SIA ACOUSTICS
A division of Robert Derector Associates

## A PRACTICAL GUIDE TO OFFICE ACOUSTICS

# Part 1: Frequently Asked Questions

This series of seven short 'white papers' is intended to present the key acoustical issues in office design and construction. Our goal is to help Architects, Office & Project Managers evaluate the acoustical performance needed to meet expectations on their projects.

We find that the acoustics of modern offices are increasingly important and are often overlooked in the design effort. Issues such as; noise control, privacy, speech intelligibility, distraction, and the use of teleconferencing are all important to consider in the design of offices. The following notes are intended to explain the key issues and help guide the design process.

**Topics:**

1. Frequently Asked Questions
2. Privacy
3. Ambient Noise
4. Room Acoustics
5. Telephone Booths
6. Teleconference Rooms
7. LEED Acoustic Performance

## PART 1: FREQUENTLY ASKED QUESTIONS (FAQs)

We start this series of 'tech-notes' with a set of Frequently Asked Questions (FAQs). These FAQs address basic questions about the acoustical issues of office design.

### Q1. What is the difference between Room Acoustics and Room Isolation?

**A1.** Room Acoustics usually refers to the sound within a room. For office spaces, the main acoustical goals are typically; to achieve a comfortable place to speak, adequate speech intelligibility and acceptable use of a speaker/conference-call system. Meeting these goals is mostly a function of the room finishes, such as; if an Acoustical Ceiling (typically Acoustical Tile) or Carpet is used, or the use of acoustical panels on the walls or built into workstations or credenzas.

Room Isolation is the ability to contain sound within a room and block sound from spaces outside of the room. Room isolation is primarily determined by the construction of the walls, ceiling, doors, glazing and penetrations of the room (such as ductwork and conduits).

It may seem counter-intuitive, but adding acoustical panels inside of a room that help control sound within the room, will (in general) *NOT help with room isolation*! This is a common mis-understanding and one that can be costly to correct.

### Q2. What is STC and how does it relate to what I will actually hear?

A2. STC stands for Sound Transmission Class. The STC is a single number metric that is used to indicate the ability of a partition to 'block' sound. The higher STC value, the more sound is 'blocked'. It is important to note that you can easily pick a partition with a higher STC value and then unintentionally reduce its performance by adding untreated penetrations for ductwork, conduits or wall boxes. Below is a table that shows what the AUDIBLE EXPERIENCE is for various STC value partitions.

| What is Heard From Adjacent Spaces? | STC Value |
|---|---|
| Normal Speech can be understood easily | 25 |
| Normal speech audible but not well understood, Loud speech well understood | 30 |
| Loud speech audible but not well understood | 35 |
| Beginning of "privacy" | 40 |

| | |
|---|---|
| Loud speech audible, amplified speech clearly audible | 42 |
| Loud speech audible but not well understood | 45 |
| Loud sounds such as amplified speech can be faintly heard | 50 |
| Superior soundproofing. Most sounds inaudible. | 60+ |

We find that using this table, which directly links the occupants experience with an STC value, is a useful way to help clients understand the issue and make informed choices as to wall constructions.

## Q3. What role does wall construction play in achieving privacy in office design?

**A3**. Wall types play an important role in determining the level of privacy achieved in an office design. The most basic wall separating two adjacent private offices typically consists of a single 3-5/8" metal stud, batt insulation, and one layer of 5/8" gypsum board on each side, extending just above the ceiling (typically Acoustical Tiles).

This basic construction will provide a modest level of privacy, usually suitable for most offices, where common sounds from adjacent spaces are audible but not disruptive. This basic construction provides usable offices with limited Privacy.

To improve this level of privacy, offices can be constructed with insulated walls that extend slab to slab. Using slab to slab wall construction improves the level of privacy, to make loud voices from adjacent spaces audible but not easily understood. In most cases, this is a significant improvement in privacy.

Adding additional layers of gyp, resilient channels and even using double studs are all construction details that can be used when a higher level of privacy is required. Please note that in all cases, the way that penetrations of walls are detailed, (for doors, windows, conduits, ducts, etc..) can affect the level of privacy achieved.

## Q4. Does the type of door seal used matter (if any)?

**A4**. Doors are often the 'weak point' in terms of acoustical isolation of a room. Even with a heavy door panel with a high STC rating, the overall performance of the door is often limited by the quality of the perimeter seals.

For typical hollow metal or wood doors, adjustable neoprene perimeter seals and operable drop-bottom seals perform the best. A close second would be non-adjustable perimeter seals, followed by adhesive type weather stripping (although we find these wear out quickly on frequently operated doors).

For glass doors that are part of an office-front glazing package, it is generally best that the seals come directly from the manufacturer of the wall/door system, as they are best able to coordinate attachment. Many manufacturers also offer drop-bottom seals and perimeter seals. This is important to review in addition to the STC ratings of the walls, published by the manufacturers, which often do not reflect the performance of the door and seals.

## Q5. What role does the HVAC system design play in achieving Privacy?

**A5.** Any penetrations through an acoustical partition can act to degrade the acoustical performance of the partition if they are not properly coordinated and detailed. This is especially true for large ductwork penetrations and/or open return air transfer grilles.

Generally, it is best to route ductwork through walls that are not sound critical. For private offices, it is typically better to route ductwork through the wall facing the corridor rather than through the wall to adjacent private offices. This is because privacy between adjacent offices is typically more important than privacy from a corridor.

Of course, there are always cases where routing ductwork through acoustically critical walls is unavoidable. In these cases, there are a number of solutions that can be used to maintain adequate privacy such as; adding internal or external acoustic lining to the duct, duct silencers, extra lengths of duct and/or additional elbows. The best and most cost-effective solution will vary based on the level of isolation or privacy required.

The use of open air transfer grilles is one of the most common ways in which privacy is unintentionally degraded. We recommend using internally lined transfer ducts which incorporate a number of 90-degree elbows to maintain privacy.

## Q5. Do the acoustics of conference rooms matter?

**A5.** A good conference room has both adequate speech intelligibility and privacy. This is especially important in today’s work environment with office floor plans becoming more densely populated, and with more open plan designs. With more workers in smaller spaces, it has become more important to have meeting spaces that offer a quiet and private work environment.

## Q6. Why are the acoustics of teleconference rooms so important?

**A6**. Every modern teleconference system has echo cancellation capabilities. This feature avoids echoes and feedback by filtering out delayed sounds from the conversation. Even the most sophisticated teleconference systems can fail at reducing echoes and feedback in an overly reflective or reverberant room. Teleconferencing systems perform better in rooms that are acoustically treated to address tonal balance and eliminate unwanted reflections.

It is also important to limit background noise levels in teleconference rooms. This is because microphones actually pick up background noise more easily than the human ear. While the noise may not be disturbing to in-person attendees, it can be disturbing to attendees listening in via the teleconference system. A higher background noise level can also interfere with the echo cancellation capabilities of the system.

## Q7. What is sound Masking, why is it used and when is it needed?

**A7.** Sound masking systems emit sound (typically a type of noise) over a broad range of frequencies, with an emphasis on the speech frequency range. These systems are designed to make speech and other common office sounds less obtrusive by slightly raising the background noise level in the office.

SMS's are best suited in large open office environments, where there are many densely packed workstations. They can also be useful outside of conference centers to help increase privacy.

## Q8. Can HVAC sound be used as a low-cost sound masking system (SMS)?

**A8.** While it would be ideal if our clients could save money by avoiding the expenses of both quieter HVAC systems and a SMS, this is not a viable solution.

Although some HVAC noise might sound similar to a SMS, it is missing two key qualities; Spatial consistency and a frequency content tailors to speech and office sounds.

A good SMS provides consistent sound in both overall volume and frequency content. This allows it to be less noticeable while also effectively masking key speech frequencies.

It is also worth noting that HVAC systems in open office areas are typically designed with a less stringent Noise Criteria (NC) than most enclosed office spaces. While conference rooms would be designed to NC-30 or NC-35, open office areas are typically designed for NC-40 to NC-45. If these spaces were any louder, it would likely be disturbing or uncomfortable to occupants.

## Q9. Are all Acoustical Ceiling Tile panels the same acoustically?

**A9.** Acoustic Ceiling Tile (ACT) panels are a very common acoustical ceiling treatment for offices as they help absorb sound and reduce reverberation. ACT panels acoustic properties vary by performance from manufacturer and model. These ceiling panels are generally rated for two acoustic properties; Noise Reduction Coefficient (NRC) and Ceiling Attenuation Class (CAC).

In general terms, the NRC represents the average percentage of sound that is absorbed by the material (0 being perfectly reflective, and 1 being perfectly absorptive). CAC rates the tile's efficiency as a barrier to airborne sound transmission, meaning how much sound travels to adjacent rooms. The higher the rating, the better the ceiling is at noise control.

We typically specify an open office area should have 50% of it’s ceiling area treated with a ceiling tile of minimum NRC 0.85 while a conference room should have 75% to 90% of the ceiling area treated.

## Q10. What are the various types of acoustical panels and which do I need?

**A10.** Acoustical panels come in a variety of different styles and finishes. Most acoustical panels consist of an acoustically absorptive core that is finished with an external covering for both aesthetics and durability. The acoustical core typically consists of fiberglass or mineral wool. A 1” or 2” thick core will be ideal for most office applications.

There are many options for the external covering, which allows designers and architects some flexibility to meet their desired aesthetic. Typical coverings include; fabric, perforated vinyl, perforated metal, and perforated or ‘slatted’ wood. The covering must be acoustically ‘transparent’ in order to let sound through to be absorbed by the core.

Acoustical felt wall coverings are also very popular for office spaces. Felt can be made from either PET (recycled plastic) or sustainable wool, and is available in many colors. Many felt wall coverings are also ‘tack-able’ meaning they can be used to pin up notifications, photos, etc.

Acoustical ‘wood wool’ is also a common material for acoustical panels. This material is sometimes referred to by the popular brand name “Tectum”, which is a product of Armstrong World Industries. Wood wool is made from recycled wood, and can be moulded into many shapes and dyed to a variety of colors.

Acoustical plaster is a very high-quality treatment option, which can provide acoustical absorption that is virtually ‘invisible’. These systems typically consist of an acoustically absorptive core, which is applied to a flat substrate (typically gypsum board). The absorptive core is then troweled over with an acoustically transparent ‘plaster’ which can be dyed to a variety of colors. This results in a finish that is very similar to that of painted gypsum board. These systems tend to be expensive due to the skilled labor required for seamless installations.

Spray-applied acoustical treatment is often used to treat large areas of ceiling in open-office areas. This material is spray-applied to a flat surface such as concrete or gypsum board. Multiple coats are added to achieve the desired thickness (0.75” to 2” thickness is ideal for office spaces). This material can also be dyed to various colors.

