Consequently, a different source of controlled background sound may be needed to mask the intruding sound of speech and to preserve the privacy of a conversation without being obtrusive in and of itself. That sound is called electronic masking sound.

Ceiling Penetrations

Light fixtures, sprinklers, air diffusers, and other penetrations can present a challenge in some ceiling spaces. Two key techniques can be employed to ensure that speech privacy is maintained.

First, according to an acoustical study performed by acoustical consultants at Acentech, the ceiling system CAC has a significant effect on speech privacy index – even in cases of poor ceiling layout/design.

Second, Acentech found that speech privacy is further improved by good architectural ceiling design. Good ceiling design includes having diffusers and lights at least four feet from common walls and ducting or using boots on the air return.

In addition, the vast selection of light fixtures available provide many options that enhance sound isolation and preserve speech privacy.

Summary

Some manufacturers hypothesize that since the ceiling plane is compromised by penetrations, investing in a high CAC panel contributes little to achieving necessary speech privacy. Field measurements conducted in a real working office by an independent acoustical consultant, show that CAC does indeed matter and that increasing a panel's NRC can't compensate for a low CAC.

The minimum acceptable CAC of 35 was shown to be valid according to this field study, thus backing up design experience gained over the last 40 years in building research.

Acoustical Case Study Independent Acoustical Measurements and report by Acentech Inc.

Acentech, an acoustical consulting firm headquartered in Boston, Massachusetts, conducted a field test of acoustic performance using two types of ceiling tiles in a working office environment.

Acoustical Tests Completed

– Noise reduction between spaces was measured with testing done per ASTM E336.
– Reverberation time within the space was calculated using ASTM E2235
– Privacy index was measured according to ASTM E1130

Field Test Parameters

Two adjacent offices of the same size and design were used to conduct these tests. Each office was generally rectangular in size with dimensions 10 ft. x 14 ft. x 9 ft. The ceiling was suspended under a five foot open ceiling plenum that ran continuously over the common wall. The offices each had two drywall walls, one acoustically treated wall (NRC 0.60) and one wall of glass; the floors were commercial carpeting.

Conclusions

Making an investment in a closed office or conference room is done because confidential speech privacy is both expected by the occupant and is necessary to conduct certain types of business. Privacy is expected in situations where business in financial, medical, human resources, law, etc., are being conducted. These requirements are mandatory by regulations such as the Health Insurance Portability and Accountability Act (HIPAA), and are written into standards such as the FGI Guidelines for Design and Construction of Healthcare Facilities, ASHRAE 189.1, LEED, and WELL.

The ceiling system CAC has a significant effect on speech privacy – even in cases of poor ceiling layout/design when measured in a real office environment. Speech privacy is further improved by good architectural ceiling design.

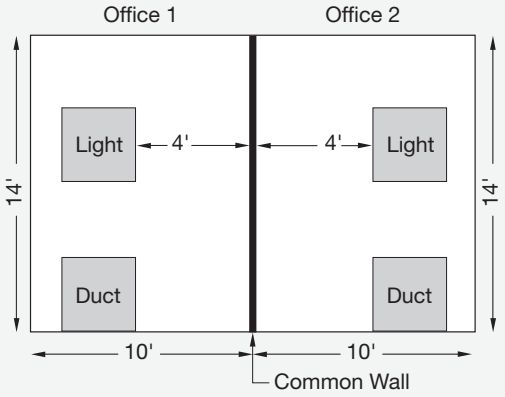
Products and Scenarios Tested

Armstrong® Ceiling Panel: Acoustical ceiling tile with NRC 0.75/CAC 35

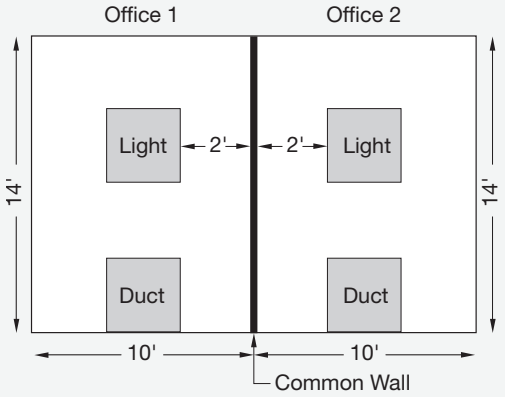
Competitor Ceiling Panel: Acoustical ceiling tile with NRC 0.90/CAC 22

