# Special Discussion Area Construction Guide

## GCPSG-017 (2024)

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Publication Issued: 2022-12-12
Updated: 2024-02-07

# Foreword

The GCPSG-017 – Special Discussion Area Construction Guide is an UNCLASSIFIED publication, issued under the authority of the Royal Canadian Mounted Police Lead Security Agency for Physical Security (RCMP LSA).

This is a Government of Canada publication to serve as a guide for addressing speech security construction and best practices for departments, agencies and employees of the Government of Canada.

Suggestions for amendments and other information can be sent to the RCMP Lead Security Agency RCMP.LSA-GRC.POSM@rcmp-grc.gc.ca.

# Preface and Acknowledgements

The purpose of the section is to highlight the linkage between this GCPSG and the "Speech Security Best Practice Guide (SSBPG)" commissioned in 2014, and published by Public Service and Procurement Canada (PSPC) as a departmental guide in 2021.

The SSBPG was the result of collaboration and extensive research efforts of PSPC, National Research Council (NRC), RCMP and private sector experts to provide guidelines on meeting speech security requirements for office accommodations. The intent was a set of guidelines pertaining to speech security for enclosed rooms to aid in the successful delivery of office accommodations. The RCMP LSA embarked on a plan to endorse the SSBPG and make it suitable for all of the GC.

It is with grateful acknowledgement to the original contributing authors of the SSBPG, NRC, RCMP and PSPC (formerly Public Works and Government Services Canada) that this guide has been developed and published. Contributors will be consulted on future updates to this guide.

# Effective Date

The effective date of GCPSG-017 Special Discussion Area Construction Guide is 2022-12-12.

# Record of Amendments

| Amendment No. | Date | Entered By | Summary of Amendment |
|---|---|---|---|
| **1** | 2023-06-09 | D. Pumphrey | Fixed email link directing to wrong address |
| **2** | 2024-02-07 | T.R. Murphy | Correction/Removal of Secure Discussion Area terminology |
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Note: Authority for modifications or variances is Royal Canadian Mounted Police Lead Security Agency for Physical Security (RCMP LSA).

# Contents

# 1. Introduction

## 1.1. Purpose

The purpose of this guide is to provide Government of Canada (GC) employees with information on the requirements for establishing a Special Discussion Area (SDA). Employees should also consult their departmental security policies, directives, standards, processes, and guides for additional information and direction.

## 1.2. Applicability

This guide identifies physical security requirements for establishing special discussion – speech secure areas but may not fully address the IM/IT security (cybersecurity) for GC systems used in the creation, processing, or storage of electronic information.

## 1.3. Information Technology Considerations

With the constantly evolving threat landscape, and the convergence of physical and information technology (IT) security, the requirement to assess the risk of any application and/or software connected to a network to operate and support equipment in Government of Canada controlled buildings is critical. Some examples of these control systems could be for items such as, but not limited to, security lighting, perimeter gates, doors, HVAC, etc.

Before implementing any applications and/or software that will control and/or automate certain building functions, your departmental security requires the completion of a Security Assessment and Authorization (SA&A). This will ensure that the integrity and availability of the components the applications and/or software controls are maintained and that any risks highlighted will be mitigated. Starting the SA&A process early is highly recommended to ensure project delivery schedules are not affected. For more information on the SA&A process, please consult your departmental Security.

# 2. Contact Information

For more information, please contact:

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# 3. Acronyms

| Abbreviation / Acronym | Meaning |
|---|---|
| **ASHRAE** | American Society for Heating, Refrigerating and Air-Conditioning Engineers |
| **ASTM** | American Society for Testing Material |
| **AC** | Articulation Class |
| **AI** | Articulation Index |
| **FSA&A** | Facility Security Assessment & Authorization |
| **GC** | Government of Canada |
| **IT** | Information Technology |
| **NPMS** | National Project Management System |
| **NRC** | National Research Council |
| **PSPC** | Public Service and Procurement Canada |
| **RCMP LSA** | RCMP Lead Security Agency for Physical Security |
| **SA&A** | Security Assessment and Authorization. |
| **SCIF's** | Secure Compartmentalized Information Facilities |
| **SDA** | Special Discussion Area |
| **SII** | Speech Intelligibility Index |
| **SNR** | Signal to Noise Ratio |
| **SPC** | Speech Privacy Class |
| **SSBPG** | Speech Security Best Practice Guide |
| **STC** | Sound Transmission Class |
| **TL** | Transmission Loss |
| **TRA** | Threat and Risk Assessment |

# 4. Glossary

| Term | Definition |
|---|---|
| **Articulation Class** | A single number rating system used to determine how walls, ceilings, desks, chairs, etc., provide sound attenuation in an open environment. |
| **Articulation Index** | A testing method used to measure speech privacy in open floor plan type spaces (offices, meeting rooms, etc.) by indicating how background noise can affect speech levels. |
| **Asset** | Tangible or intangible things of the Government of Canada. Assets include but are not limited to information in all forms and media, networks, systems, materiel, real property, financial resources, employee trust, public confidence and international reputation. |
| **Attenuation** | As sound passes through different objects or layers, it impacts the quality of the sound. |
| **Facility** | A facility may be a building (whole or part) and may include its site or land, or may be an area or construct that is not a building. (ie. weapons ranges, agriculture fields). |
| **Speech** | A physical measure directly related to the intelligibility of speech that is |

| | |
|---|---|
| **Intelligibility Index** | calculated from acoustical measurements of noise and speech |

# 5. SPC and Standards Background

Prior to American Society for Testing Material (ASTM) E2638 and the speech privacy class (SPC) criteria there were no specific standards available to definitively quantify speech security design requirements or assess compliance. In some cases, it was attempted to adapt standards developed around defining the quality and intelligibility of speech at various receiver points inside a large room or auditorium, to defining the loss of same to receiver points outside a room. This would refer to standards and terminology such as Speech Intelligibility Index (SII - ANSI S3.5), Articulation Index (AI - ASTM E1130) and Articulation Class (AC - ASTM E1111). While these methods do indicate loss in speech intelligibility, results may be uncertain when attempting to use them to define the speech security provided by a room's envelope. They also require various exceptions to be made in the standard measurement procedures and analysis process and don't directly relate to security protection criteria.