When selecting acoustical treatments, be sure to pay attention to the NRC (Noise Reduction Coefficient) value of the product. NRC is the average percentage of sound that is absorbed by the material (0 being completely reflective, and 1 being completely absorptive). This data is typically published by the manufacturer, and can vary depending on the material thickness, mounting type, and other factors.

For most office space applications, we recommend selecting treatments with an NRC of 0.80 or greater.

## Q11. What are NC Values and which do I specify?

**A11.** Noise Criteria (NC) is the most commonly used metric for quantifying ambient (background) noise levels in office spaces. The NC level of a space is obtained by plotting the ambient noise spectrum (measured in whole octave bands) against a set of standardized Noise Criteria curves. These curves account for the sensitivity of the human ear, which is more sensitive to higher frequencies than lower frequencies. The NC value of the measured spectrum corresponds to the lowest NC curve under which it falls.

Choosing the appropriate Noise Criteria is important when specifying acceptable levels of noise within an office space. The design NC level should be determined based on the function and expected usage of each space, so they may differ slightly from project to project. For example, the typical design level for an open office would be NC-40 to 45 while for a teleconference room, where a lower ambient noise level is desired, would be NC-25.

SIA ACOUSTICS
A division of Robert Derector Associates

**Questions or Comments?**
**We would love to hear from you!**
**Please call or send us an email:**

**212.764.7272   SIAacoustics@derector.com**

SIA ACOUSTICS

A division of Robert Derector Associates

# A PRACTICAL GUIDE TO OFFICE ACOUSTICS

## Part 2: Privacy

## PART 2: PRIVACY

Not every office space needs to be completely private. There are some spaces where privacy is critical and others where a more modest level of privacy is required. This note addresses the design issues involved in meeting various levels of privacy in office design.

To achieve privacy in an enclosed office or meeting room, the following topics must be addressed:

- What Constitutes Privacy?
- Wall Construction
- Impact of Doors and Windows
- HVAC System Design & Implementation
- Other Penetrations

Each of these topics is discussed below.

### A. What Constitutes Privacy?

How private does a meeting need to be? For some meetings, privacy is a minimal concern, for others it is extremely important.

In order to provide an appropriate level of privacy for each space, we encourage the Client to give us their input as far as their privacy expectations and the needs of their business. To guide this process, we typically work with the client and/or architect to assign a “Privacy Tier” to each type of space.

Table 2.1 below gives an example breakdown of a 4-tier privacy approach with a description of each tier and typical spaces that might be included within each tier.

**Table 2.1** - Sound Isolation Tiers

| Privacy Tier | Description | Typical Space |
|---|---|---|
| Tier 1 | **MOST PRIVATE**: Conversation within these spaces is completely inaudible when standing in adjacent spaces. These spaces are used to discuss confidential material. | Conference/boardrooms for strategic planning, human resource spaces, audit spaces, etc. |

| | | |
|---|---|---|
| Tier 2 | **GOOD PRIVACY:**Conversation within is unintelligible and mostly inaudible when standing in adjacent spaces. | Typical conference rooms, huddle rooms, phone rooms, executive offices, etc. |
| Tier 3 | **LIMITED PRIVACY:** Conversation within may be intelligible when standing in adjacent spaces. | Typical private offices, wellness rooms etc. |
| Tier 4 | **NO PRIVACY:** Conversation within is clearly intelligible from outside or nearby. These spaces are mostly open to adjacent areas. made to ensure that activities in these spaces do not disturb occupants in nearby or adjacent spaces. | Open office areas with workstations, open copy/print rooms, open pantry areas. |

After a Privacy Tier has been assigned to each space, we can begin to assign specific acoustic performance criteria to each Tier. Sound Transmission Class (STC) is the acoustic metric most commonly used for this purpose. Table 2.2 below correlates an ‘*experiential description’* to several STC values.

**Table 2.2** - “What is heard from adjacent spaces?” and related STC values.

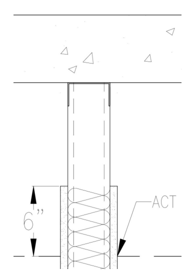
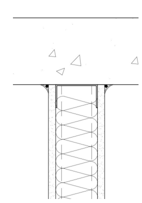
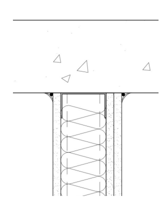
| What is Heard From Adjacent Spaces? | STC Value |
|---|---|
| Normal Speech can be understood easily | 25 |
| Normal speech audible but not well understood, Loud speech well understood | 30 |
| Loud speech audible but not well understood | 35 |
| Beginning of “privacy” | 40 |
| Loud speech audible, amplified speech clearly audible | 42 |
| Loud speech audible but not well understood | 45 |
| Loud sounds such as amplified speech can be faintly heard | 50 |
| Superior soundproofing. Most sounds inaudible | 60+ |

By using a “what it will sound like” description, we avoid confusion when using unfamiliar technical metrics like STC with clients and designers. This can make the selection of wall types more understandable and provides clarity for our clients. The related STC values can be used to then select the appropriate wall construction.

B. Wall Construction

Wall Construction is usually the first item on our privacy list that is addressed. This is because increasing the ability of a wall to ‘block or contain’ sound often requires thicker assemblies (commonly by adding additional layers of gypsum board). This can impact space planning. It is not uncommon to see most office and meeting room walls shown as one thickness in test fit diagrams. Table 2.3 below contains a list of common office wall types and the STC rating of these assemblies:

**Table 2.3** - Sample partition assemblies and corresponding STC value and thickness

| **Partition Construction** | **STC Value** | **Wall Thickness for 3-5/8” stud(s)** | **Detail** |
|---|---|---|---|
| Single stud w/ one (1) layer GWB each side, terminating 6” above scheduled ceiling (assumes an Acoustical Tile Ceiling in office) | 35 -40 | 4-7/8” |   |
| Single stud w/ one (1) layer GWB each side (Wall extends slab to slab) | 42 -45 | 4-7/8” |  |
| Single stud w/ one (1) layer GWB on one side and (2) layers GWB on the other side) | 45 -47 | 5-1/2” |  |

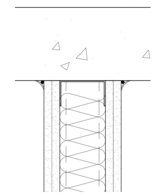
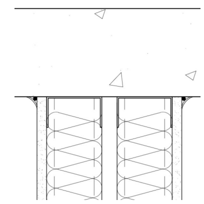
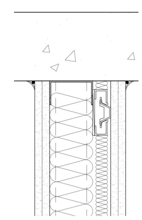
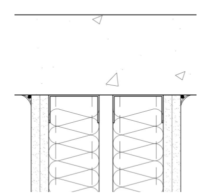
| | | | |
|---|---|---|---|
| Single stud w/ two (2) layers GWB each side | 47 -50 | 6-1/8” |  |
| Double Stud w/ one (1) layers GWB each | 52 -55 | 9-1/2” |  |
| Single stud w/ two (2) layers GWB one side, two (2) layers GWB on resilient isolation clips opposite side | 60 | 7-5/8” |  |
| Double stud w/ two (2) layers GWB each side | 63 | 10-3/4” |  |

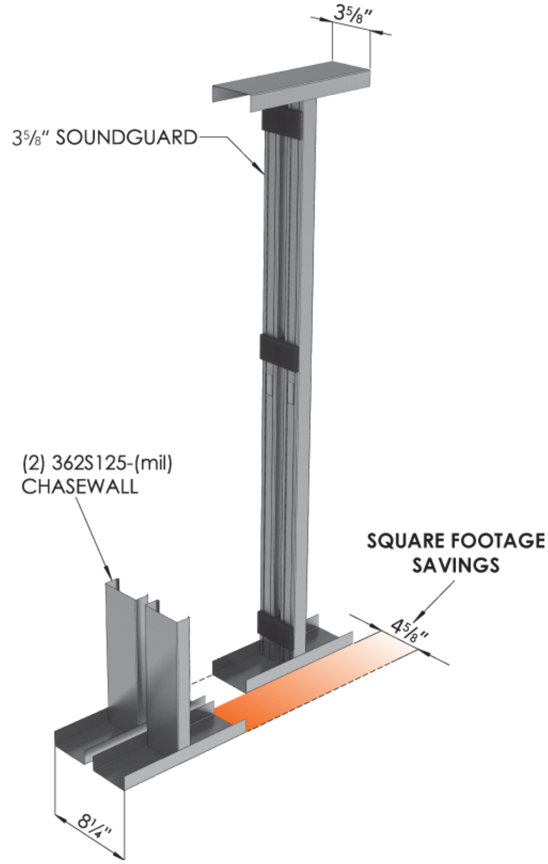
Table Notes:

1. All studs assumed to be 3-5/8” metal stud, 16” on center.
2. Stud cavity is assumed to be filled with internal insulation.
3. Double stud walls are assumed to have a 1” gap between the two rows of studs.

While the wall constructions shown in the table above are commonly used, there are some new products that allow thinner walls that provide higher STC values. One such item is Marino\WARE’s *SoundGuard*™ *Silent Steel Framing System* that can provide an STC-52 rated wall with only a 4” width. Given the high value of space, we expect to see this type of product in more common use.

SIA Acoustics : A division of Robert Derector Associates
19 West 44th Street, New York, NY 10036
212.764.7272 SIAacoustics@derector.com www.derector.com

**Figure 2.1** - *SoundGuard* stud by Marino\WARE



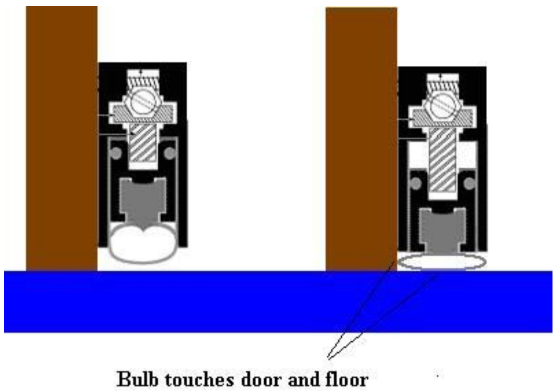

C. Impact of Doors & Windows

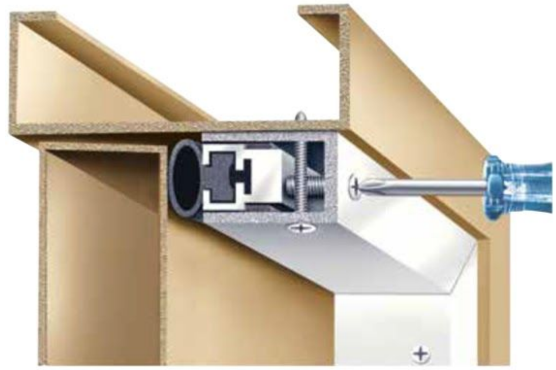
When discussing privacy of private offices and meeting rooms the impact of doors and windows is an often overlooked design element in office privacy. These are often the source of sound 'leaking' from one office space to another.