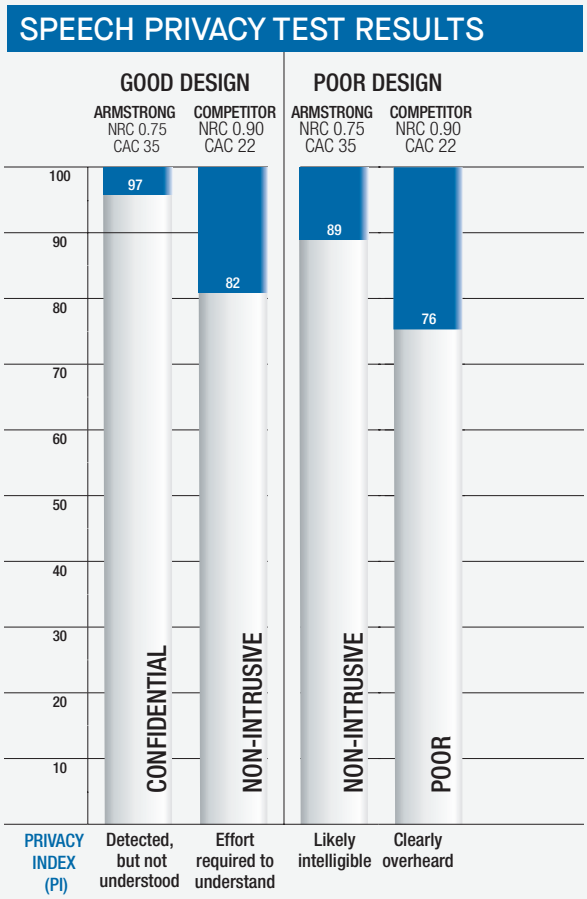
Situation: Both products were tested in each of the following scenarios:

1. Good design – 2' x 2' lights 4 ft. from common wall, 2' x 2' ducted grill return 4 ft. from common wall with 90 degree boot.



2. Poor design – 2' x 2' lights 2 ft. from common wall, 2' x 2' open grill return 2 ft. from common wall (no boot).

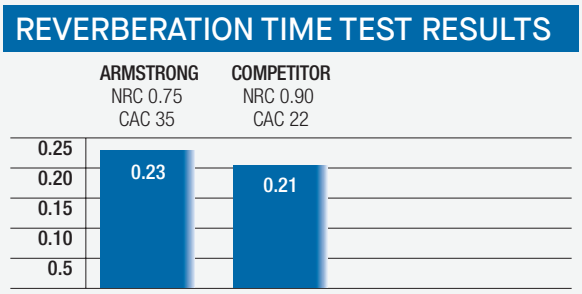




Measured Noise Reduction Test Results

When good mechanical, electrical, and plumbing (MEP) design was used, the CAC 35 tile outperformed the CAC 22 tile by 9.1 dB. This means that intruding sound will be half as loud with the CAC 35 ceiling tile.

Reverberation time is a measure for rating the quality of the sound environment within an architectural space.The reverberation time as averaged over four measurements in each room with each ceiling tile, and averaged over the mid-frequency range (range of speech) were as below:



Results

Using a ceiling with CAC 35 versus a CAC 22 resulted in a substantial difference in speech privacy performance between the spaces. The difference in speech intelligibility within the space was imperceptible using a ceiling with NRC 0.75 versus NRC 0.90.

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