While subjective testing may still be somewhat relevant as it provides a "real" performance indication using human listeners and real or recorded voice sources, its results are reported statistically and based on the responses of the varying test subjects. Therefore, ideally to be the most effective this would require using various ages, genders, and languages for test participants for both sources and receivers. It requires formulating source content, reviewing test responses and providing results based on various source and receiver scenarios. Depending on security requirements and the number of rooms required to test this could become an inefficient and involved process that may not provide definitive results easily linked with security criteria. If the results tend to be uncertain then quantitative acoustical testing methods would likely need to confirm actual results. Although once used commonly these methods may be best suited to client performance demonstrations in mock-ups or with selected as built examples.

Standards based on sound absorption and sound transmission loss such as ASTM E90 and E336 have been traditionally used to rate the performance provided by specific wall designs and materials determined under ideal laboratory conditions (E90) and for the measurement procedures used to determine their performance as built (E336). The criteria commonly referred to as Sound Transmission Class (STC) has sometimes been arbitrarily and/or improperly used in project specifications and its specific performance implications misunderstood and presumed. The most common misconception being that, specifying a particular STC wall design will translate into an equivalent STC room performance as built, and therefore will also meet speech security requirements assumed for the STC specified. Fit-up specifications may also fail to account for the entire room envelope's STC requirements such as for the floor/soffit slabs, ceilings, doors and windows or other features. What also has to be considered are the HVAC duct layout and return air system, electrical conduits, sprinkler pipes or other services traversing room walls and introduced into the wall cavities which affect the room's overall acoustical and speech security performance.

While the sound transmission loss is also part of the basis of the SPC criteria, it also considers other factors such as proximity, background noise levels and probability factors and is concentrated specifically on speech characteristics and propagation. The "STC" standard procedures and criteria provide a good basis to specify design requirements and still have their relevance particularly for infield assessments prior to completion of construction for performance checks. There are variations in these test methods and reporting criteria based on various factors but ultimately all provide what may be considered an "average" in-field performance and may indicate if security compliance is probable or not. However, they don't quantify speech security unequivocally and could easily not identify sound/security leakage points, and yet still indicate compliance with STC design criteria.

The ASTM E2638 measurement procedures referenced provide a refined process that can accurately and efficiently define speech security provided around the entire room's accessible perimeter, and can identify the location of specific points where speech security leaks may exist. It should be noted that E2638's testing procedures are limited to assessing fully completed constructions ready for occupancy, or in assessing existing room constructions. The intent of the SSBPG is to minimize the risks of discovering that problems exist late in commissioning process by proper planning, construction and quality control methods throughout the projects progress. Testing requirements may then be limited to a smaller percentage of locations or to those requiring the highest levels of speech security compliance.

Table 1 provides the SPC criteria ratings and the corresponding level of protection that would be associated with them and is based on the highest level of sensitive information to be discussed in them. Details related to construction process requirements are provided in Section 6.

# 6. Speech Security Project Management

It is beyond the scope of this guide to include all the various project management activities and tasks where its implications need to be applied in all cases, it is assumed that project management teams will know best where they are most relevant. What is important to take into account from a project's inception, is the provision of speech security requires significantly more logistical considerations and resources to implement than "standard' fit-up requirements and should not be considered as an "add-on" dealt with at later stages of a project. It is important to ensure that a Threat and Risk Assessment (TRA) has been completed and to use the Facility Security Assessment & Authorization (FSA&A) process during project management for the construction of an SDA. The following general accommodations scenarios are those that would be the most commonly encountered when building an SDA.

## 6.1. Existing Space

The use of existing locations "as is" that may be adapted to meet the client's entire security and accommodation requirements with existing locations within the facility that have been tested and certified to meet a client's SPC security requirements.

## 6.2. Partial Retrofits

Partial retrofits would imply a limited number of spaces within larger existing facility which require renovations to meet speech security requirements. This may include rebuilding or enhancing specific room walls or partitions, adding vestibules, modifying duct work, replacing doors or as required to meet the specified SPC requirements. These situations may introduce various challenges to properly implement into existing base building design and layouts.

### 6.3. New Construction or Full Retrofits

The main concentration and content of this guide is based on the provision of larger scale new constructions or full retrofit projects requiring multiple speech secure rooms within a larger open plan office area and/or between adjacent rooms and spaces. These scenarios allow the opportunity to implement and integrate speech security requirements as efficiently and effectively as possible into the National Project Management System (NPMS) model for accommodation plans.

### 6.4. Speech Security Cost and Schedule Forecasts

Initial accurate forecasting of speech security requirements is critical as costs and timelines can be significantly more than those required for the provision of "standard" closed office space and these should be well accounted for and justified from the start. While these details and forecast will need to be further refined in later project stages it would be prudent not to underestimate the possible implications.

Using the layout concept or an established layout plan, the secure closed offices and other rooms need to be located and identified on the plan as best as possible. The corresponding established SPC security protection levels need to be determined and assigned to those rooms, at a minimal this would require knowing the number, type and approximate size of rooms and security protection level required. However, having a relatively accurate layout plan would also allow for preliminary mechanical systems routing to also be conceptualized in order to aid in estimating these implications. It may be desirable that identifying speech secure locations and assigning the appropriate SPC criteria be done in cooperation with security officials conducting TRA and/or other assessments.

In order to try and accurately forecast costs and timelines associated with the provision of speech security consideration needs to be given to, base building design details; services routing; "non- standard" and enhanced interior design specifications; special materials/features quantities and availability (e.g., high STC doors); labour skills and scheduling; security compliance testing. Well- coordinated plans, lines of communication and schedules will need to be developed between the SST and the various disciplines of consultants, contractors and trade subcontractors in order for implementation to be completed effectively and efficiently.

## 7. Selecting Speech Security Criteria in terms of SPC Values

This section describes criteria that are intended to protect information discussed in closed rooms against normal overhearing by eavesdroppers outside the room. 'Discussions' include speech from people in the room talking to each other, or talking into telephones and other communication systems. (Italicized words in this section are explained in the definitions of Section 7.1 below).

The criteria are expressed in terms of the SPC values and are intended to provide acceptable protection for the highest level of information that may be discussed in a particular room. The criteria are to ensure that the construction of the room together with the ambient noise level outside the room will appropriately reduce the risk of speech, transmitted from the room, being intelligible or audible to listeners located outside the room.