The mass of doors and windows tends to be much lower than that of the wall assemblies. This can result in a sound transmission path from one space to another as the mass of a material determines its ability to block noise. During the office design phase the choice of door and window glazing is important inorder to ensure the required tier of privacy is achieved.

Frameless glass doors add a sophisticated aesthetic to an office environment but can also provide low levels of privacy as airborne noise is allowed a flanking path at the door perimeters. Using perimeter seals and operable drop-bottom seals to eliminate gaps at door perimeters is an important step in reducing airborne sound escaping or entering an office space.

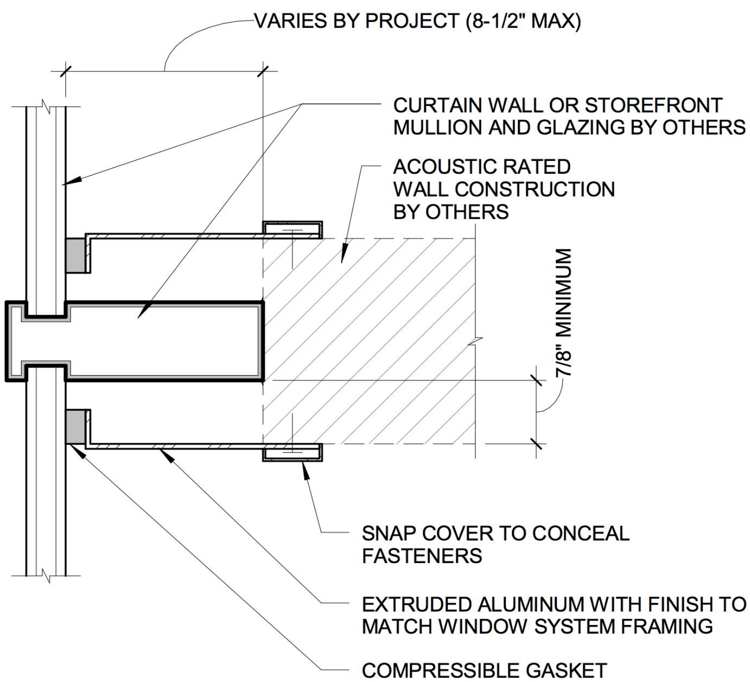
**Figure 2.2** - Operable drop-bottom seal (left), adjustable perimeter seal (right)



A common problem area is the use of hollow mullions for window glazing. Interior walls separating adjacent office spaces often die into exterior glazing assemblies at a mullion. If these mullions are hollow, they offer little acoustic privacy. One method of preserving privacy with hollow mullions is to 'encase' the mullion either within the wall construction or with a mullion trim cap.

**Figure 2.3** - Million trim cap by *Mull-it-Over*



D. HVAC System Design & Implementation

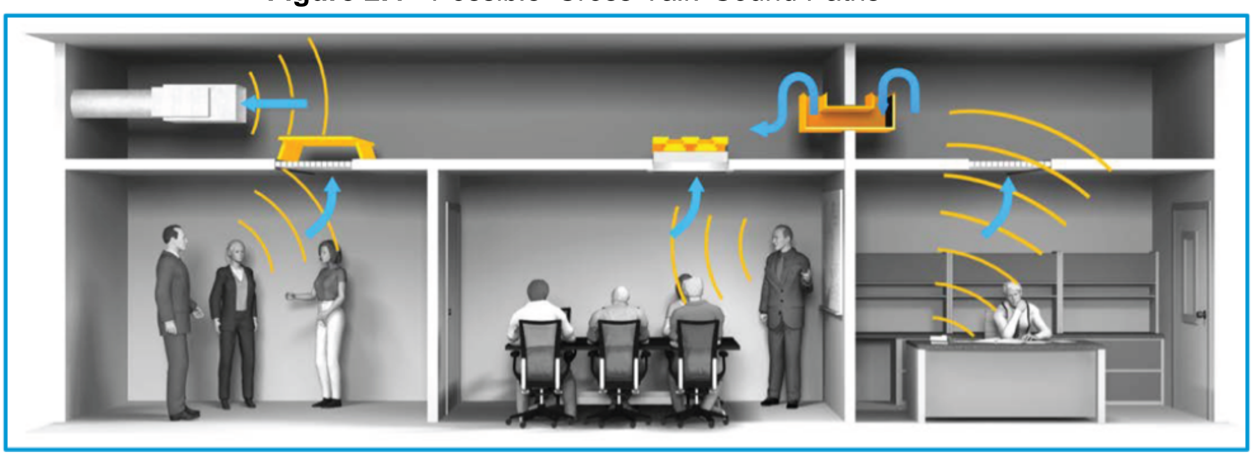
In typical office layouts, the bulk of the HVAC systems (ductwork, air terminal units, etc.) are run overhead. This equipment is generally hung from the slab above, either in open ceiling spaces or hidden above acoustic ceiling tiles or dropped gypsum board ceilings.

As occupied office spaces need conditioned air, there is almost always ductwork penetrations through the walls (and sometimes ceilings) of these spaces. These penetrations can greatly reduce the privacy provided by the partitions unless properly coordinated. Sheetrock installers should take care to minimize the gap between the gypsum board and the duct (less than ¼” is recommended). Any remaining gaps should then be fully sealed with acoustical sealant.

Even if duct penetrations are fully sealed, ductwork can still carry sound between sound-sensitive spaces unless properly addressed. For spaces requiring higher levels of privacy, we recommend routing ductwork through non-critical partitions whenever possible. For example, running ductwork through the wall separating a conference room from an adjacent corridor would be a better choice than through the wall shared with an adjacent conference room.

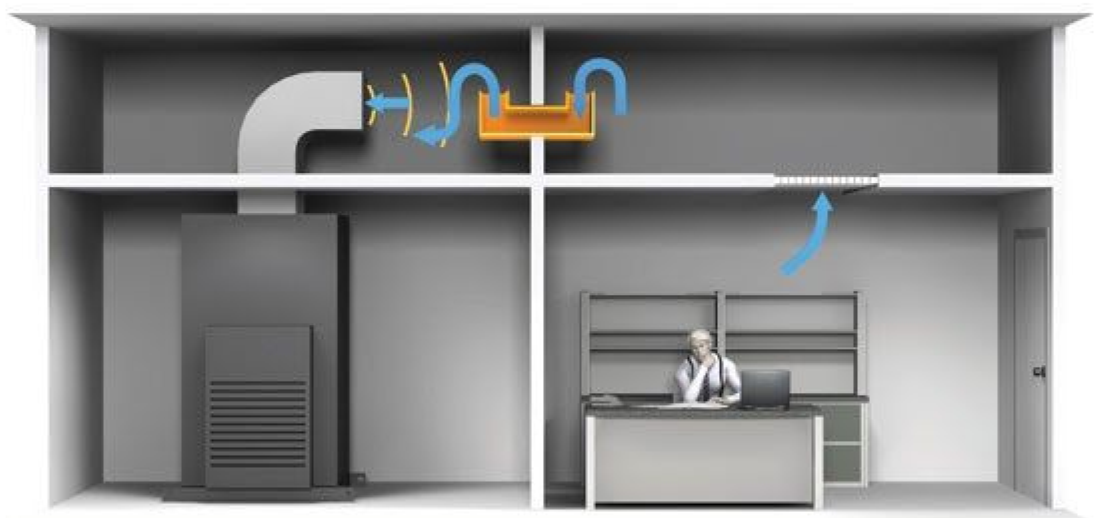
If a duct has air outlets on either side of a sound-critical wall, this can greatly reduce the privacy provided by the wall. In these cases, sound can enter the outlet in one space, travel a short distance down the duct and escape through the outlet in the adjacent space. This phenomenon is called ‘cross-talk’. Cross-talk can be minimized by adding a number of internally lined elbows in the duct branch before each air outlet. Typically, two internally lined 90-degree elbows on each branch will suffice.

**Figure 2.4** - Possible ‘Cross-Talk’ Sound Paths



We recommend reviewing the return air ductwork scheme to ensure that privacy is maintained when needed. In HVAC design for offices, it is typical to use the space above an ACT or gypsum board ceiling as a return air plenum. In these cases, a return air grille will be provided in the ceiling to allow return air to flow from the conditioned room into the plenum. A return air transfer duct will be required to allow the air to escape the plenum through the walls (which should be otherwise 'airtight' for privacy).

**Figure 2.5** - Return Air Transfer Scheme



We recommend that return air transfer ducts are internally lined and incorporate one or two 90-degree elbows, depending on the level of privacy needed. For applications requiring very high privacy levels, an inline duct silencer can be used instead of a traditional duct. Silencers should be coordinated with the project's Mechanical Engineer to minimize air pressure drop, especially for return air applications.

E. Media Walls

Media walls for conference, teleconference, and meeting rooms can present a significant privacy issue if not addressed. In these spaces, it is common to see monitor displays and loudspeakers mounted to the wall. What is not seen is the large 'back boxes' that typically accompany this equipment. These 'back boxes' or 'chief boxes' are recessed into the wall and house all of the cabling associated with the monitor or equipment (electrical, data, audio, video cables, etc.).

Recessed back boxes create a large penetration through one side of the wall, which can greatly diminish privacy to the adjacent space. Back-to-back media walls create an even greater privacy issue. Since wall-mounted loudspeakers are a source of sound and vibration (even without a back box), they can often be heard in adjacent rooms unless properly addressed.

**Figure 2.6** - Recessed chief box

We recommend avoiding back-to-back media wall installations whenever possible. Media walls construction details should be carefully reviewed to ensure the desired level of privacy is achieved. At a minimum, we recommend that these details incorporate at least one layer of gypsum board behind the back-box.

For a one-sided media wall with greater privacy concerns, we recommend constructing the wall using a double-row of studs. This achieves greater acoustic privacy by de-coupling either side of the wall. If overall partition thickness is of concern, a single-stud with resilient clips can be used instead of a double-stud. Note that this will achieve approximately 70% of the performance of double-stud construction.

Large loudspeakers should be mounted using vibration isolators. A simple isolation method is to mount the loudspeaker to a layer of plywood, which is affixed to the wall using resilient clips. The plywood can be painted and the space behind can be used to house cabling, much like a chief box.

F. Other Penetrations

Any penetrations (piping, electrical conduits, etc.) through office wall and floor partitions can act as easy sound flanking paths. Plumbing and electrical conduit penetrations should be sealed at the perimeter of the penetration using an acoustic sealant ensuring airtight seal.