The speech privacy and speech security criteria included in this section are a key part of providing secure closed rooms for discussions. These criteria are intended to ensure only that the construction details and mechanical equipment of the building provide adequate speech privacy or speech security at locations outside particular closed rooms. They are intended to mitigate the risk of normal overhearing of speech sounds, transmitted from a room, by eavesdroppers located outside the room. These criteria should be applied to both new constructions and existing closed rooms where sensitive material is discussed.

These criteria will not be sufficient to protect against more determined forms of eavesdropping, such as listeners touching the wall or using electronic surveillance devices. Such more determined forms of eavesdropping are beyond the scope of this section. To address such threats, it is necessary to consider other factors (such as restricting access to adjoining spaces, (See also Section 6), in addition to meeting the minimum required SPC values provided in Section 7.1 and Table 1. This section does not take into account the many technical details that need to be considered to protect against more determined forms of eavesdropping, nor does it consider the physical protection of sensitive assets such as documents.

## 7.1. Section Definitions

- Intelligibility of speech: Speech is said to be intelligible when more than 50% of a panel of attentive listeners with unimpaired hearing can correctly repeat back at least one word of short test sentences.
- Audibility of speech: Speech is said to be audible when more than 50% of a panel of attentive listeners with unimpaired hearing can just hear some speech sounds although they may not understand any of the words.
- Speech Privacy: Conditions in which it is difficult to understand speech from a nearby room. Speech may be occasionally intelligible although speech sounds will be frequently audible.
- Speech Security: A high level of speech privacy where speech sounds from a nearby room would be no more than very rarely intelligible and only occasionally audible.
- High Speech Security: A very high level of speech privacy where speech sounds from a nearby room would be essentially unintelligible and only very rarely audible.
- SPC: A quantity combining a measure of the attenuation of speech sounds transmitted from a closed room and the level of ambient noise at points outside the room. SPC values are directly related to the audibility and intelligibility of speech, transmitted from a nearby closed room, and are technically defined in the ASTM E2638 measurement standard and reference.
- Closed room: A room where the walls, with included doors and windows, along with the floor and ceiling, form a completely closed space, providing sound isolation between the room and all adjacent spaces.

- Normal overhearing: The action of an eavesdropper (with good hearing) outside a closed room, listening attentively at locations possibly close to, but not touching, the outside of the room, and not using electronic devices to aid in hearing speech sounds transmitted from the closed room.
- Ambient noise: General sounds in the indoor environment such as ventilation noise, the sounds of office equipment, or more distant conversations that can mask or make it more difficult to hear or understand particular speech sounds.
- Frequently audible: audible approximately once every 2 minutes.
- Occasionally intelligible/audible: intelligible or audible approximately 4 times in a 1 hour period.
- Very rarely intelligible/audible: intelligible or audible approximately 4 times during an 8 hour period.
- Essentially unintelligible: intelligible approximately once in a period of two working days (i.e. 16 hours).

## 7.2. Speech Privacy and Speech Security Criteria

### 7.2.1. Minimum SPC Criteria

All rooms for sensitive discussions should be designed to have a minimum SPC rating determined by the highest level of information to be discussed in the room. The minimum recommended acceptable SPC values are given in Table 1. Room designed to meet a particular SPC value, and tested to confirm that the level has been achieved, is acceptable for discussions of all levels of information up to and including the highest level of information specified in Table 1 for the particular SPC value.

The terms in Table 1 concerning how often one or two words from an adjacent room might be audible or intelligible may be described as follows:

- Frequently audible: audible approximately once every 2 minutes;
- Occasionally intelligible/audible: intelligible or audible approximately 4 times in a 1 hour period;
- Very rarely intelligible/audible: intelligible or audible approximately 4 times during an 8 hour period; and
- Essentially unintelligible: intelligible approximately once in a period of two working days (i.e. 16 hours)

**Table 1 – SPC ratings and Information Categories**

| Category | Highest Level of Categorization | Minimum Acceptable SPC | Speech from room is... |
|---|---|---|---|
| Standard Speech Privacy | Protected B | 75 | occasionally intelligible, and frequently audible |
| Standard Speech Security | Protected C, Secret | 80 | very rarely intelligible, and occasionally audible |
| High Speech Security | Top Secret | 85 | essentially not intelligible, and very rarely audible |

#### 7.2.2. Other categories of information

The terms used to describe the highest level of information to be discussed in Table 1 (Protected B, Protected C, Secret, and Top Secret) are categories of sensitive information used by the Canadian Government. Often different terms may be used, or the same terms may be used differently in other jurisdictions. For example, the term 'Confidential' may have more significant implications in other jurisdictions than in Canada. Other types of information may also need the same protection as one of the 3 categories in Table 1. As an example, solicitor-client conversations may require rooms with SPC 80 ratings, but in some special cases would require an SPC 85 rating. Similarly, discussions between judges in court houses might typically require rooms with SPC 80 ratings, and doctor-patient conversations possibly rooms with SPC 75 or 80 ratings. However, it is not possible in this section to give equivalencies between all other categories of information and those in Table 1. The user needs to equate the needs of such other types of information to those provided by one of the categories in Table 1.

### 7.3. Exceptional speech security requirements

In some exceptional cases, the information being discussed may be rated higher than Top Secret. This might lead to the requirement for an even higher level of speech security corresponding to an SPC of 90 which would provide conditions for which speech would be unintelligible and essentially always inaudible to an eavesdropper outside the room. This may require a Threat Risk Assessment (TRA) to justify the need for this higher security and very specialized help to ensure that the design meets such exceptional requirements. SPC 90 would be costly and difficult to achieve in most situations.

### 7.4. Testing for Compliance with Criteria

All new and newly renovated rooms for sensitive discussions should be tested by an independent third-party acoustical specialist for compliance with the required SPC rating following the procedures described in ASTM E2638 [1,2]. Measurements should include more likely locations of potential eavesdroppers and more likely locations of weak points in the sound isolation of the room such as near doors. Testing should be repeated after any renovations to the room that may affect the integrity of the room boundaries, as well as after changes to correct previously identified deficiencies. In addition, testing should be repeated periodically to confirm the continuing compliance with the required criteria in spite of wear to door seals and other possible degradation due to wear over time. Re-testing would be particularly important for rooms intended to provide protection to the High Speech Security level. Rooms that have not been tested to demonstrate their compliance with a particular SPC criterion should not be used for discussion of sensitive information.

### 7.5. Consideration of Adjacent Spaces

Control of adjacent spaces is always desirable and a system of hierarchical zones can ensure that adjacent spaces are restricted to acceptable personnel. Rooms intended to provide protection to the Speech Security and High Speech Security levels should not be adjacent to an uncontrolled space.