Other larger flanking penetrations (such as those found when convector units run between adjacent offices) can be closed off using sound barrier pillows. Packing of sound barrier pillows around piping and electrical conduit will help to ensure no voids within the convector covers will significantly improve office privacy.

Unsealed electrical outlet boxes are known ‘sound leaks’ in office wall assemblies. We recommend staggering electrical outlets on either side of a sound critical wall by at least one stud bay. This increases the distance between ‘sound leaks’ for greater attenuation. Privacy can be further increased by applying a sound control putty to the rear of the sheet metal electrical box within the stud cavity. Care should be taken to ensure the back-box is completely covered with the acoustical putty.

**Figure 2.7** - Electrical box with acoustical putty (*Isobacker* by *Kinetics*)

SIA ACOUSTICS
A division of Robert Derector Associates

**Questions or Comments?**
**We would love to hear from you!**
**Please call or send us an email:**

**212.764.7272 SIAacoustics@derector.com**

SIA ACOUSTICS

A division of Robert Derector Associates

# A PRACTICAL GUIDE TO OFFICE ACOUSTICS

## Part 3: Ambient Noise

## PART 3: AMBIENT NOISE

Excessive ambient noise can be disruptive to the work environment. However, extreme silence can be just as uncomfortable. Common sources of ambient noise include; HVAC, electrical, plumbing, elevator systems. When office spaces are located along the exterior of the building, environmental sounds such as road, rail, and air traffic can impact the overall noise level with the office.

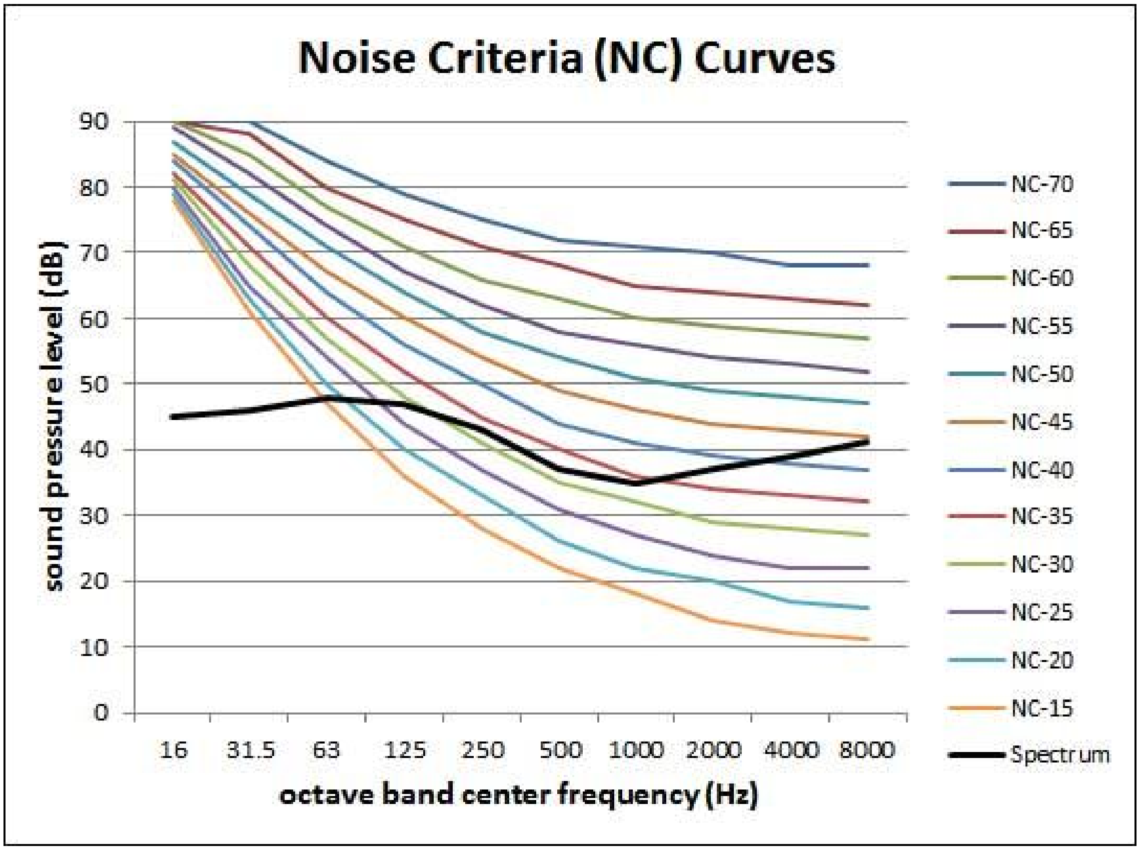
Achieving an appropriate ambient noise level is important to both the functionality of a space and the comfort of occupants. In this section we will discuss how to quantify and specify an appropriate background noise level for a given space, as well as basic methods for limiting noise to achieve this level.

A. Quantifying Ambient Noise Levels

Noise Criteria (NC) is the most commonly used metric for quantifying ambient noise levels in office spaces. The NC level of a space is obtained by plotting the ambient noise spectrum (measured in whole octave bands) against a set of standardized Noise Criteria curves. These curves account for the sensitivity of the human ear, which is more sensitive to higher frequencies than lower frequencies. The NC value of the measured noise level corresponds to the lowest NC curve under which it falls.

Consider the example below, which shows an octave-band noise spectrum plotted against the NC curves. The measured spectrum in this example would be NC-45. In this case, the NC-45 level is determined by the 8,000 Hz band, which falls on the NC-45 curve.

**Figure 3.1** - NC Example




B. Establishing Design Criteria

The NC metric is used to establish design criteria for each space within an office. The table below shows the typical design NC level for a variety of typical office spaces.

**Table 3.1** - Typical Design NC Levels

| Space Type | Typical Design NC Level |
|---|---|
| Teleconference Room | NC-25 |
| Conference/Meeting Room | NC-30 |
| Private Office | NC-35 |
| Open Plan Office, Corridor, Lobby | NC-40 to NC-45 |

(Per ASHRAE Handbook Ch. 48)

The design NC level should be determined based on the expected usage of each space, so they may differ slightly from project to project. The levels above can serve as a starting point for most office projects.

For example, teleconference rooms have the lowest NC level target. This is because low noise levels are critical to maintaining speech intelligibility, especially over tele-conferencing systems. General purpose conference rooms have been assigned NC-30 since they require low noise for good speech intelligibility, but they are not as sound critical as dedicated teleconferencing spaces.

By comparison, open plan office areas have one of the highest noise levels (NC-40 to NC-45). This is because speech intelligibility is not as critical in these spaces. These spaces are usually noisier anyway with densely packed workstations and ringing phones.

C. Achieving Design NC Levels

There are many potential noise sources in a given space that can impact the resulting NC level. We find that HVAC systems are most commonly the driving factor for achieving NC level targets in office spaces.

There are three main sound sources to consider when designing an HVAC system to meet a given NC level. These are: ducted noise, radiated noise, and turbulent air noise.

**Ducted Noise:**

Ducted noise comes through the supply outlet or ducted return inlet of a mechanical unit (such as VAV, FPB, AHU, etc.). This noise propagates down the duct and into spaces served by the unit. This noise can be attenuated by adding internal acoustical duct lining, increasing the length of the duct, or adding 90-degree ‘elbows’ or in-line duct silencers.

Table 3.2 below contains rough guidelines for the design of ductwork between variable air volume boxes (VAV’s) and the spaces they serve. These guidelines are presented based on the design NC of the space.

**Table 3.2** - Minimum Duct Lengths for VAV's

| Design NC | Min. Length of 1" Internally Lined Ductwork |
|---|---|
| NC-25 | 20-ft, plus one elbow |
| NC-30 | 15-ft, plus one elbow |
| NC-35 | 10-ft, plus one elbow |

Table 3.3 below contains similar guidelines for ductwork downstream of Fan Powered Boxes (FPB's) before discharging into the space served.

**Table 3.3** - Minimum Duct Lengths for Fan Powered Boxes (FPB's)

| Design NC | Min. Length of 1" Internally Lined Ductwork |
|---|---|
| NC-25 | 20-ft, plus 2 elbows |
| NC-30 | 15-ft, plus 2 elbows |
| NC-35 | 10-ft, plus 2 elbows |

Note that, while the guidelines in Tables 3.2 and 3.3 above are a good starting point, the exact amount of ductwork attenuation that is required will depend on the specifics of the unit and expected operating conditions.

In cases with large fan-powered equipment (typically greater than 1200 CFM) duct break-out noise should also be evaluated. Duct break-out noise occurs when the noise from inside the duct transmits to a space through the sheet metal of the duct. This can occur even if the duct does not serve the space in question. There are several ways of resolving this issue, including wrapping the duct with mass-loaded vinyl or enclosing the duct in a gypsum board soffit. An acoustical tile ceiling can also provide enough attenuation in some cases.

**Radiated Noise:**

Radiated noise comes directly through the body (or casing) of a mechanical unit itself, rather than down the duct. Though this noise is typically lower in level than ducted noise, it can just as easily exceed design NC levels if not properly addressed.

We typically recommend locating terminal units (VAV's and FPB's) outside of sound sensitive spaces. For example, a VAV serving a conference room should be located outside of the room in a nearby corridor or open office area. If the area outside of the room has an acoustical tile ceiling, this is often enough to meet NC-40 to NC-45.

If there is no ACT, or the ACT does not provide enough attenuation, the unit can be enclosed with a gypsum board enclosure to meet the design NC level of the space. The enclosure will typically require an access panel for maintenance of the unit, which may need to be acoustically rated depending on the noise of the unit.

**Turbulent Air Noise:**

The number one determining factor for air turbulent noise is velocity. Faster moving air is much more likely than slow air to cause turbulent noise at duct transitions such as diffusers, grilles, elbows, and dampers. The velocity of air is dependent on the amount of air (measured in cubic feet per minute, CFM) and the size (height and width) of the duct through which it travels. Since the CFM is fixed based on the heating, cooling, and ventilation demands of the space served, the duct size must be adjusted to achieve an appropriate velocity. This velocity should be based on the design NC of the space in which the duct is located.

**Figure 3.2** - Possible HVAC Sound Paths

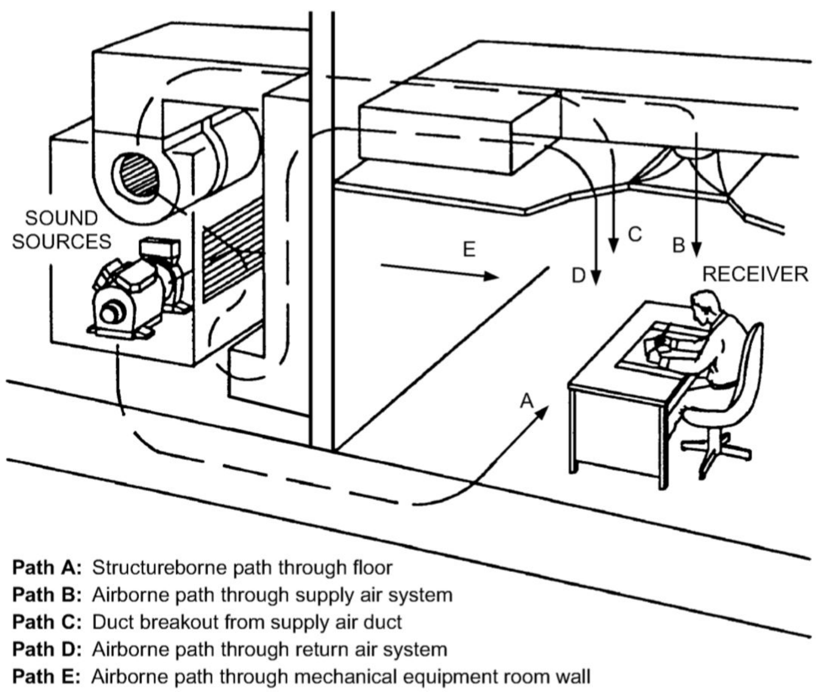


Table 3.4 below contains guidelines for duct air velocity based on the design NC of the space and condition of the duct (per ASHRAE Handbook, Ch. 48).

**Table 3.4** - Max. Recommended Duct Air Velocities

| **Main Duct Location** | **Design NC** | **Maximum Air Velocity, FPM** | |
|---|---|---|---|
| | | **Rectangular Duct** | **Circular Duct** |
| In shaft or above drywall ceiling | 45 | 3500 | 5000 |
| | 35 | 2500 | 3500 |
| | 25 | 1700 | 2500 |
| Above suspended acoustic ceiling | 45 | 2500 | 4500 |
| | 35 | 1750 | 3000 |
| | 25 | 1200 | 2000 |
| Duct located within occupied space | 45 | 2000 | 3900 |
| | 35 | 1450 | 2600 |
| | 25 | 950 | 1700 |

Table 3.4 Notes:

1. Branch ducts should have airflow velocities of about 80% of the values listed.
2. Velocities in final run-outs to outlets should be 50% of values listed.

Supply diffusers and return registers can also cause excessive turbulent air noise if not properly sized. The rated NC level for a diffuser or register device is typically published by the manufacturer and is a function of the size/type of the device and the airflow velocity. We recommend selecting these devices for at least 5 NC-points below the design NC of a room. For example, an NC-30 conference room should be equipped with diffusers/registers that meet NC-25 or lower.

If NC levels are not available from the manufacturer, we recommend sizing the device for an appropriate air velocity. Table 3.5 below contains guidelines for the maximum air velocity within the neck of supply diffusers and return registers to achieve the design NC level of the space served (per ASHRAE Handbook, Ch, 48).

**Table 3.5** - Max. Recommended Velocity at Neck of Diffusers & Registers

| Type of Opening | Design NC | Max. Air Velocity, FPM |
|---|---|---|
| Supply air outlet | 45 | 625 |
| | 40 | 560 |
| | 35 | 500 |
| | 30 | 425 |
| | 25 | 350 |
| Return air inlet | 45 | 750 |
| | 40 | 675 |
| | 35 | 600 |
| | 30 | 500 |
| | 25 | 425 |

Many HVAC systems require volume dampers in the duct branches serving each supply diffuser or return register. This is necessary to achieve balanced airflow through each opening. These volume dampers can cause excessive turbulent noise by restricting airflow. We recommend minimizing the amount of damper noise that reaches the space served by locating dampers as far away from the air opening as possible. A good rule of thumb is 5-ft or more between the damper and the nearest air opening serving spaces that are NC-30 and below. The exact distance required will depend on the ductwork layout and total static pressure within the duct.

SIA ACOUSTICS
A division of Robert Derector Associates

**Questions or Comments?**
**We would love to hear from you!**
**Please call or send us an email:**

**212.764.7272 SIAacoustics@derector.com**

SIA ACOUSTICS

A division of Robert Derector Associates

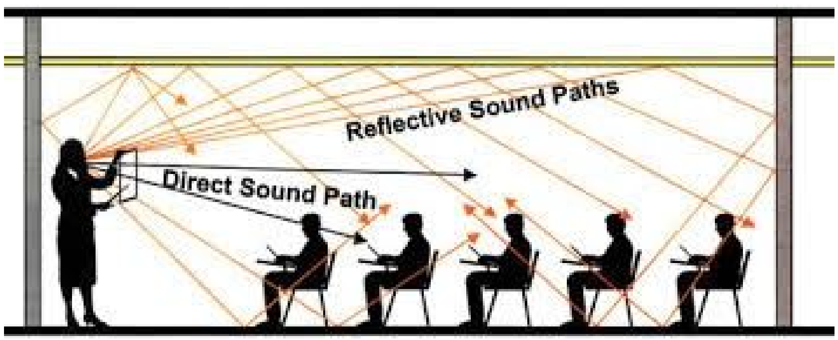
A PRACTICAL GUIDE TO OFFICE ACOUSTICS

# Part 4: Room Acoustics

# PART 4: ROOM ACOUSTICS

Room acoustics describes how sound behaves in an enclosed space. The most common source of sound within an office space is typically speech, whether from a physical occupant or from an AV loudspeaker or speaker-phone. Speech propagates from the source to the receiver, but can also interact with the surfaces within the space. This contributes reflections and reverberation to the overall sound. These reflections and reverberation can degrade speech intelligibility if not properly controlled. Room acoustic design of office spaces is focused primarily on ensuring adequate speech intelligibility by controlling reflections and reverberation.

**Figure 4.1** - Direct and Reflected Sound Paths




A. Design Criteria for Various Types of Office Spaces

In offices, the most common types of spaces and their expectations with regard to room acoustics are listed below:

1. Open Plan Offices

Open plan office setups make it easier for employees to communicate and collaborate. However, these spaces typically have higher ambient noise levels from both HVAC systems and general activity from the occupants. The main goal when designing an open office space is to provide acoustical treatments to control reverberation and reflections of sound so they do not become excessive and/or distracting.

2. Private Offices

The acoustical design of private offices is primarily focused ensuring comfort for occupants by controlling reverberation. Working in an overly reverberant space for long periods of time can cause fatigue and decreased productivity. Controlling reverberation also makes it easier for the occupant(s) to converse both in person and over the phone.

3. Focus/Huddle/Wellness Rooms

These spaces are similar to Private Offices, allowing users of the spaces to work and communicate with ease and comfort. Focus and Huddle Rooms are often used as a meeting space for small groups, making speech intelligibility the main concern. Wellness rooms provide a space for employees to rest and recuperate, making comfort the main concern.

4. Meeting & Conference Rooms

These spaces are often used for focused communication with a group of people or to discuss confidential material. With the rise and importance of virtual communication, these rooms must be designed for optimized speech intelligibility for both in-person meeting attendees and remote attendees via teleconferencing system(s).

B. Reverberation Time

Reverberation Time (RT) is one of several measurable parameters that define the sound quality of an acoustic space. Reverberation time can be defined as the time it takes for a sound to fully decay, or become inaudible after it is produced.

Higher RT's (referred to as "live" or "wet") can bring to life a symphonic orchestra. Shorter RT's (referred to as "dead" or "dry") are more conducive to good speech intelligibility required for office spaces.

Reverberation Time is dependent on both the size (or cubic volume) of the space and the materials (or finishes) used within the space. Larger spaces typically have higher RT's than smaller spaces. The size of the space is typically fixed by the intended usage and number of occupants. This leaves the design of finishes (or room treatments) as the most effective way of controlling RT's.

C. Room Treatments

In order to achieve the required acoustic functionality of a space, it must be properly treated to control reverberation and reflections.. Reverberation times are most effectively reduced by using acoustical treatments such as acoustical ceiling tile (ACT), fabric-wrapped acoustical panels, felt ceiling baffles and wall coverings, acoustical plaster, and more. However, the RT can also be reduced slightly with the use of non-acoustical materials that absorb sound, such as upholstered furniture and carpet.

Mid-frequency sound (250 Hz to 1,000 Hz) is generally the most critical in office spaces because it is in the range where speech is produced. The reverberation time within a space can be controlled by the ratio of sound-absorptive surface area to sound-reflective surface area.

The Noise Reduction Coefficient (NRC) rating is used to classify the absorption properties of materials. In general terms, the NRC represents the average percentage of sound that is absorbed by the material (0 being perfectly reflective, and 1 being perfectly absorptive). While the NRC metric accurately reflects the ability of a material to absorb speech frequencies, it does not accurately reflect low-frequency performance (250 Hz and below). For this reason, NRC is a good metric to use in the majority of office space applications. However, we advise against relying on this metric in applications where low-frequency performance is important.

Table 4.1 below provides guidelines for the recommended coverage of acoustical treatment for typical office spaces. The minimum recommended areas of treatment are presented in terms of a percentage of the room footprint (or ceiling area).

**Table 4.1**- Acoustical Treatment Guidelines

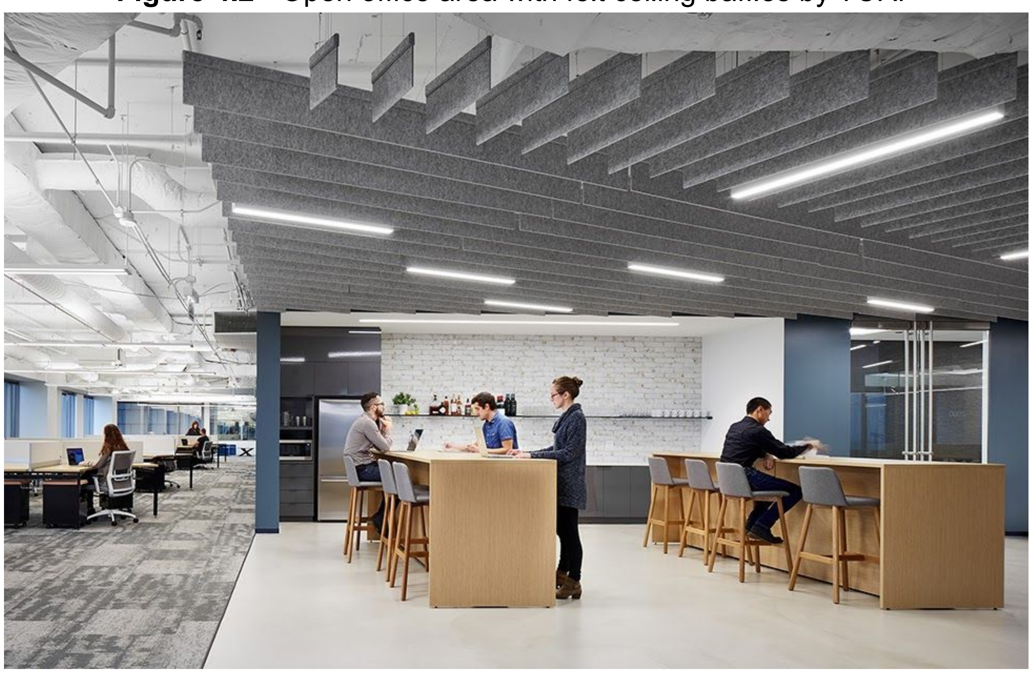
| Space Type | Treated Surface | Minimum Treatment Area | Minimum NRC |
|---|---|---|---|
| Conference, Huddle, Tel/Focus, Secured Work Rooms | Ceiling | 90% of total ceiling area | 0.85 |
| | Walls | 25% of total ceiling area | 0.95 |
| Private Offices | Ceiling | 75% of total ceiling area | 0.85 |
| Open Office Areas | Ceiling | 50% of total ceiling area | 0.85 |

1. Ceiling Treatment

Acoustical Ceiling Tiles (ACT) systems are a very common acoustical ceiling treatment for offices. These systems can be mounted directly to the ceiling (A-mounted) or suspended in a ceiling grid (E-mounted). The air space created by suspending the ACT in a grid provides better low frequency absorption, as well as providing a plenum space to hide HVAC equipment.