Control of access to adjacent spaces is not needed to prevent normal overhearing of speech from the room, but is helpful to mitigate more determined types of eavesdropping involving touching the walls of the room or using electronic devices. Protection against such more determined forms of eavesdropping is beyond the scope of this section but would usually require control of adjacent spaces.

In some situations, an unoccupied adjacent space can be used as a buffer zone to enhance the speech security of the room. For example, a 'room-within-a-room' type construction can be used to achieve very high levels of speech security. In these situations, SPC ratings could be measured between the room and spaces outside of the immediately adjacent buffer zone. In other cases, where the adjacent space is occupied or where people pass through the adjacent spaces, it should not normally be counted as a buffer zone when measuring the SPC rating of the room. Where there can be people in the space, it can only be included as a secure buffer zone if all people in the adjacent space have a legitimate need to know the material to be discussed in the room.

### 7.6. Designing to Achieve these Criteria

There are many details that will influence the acoustical privacy of a meeting room [4]. To ensure that 'as-built' constructions meet the desired performance goals, it is good practice to design for an SPC value of up to 5 points higher than the criterion design goal for each category because the real construction will often not perform as well as intended. It is also important that there is careful monitoring of the construction process to provide appropriate quality assurance. Having an adequate wall is only one part of the problem. Doors into a closed room usually limit the sound isolation and a carefully designed vestibule is often needed. There are also many other sound paths that allow sound to be transmitted from the meeting room to adjacent spaces other than directly through the common wall. These would include: thin concrete floor slabs, connecting ducts, pipes and conduit penetrating the room boundaries. Without proper consideration of all of these flanking paths, it will not be possible to achieve the requirements for higher levels of security.

It is recommended and is usually cost effective to use an acoustical consultant with expertise in designing rooms for acceptable speech security when constructing closed rooms for all levels of sensitive discussions. This is essential for exceptional cases above the High Speech Security category, where each room needs to be specially designed to meet all local requirements, as well as the specified minimum SPC value.

## 8. Design Details for Speech Security in Terms of SPC Values

This section includes practical design information to help users successfully achieve high speech security. This includes: floor plan concepts that more easily make it possible to create speech secure rooms, descriptions of common causes of failures, design details that have been found to help provide high speech privacy, and extensive tables of wall TL(avg) values.

Section 7.2.1 described the SPC rating that includes measures of the ambient noise and the speech sounds transmitted through walls. It is essential that both factors are appropriate to achieve the desired speech privacy for a particular room. The amount of transmitted speech sounds is determined by the apparent average transmission loss of the wall TL(avg) and values of TL(avg) are included in this section for 94 different types of wall constructions. At the design stage ambient noise levels can be estimated as described in Section 7.2.1 of the main document.

There is of course much more to achieving adequate speech privacy than choosing the right wall construction. This section attempts to provide a wide range of practical information to aid the user to get successful results with the desired level of speech privacy.

## 8.1. Design of Different Kinds of High SPC Rooms

The design of high SPC rooms, or suites or even entire buildings will be most successful if a system's design approach is used. The system comprises all the elements which make up the area to be controlled in terms of SPC. This includes all of the building systems, such as HVAC, plumbing, fire protection, electrical services, communications and connectivity, security and signaling systems, building envelope, structure, and of course the architectural design. A plan of the area needs to first be evolved by consideration of the space available, the space required and the adjacencies between the various areas of the building. A successful product in terms of high speech privacy rating (ie. high SPC rating) has to consider all of the elements involved, including not only the constructed space but also the access to the spaces surrounding the protected space. It is only if all of the elements of the system are given due consideration that a high SPC result can be achieved. Since any single element in the system can cause a failure in speech privacy, it is paramount to always consider the overall area being protected as a system and to consider the interactions of each element and how they affect the overall performance. It is of no use to have 90% of the elements functioning perfectly and have a failure in SPC due to just 10% of the elements performing inadequately in terms of sound isolation.

Once the adjacencies and space planning have been considered, the detailed architectural design can commence. The easiest part of any design of a highly sound isolated space is the selection of a wall or floor section from a catalogue or listing of such assemblies. However, this alone usually does not ensure high performance, as it is all of the other elements that can reduce the final performance. All of the parties involved need to participate in the design and construction phases with the understanding that no single element of the system can be left unconsidered. This means that the client who will occupy or use the space, the designers, project managers, the builders and property owners need to work together to allocate sufficient resources to ensure the success of the project. For example, the HVAC design cannot be done independently of the architectural design, as ducts need to be run in such a way that the holes and cavities inside the ducts do not compromise the sound isolation, and so that there is room in the architectural plan to run ducts with the required routing to attenuate sound. A guaranteed failure is to have the architect evolve a floor plan and then to have the mechanical engineer run all of the ductwork straight through from one room to another because there is insufficient room in the circulation or other spaces to run the ductwork. Irrespective of how well the walls have been designed or constructed, the sound will enter into the ducts and travel from room to room, bypassing the wall. This is an example of a system failure, where weakness in one single element in terms of sound transmission causes a poor result in terms of SPC.