As an alternative to ACT, an array of acoustical baffles can be hung from the ceiling. Acoustical baffles can be made from a variety of sound-absorptive materials such as felt, fiberglass, or mineral wool. Fiberglass and mineral wool baffles are typically finished with wrapped fabric or perforated metal. The acoustical performance of these systems is dependent on the size and material of the baffles, as well as the spacing used between rows and distance from the ceiling.

**Figure 4.2** - Open office area with felt ceiling baffles by *TURF*



Non-acoustical baffles or slatted ceiling systems can also be used with absorption added to the ceiling cavity above. We recommend spacing non-acoustical baffles or slats so as to provide 25% open area or greater, to allow sound to reach the acoustical treatment above.

**Figure 4.3** - Wood slatted ceiling (right) with absorptive treatment above (left)

**Figure 4.4** - Spray-applied ceiling treatment (*K-13* by *International Cellulose*)

Acoustical plaster is a very high-quality absorptive finish with a similar mono-lithic appearance to painted gypsum board. These systems typically consist of an absorptive fiberglass or mineral wool core, which is then troweled over with an acoustically transparent plaster finish. These systems tend to be expensive, but can result in completely 'invisible' acoustical treatment. These systems are best used for ceiling applications, where they are out of reach and are less likely to be bumped or damaged.

**Figure 4.5** - Acoustical plaster system (*StarSilent* by *Pyrok*)

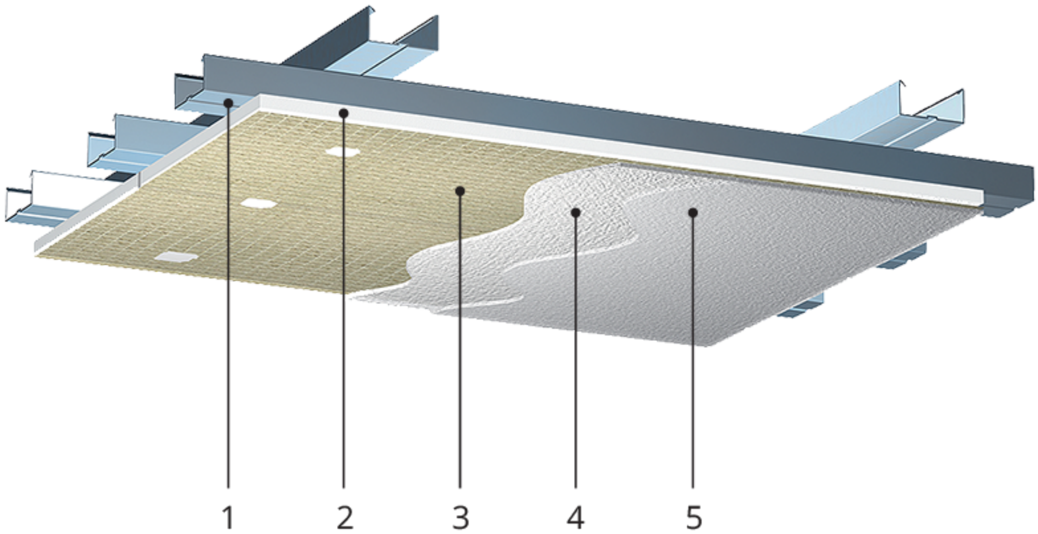



Figure 4.5 Notes: [1] Steel framing (or flat substrate); [2] StarSilent Panel (absorptive core); [3] Zinc coated drywall screws; [4] Acoustically transparent base coat plaster; [5] Acoustically transparent smooth plaster finish

2. Wall Treatment

We recommend supplementary wall treatment in Conference, Huddle, and Phone Rooms. This will help to maintain speech intelligibility by reducing flutter echo, which occurs between parallel reflective surfaces in smaller rooms. Flutter echo can be disruptive and can degrade speech intelligibility.

There are many different options for wall treatment which offer a variety of aesthetic qualities at different price points. This treatment should be coordinated with wall-mounted elements such as video monitors. We recommend placing wall treatment in the median plane (at ear-level) for the best results.

**Figure 4.6** - Office felt wall treatment by *FilzFelt*

3. Carpet

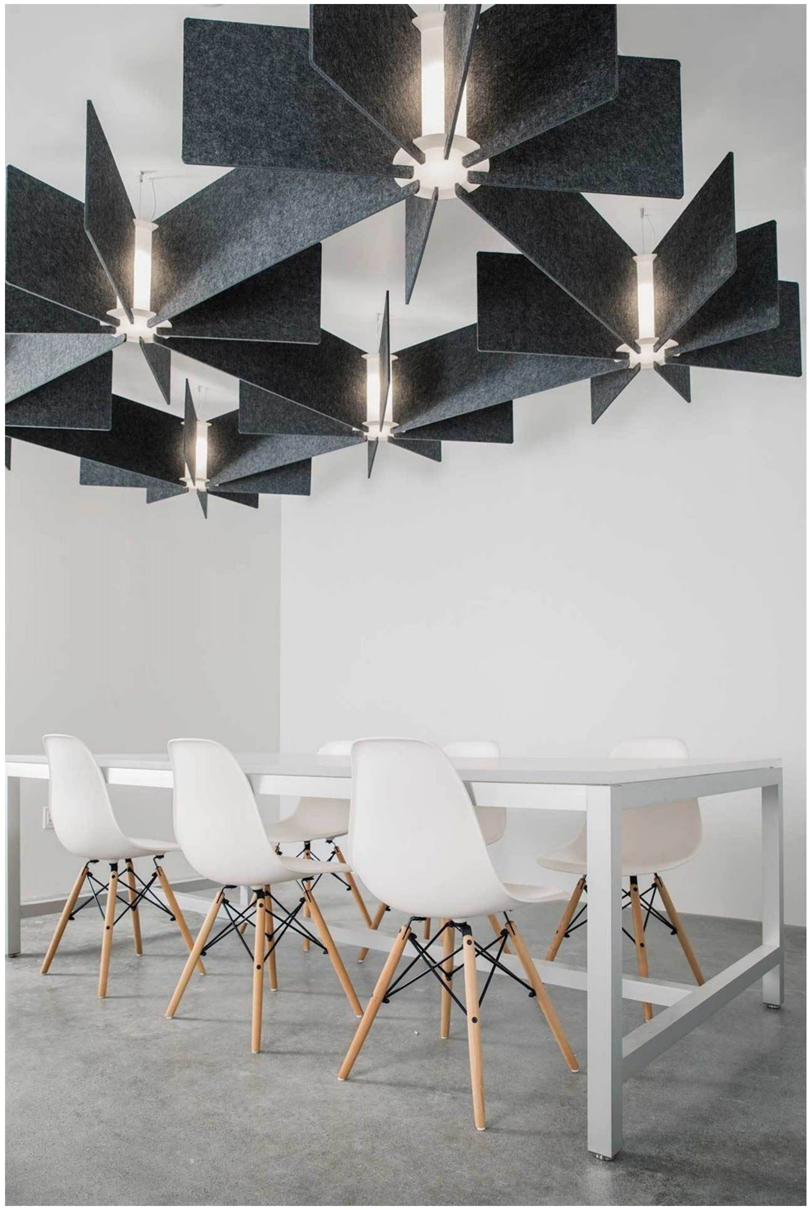
We are regularly asked if carpet can be used as acoustical treatment for offices. While carpeting certainly will not have a negative impact on room acoustics, it's benefits are fairly minor. This is because carpet is only effective at absorbing high-frequency sounds (2000 Hz and above), and provides little to no impact on critical speech frequencies (250 Hz to 1000 Hz). Some thicker carpets with plush underlayments provide modest levels of absorption in the upper speech frequencies (1000 Hz), but these are rarely used for office applications. For these reasons, we typically do not factor carpet into the overall treatment areas recommended in Table 4.1 above.

There is one major benefit to carpet in office spaces that is worth noting, though it does not pertain to room acoustics. Carpet is fairly effective at reducing foot-fall noise to floors below. A metric called Impact Insulation Class (IIC) is used to quantify the isolation of foot-fall and other minor impact noises (with higher values equating to more isolation). A typical concrete slab with wood or tile floor finish usually provides approximately IIC-25 to 30. Adding carpet instead of wood/tile can increase the performance to IIC-40 and above. This can be the difference between hearing footfall noise from above and not.

4. Furniture

Furniture can also be used to provide additional sound absorption without impacting the aesthetics of the space. Upholstered furniture can provide inherent sound-absorption. There are also a variety of types of acoustically absorptive furniture, such as phone booths, seating pods, screens and dividers. It is important to ensure these systems provide adequate levels of sound absorption, or additional acoustical treatments may be required.

**Figure 4.7** - Acoustical felt lighting fixture (*Echo* by *LightArt*)



SIA ACOUSTICS
A division of Robert Derector Associates

**Questions or Comments?**
**We would love to hear from you!**
**Please call or send us an email:**

**212.764.7272 SIAacoustics@derector.com**

SIA ACOUSTICS
A division of Robert Derector Associates

A PRACTICAL GUIDE TO OFFICE ACOUSTICS

# Part 5: Telephone Booths

## PART 5: TELEPHONE BOOTHS

In many open-plan offices, spaces are provided for employees and guests to make private phone calls. Many companies provide dedicated phone booths throughout their offices for this purpose. These booths are typically small enclosed spaces with room for a chair and a small work surface.