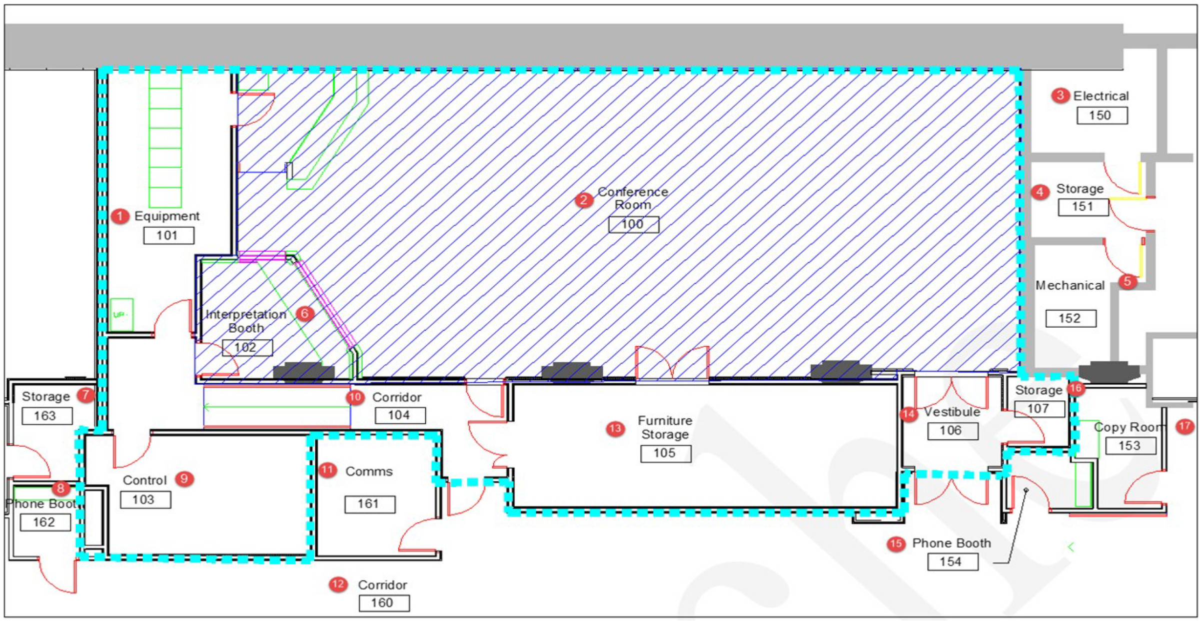
## 8.2. Speech Privacy Perimeter Concept

When considering an area or room to be protected in terms of speech privacy, it is useful to think of a secure perimeter around the area to be protected along with the room or group of rooms being protected. The room or rooms being protected as part of a suite are considered as the protected floor area from where speech to be protected originates, while the perimeter is a line outside the protected area totally surrounding the protected area. This concept is useful as it defines the area where sound sources are to be placed for testing SPC and also defines the perimeter outside the area where measuring points are to be located to verify performance. This concept also has the benefit of indicating where access is to be controlled in order to reduce potential eavesdropping. While the protected area in question can be a single room with the perimeter being that line surrounding the room, it can also be much more complex, which is where the concept is the most useful.

The simplest example is a single meeting room or office to be protected with an adjacent communicating office or vestibule. The protected area is simply the meeting room or office, and does not include the adjacent office or vestibule, as these areas have controlled access. The Speech Privacy Perimeter is the line in plain view surrounding the total area formed by the protected area plus the adjacent office or vestibule. A more complex example is a meeting room with an associated equipment room and translation room. The sound to be protected can be heard in any of these rooms, as loudspeakers may be being used to monitor speech occurring in the meeting room, or interpreters may be repeating in a different language the same protected content from a room adjacent to the meeting room. In this case the area to be protected includes not just the meeting room, but two other rooms as well. This suite of rooms may also incorporate other rooms with protected access or with access only from inside the suite, or sound locks/vestibules. Speech does not occur in these ancillary areas and as the areas have controlled access, and there are no listeners there that have not been granted access, the SPC does not need to be controlled there. One then adds a Speech Privacy Perimeter surrounding the suite consisting of the original room to be protected along with the ancillary rooms to determine a line in plan or section view where potential eavesdropping can occur. This allows the use of ancillary rooms to form intermediate areas as buffer zones where sound has to go through two sets of walls, doors or ducts before reaching the protected perimeter. This aids in reducing the performance requirements of any single element, in particular doors and glazing and ducts in order to reach the required level of SPC.

Figure 1 illustrates a large Conference or Boardroom/Meeting Room Suite with multiple ancillary spaces typically associated with such suites. There are some rooms which form part of the suite, and these rooms are accessed from within the suite itself. There are only two entrance points, the first through a double set of doors through a vestibule Rm 106, and the other a single door through a corridor Rm 104. All of the rooms that form part of the suite have been identified by room numbers in the 10X range, starting with the meeting room itself, Rm 100 through to the small storage room, Rm 107. The Service spaces surrounding the suite on the right have been given numbers in the 15X range, and these might be mechanical and electrical rooms. Other rooms unrelated to the suite in question have been given numbers in the 16X range, and these include the primary access corridor Rm 160, along with rooms part of another suite, Rm 163 and 164, as well as an unrelated room for Communications, Rm 161. The thick wall at the top is an exterior wall.

**Figure 1**




*Alt Text Figure 1 depicts a large Conference Room Suite with Protected area, shown by the hatch pattern on the floor plan, and a Speech Privacy Perimeter (heavy dashed turquoise line)*

The first task that needs to be done is to identify rooms might have voice sounds needing to be protected from eavesdropping. In this particular example, other than the large meeting room Rm 100, the only other room where speech needs to be protected is the interpretation booth, Rm 102. It is in that room that the interpreters repeat in their own voices but in a different language what was said in the meeting room. Thus speech from the interpretation booth needs to be protected. It is assumed that any person in the suite will wait to be in either of those two rooms, and with all doors closed before discussing protected material

Figure 1 also shows the areas to be protected as a hatched floor area. In some cases, it might be the case that the Control Rm 103 forms a part of the area to be protected as the sound picked up by the conferencing microphones in the meeting room might be amplified over loudspeakers for quality monitoring by the control room personnel. However, in this case it was determined that there would be no such sound reproduction in the control room and that this area did not need to be protected.

Once the areas to be protected have been identified, diagrams showing the area to be protected similar to Figure 1 should be presented to the persons responsible for determining SPC requirements to confirm that the areas indicated are indeed the only areas needing to be protected.

If the areas to be protected have been fully determined, then one can proceed to the next task which is to determine the Speech Privacy Perimeter (SPP). The SPP is simply a line surrounding the Protected Area, and it can also enclose multiple rooms which do not form part of the Protected Area. The benefit of this is that it allows surrounding rooms to form buffers for sound to pass through. This can enhance speech privacy similar to using vestibules to provide sound locks to counter the difficulties using single doors to contain sound adequately. These buffer rooms also provide spaces for ducts, HVAC terminal units and building connectivity to enter the suite without going directly through the walls surrounding the areas to be protected from an area of potential eavesdropping.

Figure 1 also includes a dashed turquoise line to identify the Speech Privacy Perimeter, which effectively surrounds the Protected Area, but not directly along the walls of the Protected Area itself. The SPP actually includes all of the rooms in the number range of 10X. This is because the floor plan has been organized in such a manner as to require entry into the suite via one of the two entrance door points in order to gain access to the rooms inside the SPP which do not form part of the Protected Area. The only reason this is possible is because careful consideration was given to establishing a SPP in the design of the floor plan, by organizing the room adjacencies, the corridors and entrance points for each room. The example shows the final design arrived at from a series of initial layouts. These layouts were revised during the design process to satisfy all of the suite's requirements while providing an effective Speech Privacy Perimeter.