### A. Design Criteria

A quality phone booth has both adequate privacy and speech intelligibility. We have covered both of these issues previously in PARTS 2 and 4 of this series, respectively. However, special attention should be paid to the finishes within these rooms used to control reverberation and reflections. This is because rooms of this size typically resonate within the range of key speech frequencies. These resonances are referred to as ‘room modes’ and can interfere significantly with speech intelligibility and user comfort unless addressed properly.

### B. Acoustical Treatment

We recommend treating phone booths with acoustically absorptive materials on both the ceiling and walls. This will help to preserve speech intelligibility by absorbing reflections in both the horizontal and vertical planes. For the best results, we recommend treating the ceiling, as well as at least two adjacent walls (forming a corner). The acoustical material that is chosen should be rated NRC 0.90 or higher in order to provide significant absorption in the key speech frequencies. The acoustical treatment should extend from approx. 3-ft above finished floor (AFF) to at least 7-ft AFF.

Acoustical treatment within Phone Booths will also help indirectly to increase the level of privacy that is achieved. Acoustic treatment will reduce the reverberant build-up of the occupant’s voice, reducing slightly the overall amount of sound that escapes the space. Perhaps the biggest impact is as a result of better speech intelligibility, the occupant will resist the urge to speak louder to ‘overcome’ an excessively reverberant space.

### C. Privacy

It is important that phone booths provide a level of privacy that is acceptable to the end user(s). In the “Privacy” section of this series, we have provided a step-by-step process on how to quantify the desired level of privacy and ensure that it is achieved. Special attention should be paid toward selecting adequate wall types and door seals, and ensuring that HVAC systems and other penetrations do not degrade privacy.

D. Prefabricated Phone Booths

Many companies are moving toward phone booths that consist of a prefabricated ‘kit of parts’ that are assembled within the office by a contractor. These systems can have an elegant appearance with plenty of glass (which is sound reflective, but acceptable if the interior also incorporates enough sound absorptive material). These booths typically have integrated electrical power outlets and connections to HVAC service. Many manufacturers provide several upgradable options such as integral TV monitors.

We recommend arranging a trial or demo of these systems to ensure that they will be acceptable. There is typically very little acoustical data provided for these systems to evaluate their performance, so experiencing them in person is the best way to ensure success. Many manufacturers either have showrooms, or they can provide access to several existing installations. Manufacturers of these systems include; Framery, Zenbooth, Cubicall, and many more.

**Image 5.1** - Phone Booth by *Framery*

There are several key issues that can affect the level of privacy that is achieved in prefabricated phone booths. These typically relate to fire alarm and sprinkler requirements by code. If sprinkler coverage is required within the booth, a sprinkler pipe must penetrate through the booth's ceiling or wall. The booth may also have to be fixed in place, so it cannot move and damage the sprinkler pipe.

A fire alarm 'speaker-strobe' is often required within the phone booth to achieve code mandated strobe visibility and alarm sound levels. Speaker strobes typically have an electrical back-box, which also requires penetrations through the booth's ceiling and/or walls unless surface-mounted.

All of these penetrations must be properly coordinated and acoustically sealed to preserve adequate privacy. All fire sprinklers and speaker strobes should be coordinated by a qualified fire protection and/or electrical engineer.

SIA ACOUSTICS
A division of Robert Derector Associates

**Questions or Comments?**
**We would love to hear from you!**
**Please call or send us an email:**

**212.764.7272 SIAacoustics@derector.com**

SIA ACOUSTICS
A division of Robert Derector Associates

A PRACTICAL GUIDE TO OFFICE ACOUSTICS

# Part 6: Teleconference Rooms

## PART 6: TELECONFERENCE ROOMS

Teleconference rooms are an important communication and learning space in modern office design. Acoustics in these spaces is critical to bring ease to communication during inhouse meetings but increasingly in virtual remote AV (audio-visual) communication.

The three main types of teleconference rooms are:

- Telephone Conferencing (Teleconferencing) - A telephone conference between two endpoints equipped with standard telephone handsets or speakerphones.
- Audio Conferencing - When conferencing audio fidelity is critical or when the number of participants at a conferencing site exceeds the performance capabilities of handset or tabletop conferencing systems, an audio-conferencing system with a telephone system interface may be deployed.
- Video Conferencing - Like audio conferencing, high-end video conferencing takes place in a purpose-built conference room using a permanently installed system. These systems will generally use multiple microphones, loudspeakers, cameras, displays, and software to transmit audio and video communication between users.

A. Privacy

Privacy of these spaces is not of high importance in all cases. This is discussed in more detail PART 2 - PRIVACY of this series documents. The following considerations should be made during this process:

- There is a requirement to prevent outside sounds from entering the teleconference space.
- When these teleconference spaces are active and busy it is important that noise generated within the spaces does not break out and cause distraction or annoyances to those working in adjacent spaces.
- If there is a media wall, the need for privacy for the adjacent space behind the media wall should be carefully evaluated. Media walls often have large recessed ‘back boxes’ and loudspeakers directly connected to the wall. Both of these issues can result in sound leakage through the media wall and need to be carefully detailed to avoid this leakage.

B. Ambient Noise

After assigning a Privacy Tier to the teleconferencing room, it is important to consider the remote communication requirements for the room. Establishing a low ambient noise level is important for optimal performance of audio tele-communication equipment. Noise from HVAC equipment should be closely looked at in the design phase to minimize the impact on projected NC levels. It may be beneficial to move noisy equipment (HVAC equipment, AV rack equipment with integral fans, etc) from the room to non-critical adjacent spaces (such as corridors, equipment closets, etc). Ambient noise is discussed in more detail in PART 3 - AMBIENT NOISE of this series.

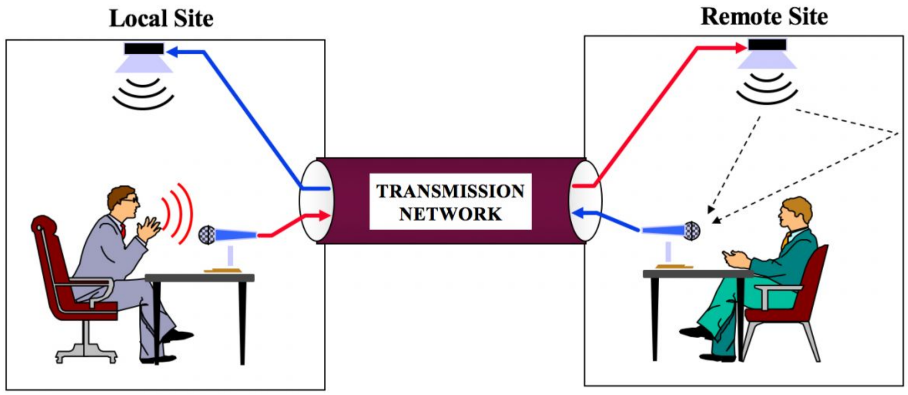
If an electronic sound masking system is being used throughout an office space, it is best to avoid installing the masking system in teleconference rooms. These systems are better suited directly outside of teleconference rooms in the adjacent corridor or open office area. This will help increase the level of privacy for sounds leaving the teleconference room, while maintaining a low ambient noise level within.

C. Room Acoustics

Equally important and often overlooked is the acoustic treatment of tele-conference rooms. Flat, reflective surfaces such as walls, ceilings and polished floors can cause sound waves to ‘bounce back’ and affect the audio quality of calls. Modern teleconference systems can help reduce some of these reflections and other noises heard by conference participants, but are limited in their performance if the room acoustics are poor. Sound reflections and reverberation can be controlled by introducing sound absorbing or sound diffusing materials into the space.

As discussed in PART 4: ROOM ACOUSTICS, the reverberation time within a space is heavily influenced by the construction materials and finishes used. With the reverberation time optimally controlled, it is important to also look at potential problematic reflections from the walls. Strong reflections from walls and other untreated surfaces can create speech intelligibility issues for the presenter and for remote teleconference attendees. Parallel reflective surfaces can also cause an annoying condition called flutter echo, which occurs when sound reflects back and forth rapidly between parallel surfaces. We recommend incorporating acoustical treatment on the ceiling and at least two walls to reduce reflections and reverberation, and to ensure adequate speech intelligibility for both in-person and remote meeting attendees.

**Figure 6.1** - Remote Communication Sound Path

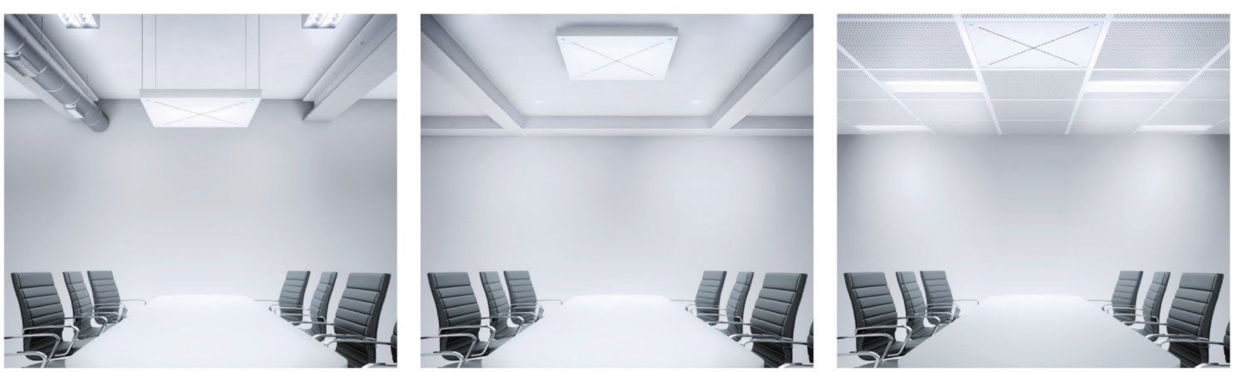



D. Accommodation of Technical Systems

It is increasingly common for office spaces to have both audio and video conferencing technology in a single room. Microphones and loudspeakers are the primary components of any teleconference room audio system. The choice of microphones and loudspeakers is important for the teleconferencing experience. The right set-up can help to reduce echo, feedback and other noises heard by conference participants.

Microphones are most commonly located in-ceiling, suspended from the ceiling, on-table, or on a sound bar mounted near the display. There are benefits to each of these microphone types.

**Figure 6.2** - Ceiling microphone (*TeamConnect Ceiling 2* by *Sennheiser*); suspended (left), ceiling-mounted (middle), flush-mounted (right)



We recommend reviewing the placement of microphones to ensure they do not pick-up noise from HVAC systems. This is especially important for in-ceiling microphones, which may be close to HVAC air inlets and outlets. Turbulent noise from moving air can also be easily picked up by microphones, so it is best to ensure that air diffusers and registers are designed to angle air away from microphones whenever possible.