The SPP forms a line along which a person could try to overhear speech from the Protected Area. It also forms a line along which one might agree to test the value of the SPC, and outside of which one does not expect to control access. Any area contained inside the SPP forms part of a controlled access zone and does not in itself require the highest levels of SPC. However, it always needs to be considered that the walls within the SPP require a high level of average Transmission Loss (TL(avg)) rather than a particular STC rating in order for the buffer rooms and vestibules to function effectively to block sound and provide the required speech privacy for the protected area. It may be required to test the performance of intermediate walls inside the SPP to guarantee performance along the SPP. In some cases, it allows the use of only one acousticallyrated door with the second one being only a regular solid door, for example, with seals all around.

In the example, the SPP line is generally not along a wall directly closing off the Protected Area, but rather along the walls of the rooms serving as sound isolation buffers. This type of design will be the most successful in terms of providing high levels of SPC, and should always be considered for rooms requiring high security, in particular for rooms with multiple doors along their perimeter, and rooms where speech is amplified over loudspeakers.

In situations where the SPP needs to be along a wall directly at the perimeter of the protected area due to planning or space constraints, such as between rooms 100 and 150, 151 and 152 in the example in Figure 1, the penetrations need to be minimized. Ducts should not be run through these walls, and all other penetrations for electrical, communications, etc. should also be minimized. These building services should rather go through the buffer rooms, such as Rm 105 for instance.

## 8.3. SDA's and SCIF's and SPC

This document does not address all the issues normally addressed in documents describing the requirements for Special Discussion Areas (SDA's) and Secure Compartmentalized Information Facilities (SCIF's) as these documents deal not only with the isolation of sound and thus speech privacy, but also physical security and other security issues such as the actual levels of security required depending on the functions of the rooms involved.

It is hoped however that the acoustical parts of these existing and generally old documents will be replaced by elements from this document based on SPC ratings, since the acoustical recommendations found in the older documents are outdated and often have not been proven to function adequately in terms of sound isolation. They have certainly not been written in terms of SPC ratings, as the standard did not exist when those documents were prepared. It is very difficult to find the sources for the designs recommended, the science behind the recommendations, or any test results backing up the recommendations relating to acoustics in the SDA and SCIF documents. Also many agencies simply copy and adapt old documents to make their own documents. An example is one document that only allows a staggered stud wood wall built on a common floor plate for adequate acoustical isolation. This is clearly not representative of modern building construction and ignores the dozens and dozens of other wall types which will provide even better sound isolation. The documents do not deal with background noise, and this is absolutely fundamental to the level of speech privacy obtained. As experience is gained in the design of high SPC construction, the documents relating to SDAs and SCIFs will hopefully be re-written and refer to this Guide which is based on scientific research on perception and performance, as well as on tests in real buildings, or at least incorporate elements of this guide.

## 8.4. Wall selector

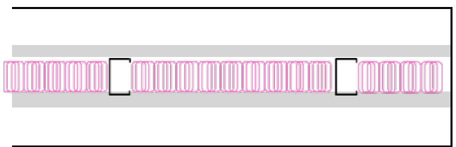
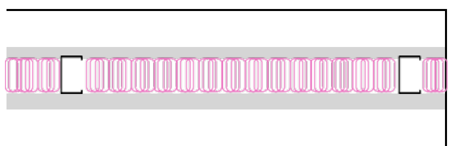
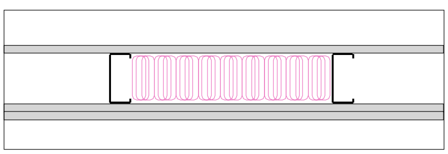
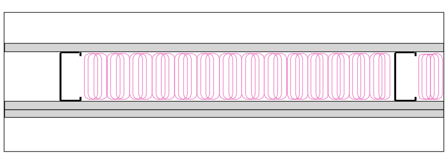
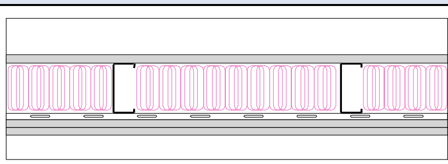
At the design stage, speech privacy criteria are specified in terms of SPC values defined in ASTM E2638 and in section 7.

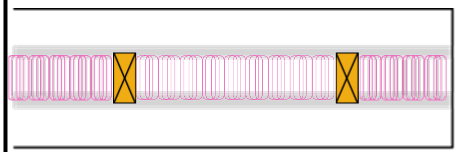
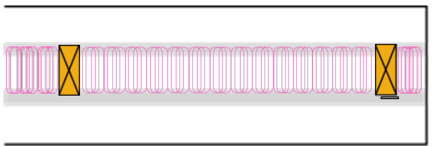
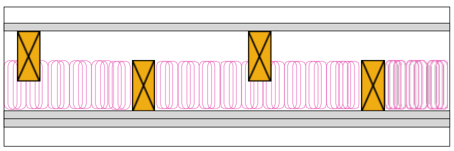
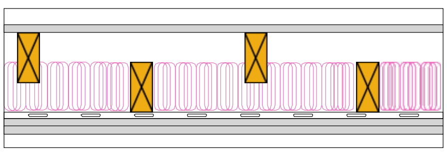
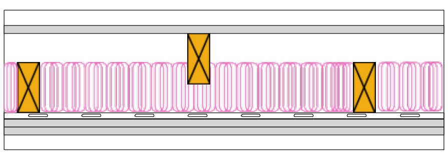
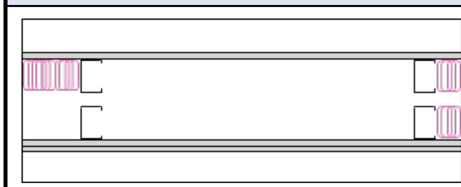
Formula: $SPC \approx TL(avg) + L_n(avg)$ – Where TL(avg) is the 'average apparent sound transmission loss' of the room boundaries and Ln(avg) is the 'average background noise level' at the location of a potential eavesdropper. In both cases '(avg)' indicates arithmetically averaging the decibel values over the speech frequencies from 160 to 5,000 Hz. The SPC rating is based on the understanding that both ambient noise levels and transmitted speech levels influence the amount of speech privacy.

This section provides extensive tables of TL(avg) values from laboratory measurements of sound transmission through various constructions. These are the same test results from which STC ratings are determined, but TL(avg) values have been found to be much more accurate predictors of the speech privacy provided by the wall.

TL(avg) values are provided for 74 types of stud wall constructions from standard laboratory test results in Table 2. This table includes a section drawing through each construction type and includes the results of combinations of 13 stud configurations and 6 different arrangements of gypsum board layers. The 6 combinations of gypsum board layers that were included are described in Table 3. The 13 different stud configurations are described Table 4. The table also includes STC ratings of each construction. However, STC values are only approximately equivalent to the TL(avg) values and are only included for those more familiar with STC values than TL(avg) values.

**Table 2 - *TL(avg) and STC values for types of gypsum board walls***

| TL(avg) /STC values | 13 mm gypsum board | | | 16 mm gypsum board | | |
|---|---|---|---|---|---|---|
| **Construction** | **1 & 1** | **1 & 2** | **2 & 2** | **1 & 1** | **1 & 2** | **2 & 2** |
|  **SS65(406)** | 51.0 / 35 | 53.5 / 40 | 56.7 / 46 | 51.3 / 40 | 54.9 / 45 | 58.2 / 52 |
|  **SS65(610)** | 49.5 / 43 | 53.1 / 48 | 55.9 / 54 | 50.9 / 43 | 54.3 / 50 | 56.6 / 55 |
|  **SS90(406)** | 52.0 / 42 | 54.4 / 48 | 57.4 / 53 | 51.5 / 45 | 55.3 / 50 | 58.3 / 54 |
|  **SS90(610)** | 52.3 / 48 | 55.1 / 53 | 55.9 / 55 | 51.9 / 49 | 54.6 / 53 | 57.6 / 56 |
| ***TL(avg) /STC values*** | ***13 mm gypsum board*** | | | ***16 mm gypsum board*** | | |
| ***Construction*** | ***1 & 1*** | ***1 & 2*** | ***2 & 2*** | ***1 & 1*** | ***1 & 2*** | ***2 & 2*** |
|  **SS90(406)_RC** | 55.1 / 48 | 58.8 / 54 | 62.7 / 60 | 53.5 / 60 | - | - |

| | | | | | | |
|---|---|---|---|---|---|---|
|  ***WS90(406)_RC*** | *53.8 / 43* | *57.1 / 48* | *61.0 / 55* | *52.0 / 45* | *57.3 / 51* | *60.7 / 56* |
|  ***WS90(610)_RC*** | *53.2 / 47* | *57.3 / 54* | *60.5 / 59* | *54.4 / 49* | *57.3 / 54* | *61.3 / 59* |
|  ***SWS90(406)*** | *54.1 / 45* | *53.8 / 50* | *56.2 / 53* | *50.8 / 49* | *54.6 / 53* | *57.2 / 57* |
|  ***SWS90(406)_RC13*** | *63.7 / 50* | *65.7 / 54* | *66.7 / 60* | *60.7 / 53* | *65.1 / 58* | *65.9 / 63* |
|  ***SWS90(610)_RC13*** | *57.8 / 49* | *63.6 / 54* | - | *53.4 / 52* | *61.7 / 56* | *68.6 / 62* |
|  ***SS40(610)_AIR25_SS40(610)*** | *61.6 / 53* | *63.8 / 59* | *66.1 / 63* | *65.8 / 55* | - | *69.6 / 65* |
| ***TL(avg) /STC values*** | ***13 mm gypsum board*** | | | ***16 mm gypsum board*** | | |
| ***Construction*** | ***1 & 1*** | ***1 & 2*** | ***2 & 2*** | ***1 & 1*** | ***1 & 2*** | ***2 & 2*** |
|  ***SS65(610)_AIR25_S65(610)*** | *59.3 / 54* | *62.4 / 60* | *64.5 / 62* | *58.5 / 55* | *62.2 / 61* | *64.9 / 65* |

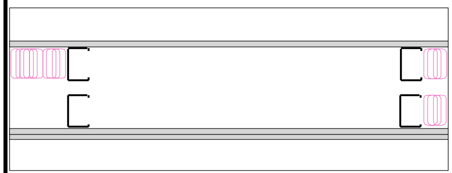
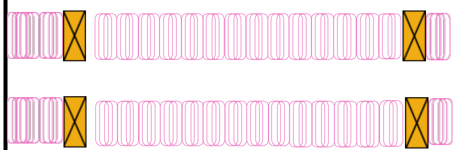
| | | | | | | |
|---|---|---|---|---|---|---|
|  ***SS65(610)_AIR25_S65(610)*** | *59.3 / 54* | *62.4 / 60* | *64.5 / 62* | *58.5 / 55* | *62.2 / 61* | *64.9 / 65* |
|  ***WS90(610)_AIR25_WS90(610)*** | *66.6 / 55* | *70.2 / 59* | *72.6 / 65* | *67.9 / 59* | *68.8 / 64* | *72.2 / 68* |

**Table 3 - Combinations of gypsum board layers included in the walls**

| Gypsum board thickness | Numbers of layers | Description |
|---|---|---|
| 13 | 1 & 1 | 1 layer of 13 mm gypsum board on each side of the wall. |
| 13 | 1 & 2 | 1 layer of 13 mm gypsum board on one side of the wall and 2 layersof 13 mm gypsum board on the other side of the wall. |
| 13 | 2 & 2 | 2 layers of 13 mm gypsum board on side each of the wall. |
| 16 | 1 & 1 | 1 layer of 16 mm gypsum board on each side of the wall. |
| 16 | 1 & 2 | 1 layer of 16 mm gypsum board on one side of the wall and 2 layersof 16 mm gypsum board on the other side of the wall. |
| 16 | 2 & 2 | 2 layers of 16 mm gypsum board on each side of the wall. |