SIA ACOUSTICS
A division of Robert Derector Associates

**Questions or Comments?**
**We would love to hear from you!**
**Please call or send us an email:**

**212.764.7272 SIAacoustics@derector.com**

SIA ACOUSTICS
A division of Robert Derector Associates

A PRACTICAL GUIDE TO OFFICE ACOUSTICS

# Part 7: LEED Credits & Acoustic Performance

## PART 7: LEED Acoustic Performance

Created by the non-profit organization USGBC (U.S. Green Building Council) LEED (Leadership in Energy and Environmental Design) is the most widely used green building certification system in the world. Its intent is to promote sustainable building practices. USGBC's stated mission is "to transform the way buildings and communities are designed, built and operated, enabling an environmentally and socially responsible, healthy, and prosperous environment that improves the quality of life."

In relation to acoustics USGBC's intent is to provide workspaces that promote occupants' well-being, productivity, and communications through effective acoustic design.

Although often overlooked, acoustical design of office spaces can play an important role in the health and prosperity of workers. A study (Seddigh, Berntson, Jonsson, Danielson, Westerlund, 2015) has shown that the effect of noise absorption variation in open plan offices improved acoustics are beneficial for health and performance. Improving acoustical conditions lead to less cognitive stress and less disturbances. According to another study (Haapahangas et al, 2008) noise was the main indoor and environmental problem (compared with thermal conditions, air quality and lighting) in both open and closed offices.

The workplace should be designed so that workers can perform tasks with ease and comfort and also interact, collaborate, communicate with others as needed. Realizing this importance, the USGBC introduced new credits that can be achieved through acoustic design beginning with LEED 2009 (v3) and evolving to the current LEED v4.1.

Compliance must be confirmed via calculations or measurements in representative rooms, and/or design documentation from a person experienced in the field of acoustics.

### A. LEED v4 vs. LEED 4.1

LEED v4 and v4.1 are the rating systems most commonly used today. Table 7.1 below summarizes the differences between these two versions of LEED in terms of the Acoustic Performance credit category. Note that we assume office projects are either considered Corporate Interiors (ID+C: CI) or New Construction (BD+C: NC).

**Table 7.1** - Comparison of LEED v4 and v4.1

| Category | LEED v4 | LEED v4.1 |
|---|---|---|
| Number of Credits<br>ID+C<br>BD+C | <br>2<br>1 | <br>1 or 2<br>1 or 2 |
| HVAC Background Noise<br>ID+C<br>BD+C | <br>Same<br>Same | <br>Same<br>Same |
| Sound Isolation<br>ID+C<br>BD+C | <br>More Stringent<br>More Stringent | <br>Less Stringent<br>Less Stringent |
| Reverberation Time<br>ID+C<br>BD+C | <br>Same<br>Same | <br>Same<br>Same |
| Sound Reinforcement & Masking Systems<br>ID+C<br>BD+C | <br>Included<br>Included | <br>Not Included<br>Not Included |

The key differences between LEED v4 and v4.1 are; the number of credits available, sound isolation requirements, and sound reinforcement & masking requirements.

In LEED v4, all acoustic performance requirements must be satisfied for a total of 1 point (for BD+C) or 2 points (for ID+C). This includes HVAC Background Noise, Sound Isolation, Reverberation Time, and Sound Reinforcement/ Masking.

Beginning with LEED v4.1, projects have the option of either 1 or 2 points (for both ID+C and BD+C). To gain one point, all occupied spaces must meet two of the following requirements:

- HVAC Background Noise Levels
- Sound Isolation/Transmission Ratings
- Reverberation Time Values

An additional 'exemplary performance' point is awarded if all three requirements are met. Note that v4.1 has no requirements related to Sound Reinforcement & Masking systems.

Some of the requirements related to sound isolation are much more stringent in v4 as compared to v4.1. We have discussed these requirements as they relate to acoustical 'standard practice' below.

As of February, 2019, all LEED v4 ID+C and BD+C projects now have the option of using any and all of the LEED v4.1 prerequisites/credits. This means that, even if you are working on a LEED v4 project, you can abide by the v4.1 requirements. In the case of acoustic performance, this has made the requirements much easier to achieve.

B. LEED Acoustic Performance vs. Acoustic 'Standard Practice'

1. HVAC Background Noise

The LEED requirements for HVAC Background Noise are provided in terms of a maximum permissible Noise Criteria (NC) for each type of space within a project. These maximum NC levels come from the 2015 ASHRAE Handbook (HVAC Applications, Chapter 48, Table 1). We discuss the NC metric in more detail in PART 3 - AMBIENT NOISE of this series.

In general, we find that some of the LEED design NC levels for office spaces are slightly more stringent than what we would consider 'standard practice'. For example, we would typically use NC-35 for the design of smaller conference rooms (with minimal AV/teleconference scope) and NC-30 for larger conference rooms (with substantial AV/Teleconference scope). The LEED requirements are approximately 5 NC-points lower, with NC-30 for all Conference Rooms and NC-25 for Teleconference Rooms.

Close coordination of HVAC systems is necessary to meet the more stringent LEED NC requirements. Additional sound attenuation measures may be necessary, including; quieter mechanical units, strategic placement of mechanical units away from sound sensitive areas, duct silencers, extra ductwork downstream of mechanical units, larger duct dimensions for lower air velocities, and more. We have discussed methods of HVAC noise control in PART 3 - AMBIENT NOISE.

Though additional sound attenuation measures may be required, we find that these are not cost prohibitive for most office projects. It is important to factor in the cost of additional HVAC coordination when deciding whether or not to pursue the LEED acoustic credits. This cost can be minimized if consultants know they are designing for LEED earlier in the design process by avoiding costly late-stage changes (change orders).

2. Sound Isolation

Both LEED v4 and v4.1 provide a variety of composite Sound Transmission Class (STC) requirements depending on the type of adjacency (i.e. 'Conference Room' to 'Conference Room', or 'Private' to 'Collaborative'). Composite STC' means that all components of a partition (including doors, windows, and penetrations like electrical outlets) must be accounted for in the overall STC value.

Since the transition to v4.1, the sound isolation requirements have become much more achievable. For example, LEED v4 requires partitions separating office and conference rooms from the adjacent corridor or open area to have a composite STC of 50. If glass office front systems are used, this means that they must be rated STC-50. In our experience, this is cost prohibitive for most projects as it requires very thick and expensive glazing systems.

The sound isolation requirements in LEED v4.1 are much more attainable. We find that these requirements are more in line with 'standard' acoustical practice. LEED v4.1 also allows the user to specify the level of privacy that each space requires based on usage (i.e. collaborative/ multi-use, private, or confidential). This gives projects more flexibility in their designs depending on the level of privacy necessary.

3. Reverberation Time

It is relatively easy to meet the LEED performance criteria for reverberation time (RT) for office projects. Our standard office space design criteria for acoustical treatment (which are generally in line with acoustical 'best practices') meet the LEED design criteria in most office spaces.

The RT of a space is a function of the size of the space (cubic volume) and the average absorption of the materials used within the space. The RT can be lowered by adding acoustically absorptive treatment to a given space to increase the average absorption. We have discussed reverberation time and outlined our standard design criteria for acoustical treatments in more detail in PART 4 - ROOM ACOUSTICS of this series.


19 West 44th Street, New York, NY 10036
212.764.7272 SIAacoustics@derector.com www.derector.com

The LEED design criteria specify maximum RT's for several types of spaces. These RT's range from 0.6 seconds (for Executive/Private Office, Conference Rooms, and Teleconference Rooms) to 0.8 seconds (for Open-plan Offices).

In many cases, the LEED RT requirements can be satisfied by adding an effective Acoustical Ceiling Tile (ACT) to each space. ACT is a very cost effective acoustical treatment. We generally recommend selecting a tile with a Noise Reduction Coefficient (NRC) of approx. 0.8 or greater. There are many options for acoustical ceiling tiles that meet this performance.

Other acoustical ceiling treatments (such as spray-applied, fabric wrapped panels, suspended acoustical baffles, etc.) can also suffice. In general, we recommend selecting a treatment with an NRC of 0.80 or greater. The area of coverage will also be important. Generally, a treated area equivalent to 80% to 100% of the ceiling will ensure compliance with the RT criteria. Note the exact area of treatment required will depend on the type of treatment and the size of the space.

Wall treatment can also help to meet the RT design criteria, but it is typically not needed in addition to ceiling treatment. We do recommend wall treatment in addition to ceiling treatment in some cases (see PART 4 - ROOM ACOUSTICS), but this is not a LEED requirement.

C. LEED Documentation Requirement

1. Submittal Material

In order to meet LEED v4.1 requirements, compliance must be confirmed via calculations or measurements in representative rooms. Calculations may be performed for HVAC background noise and/or Reverberation Time using the construction drawings.

When possible, we recommend that the required acoustic calculations be performed in the design phase in lieu of field measurements. This way potential acoustic issues can be addressed during the design development phase and remediation options discussed with architectural and mechanical teams prior to space construction saving time, money and frustration.

Typical LEED documentation submittals required for for acoustic credits include:

- LEED Acoustic Performance Calculator Spreadsheet
- AHRI calculations for HVAC background noise
- Product data and/or cut sheets showing performance of acoustical materials

2. Compliance Requirements

Each occupied room for the proposed LEED project must be listed and a space type assigned. This space type determines the LEED acoustic design criteria that must be achieved.

**HVAC Background Noise:**

To prove compliance it is required to demonstrate that the background noise requirements for all heating, ventilating, and air conditioning (HVAC) systems will be met for all occupied space/rooms types.

**Sound Transmission:**

It must be demonstrated that sound transmission class (STCc) ratings or noise insulation class (NIC) will be met for all occupied space/rooms types.
*Requirements can be lowered by 5 STCc or NIC points if sound masking systems are implemented in the spaces based on stipulated criteria.
**Ratings do not have to be met if it can be proven that the equipment noise in conjunction with the sound isolation performance of the partitions and doors will not exceed the maximum background noise requirements of the adjacent space.

**Reverberation Time:**

Criteria for RT60 reverberation times must not be exceeded. For each space type all surface materials and their associated surface area must be listed along with the Sound Absorption Coefficient (at 500, 1000 and 2000 Hz) and/or Noise Reduction Coefficient. The LEED Acoustic Performance calculator automatically calculates the RT for each space using this information.

SIA ACOUSTICS

A division of Robert Derector Associates

**Questions or Comments?**
**We would love to hear from you!**
**Please call or send us an email:**

**212.764.7272   SIAacoustics@derector.com**