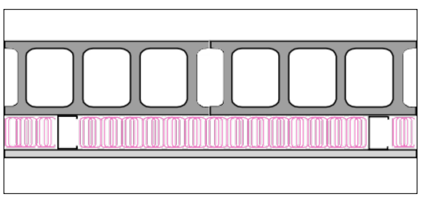
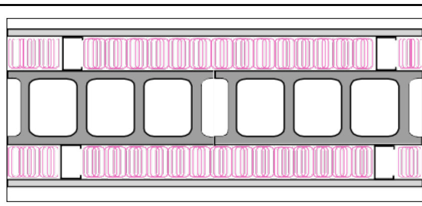
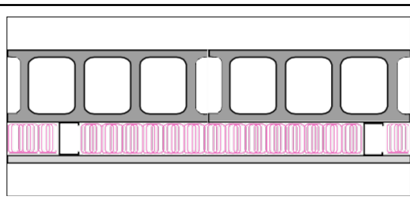
**Table 4 - Stud system configuration**

| Stud configuration | Description |
|---|---|
| SS65(406) | Single 65 mm 25 gauge steel studs at 406 mm spacing |
| SS65(610) | Single 65 mm 25 gauge steel studs at 610 mm spacing |
| SS90(406) | Single 90 mm 25 gauge steel studs at 406 mm spacing |
| SS90(610) | Single 90 mm 25 gauge steel studs at 610 mm spacing |
| SS90(406)_RC | Single 90 mm 16 gauge steel studs at 406 mm spacing with resilient channelson one side |
| WS90(406)_RC | Single 90 mm wood studs at 406 mm spacing with resilient channels on oneside |
| WS90(610)_RC | Single 90 mm wood studs at 610 mm spacing with resilient channels on oneside |
| SWS90(406) | Staggered 90 mm wood studs at 406 mm spacing |

| | |
|---|---|
| SWS90(406)_RC | Staggered 90 mm wood studs at 406 mm spacing with resilient channels on 1side |
| SWS90(610) | Staggered 90 mm wood studs at 610 mm spacing with resilient channels on 1side |
| D_SS40(610) | Double 40 mm 25 gauge steel studs at 610 mm spacing with 25 mm gapbetween stud sets |
| D_SS65(610) | Double 65 mm 25 gauge steel studs at 610 mm spacing with 25 mm gapbetween stud sets |
| D_WS90(610) | Double 90 mm wood studs at 610 mm spacing with 25 mm gap between studsets |

In addition to the data for stud walls, TL(avg) values are also included for 20 types of concrete block walls with various combinations of gypsum board surface layers in Table 5. The data is from an extensive research study of the sound insulation provided by concrete block walls [11, 12]. The two types of concrete blocks included are described in Table 6. The concrete block walls include 16 mm Gypsum board attached to one or both surfaces using one of 5 systems described in Table 7.

**Table 5 - TL(avg) and STC values for 20 types of block walls**

| TL(avg) /STC values | Single layer G16 supported by one of: | | | | |
|---|---|---|---|---|---|
| **Construction** | **WS40** | **RC13** | **ZC50** | **SS65** | **ZC75** |
|  **BLK140 – G16 on one side of block** | 55.0 / 54 | 55.7 / 53 | 57.9 / 58 | 60.6 / 60 | 60.6 / 61 |
|  **BLK140 – G16 on both sides of block** | 60.2 / 60 | 61.6 / 54 | 65.9 / 66 | 71.5 / 72 | 71.5 / 72 |
|  **BLK190 – G16 on one side of block** | 53.7 / 55 | 56.3 / 53 | 58.5 / 59 | 61.3 / 61 | 61.3 / 62 |

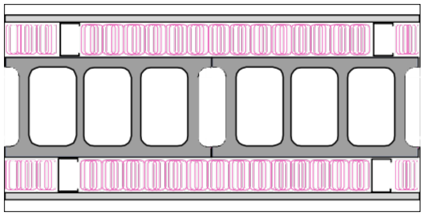
| | | | | | |
|---|---|---|---|---|---|
|  BLK190 – G16 on both sides of block | 60.9 / 60 | 62.2 / 50 | 66.1 / 65 | 72.1 / 71 | 72.1 / 72 |

**Table 6 - Dimensions and mass per unit wall surface area for concrete blocks**

| Symbol | Height, mm | Length, mm | Depth, mm | Kg/m$^2$ |
|---|---|---|---|---|
| BLK140 | 190 | 390 | 140 | 240.1 |
| BLK190 | 190 | 390 | 140 | 236.2 |

**Table 7 - Types of mounting of gypsum board on block walls**

| Symbols | Cavity depth, mm | Description |
|---|---|---|
| WS40 | 40 | Wood studs (strapping) |
| RC13 | 13 | Conventional resilient channels (25 gauge steel) |
| ZC50 | 50 | Z-bar, steel furring channels (25 gauge steel) |
| SS65 | 65 | Steel studs (25 gauge steel) |
| ZC75 | 75 | Z-bar, steel furring channels (25 gauge steel) |

It is common practice to select constructions with laboratory results up to 5 points higher than the minimum required value. Although such over design may compensate for some construction flaws, where the apparent sound transmission is limited by flanking paths, little benefit may be obtained from the over design of one particular element. In a real building the apparent sound transmission would depend on the relative importance of the various sound paths. Flanking paths can lead to lower than expected apparent TL(avg) values in field situations. The design needs to also include the effects of flanking paths and doors in calculations to determine the expected apparent TL(avg) of the room boundaries.

In addition to the data for concrete block walls with various combinations of gypsum board surface layers with cavities in Table 5, data is presented for block walls with no finishes or directly attached finishes without cavities in Table 8.

**Table 8 - TL(avg) and STC values for 11 types of simple block walls**

| Construction | TL(avg)/ STC values |
|---|---|
| **190mm Block** | 50.4 / 50.4 |
| **190mm Block with 16mm Gypsum on one side** | 50.4 / 50 |
| **190mm Block with 16mm Gypsum on both sides** | 51.6 / 49 |
| **190mm Block, painted on one side** | 48.7 / 48 |
| **190mm Block with 16mm Gypsum on one side and paint on the other** | 52.8 / 50 |
| **190mm Block with 16mm Gypsum on one side and paint then16mm Gypsum on the other** | 52.7 / 46 |
| **90mm Block** | 44.4 / 44 |
| **140mm Block, 75% full** | 49.8 / 47 |
| **140mm Block, 75% full, painted on one side** | 50.3 / 48 |
| **140mm Block, 100% full** | 52.8 / 50 |
| **140mm Block, 100% full, painted on one side** | 52.8 / 50 |

TL(avg) and STC values for common window/glazing assemblies are presented in Table 9. In this case both single regular and laminated glass values are presented for varying thicknesses of glass, from 3 mm thick to 13 mm thick, and for some common doubled glazed assemblies.

**Table 9 - TL(avg) and STC values for 10 types of windows**

| Construction | TL(avg) /STC values |
|---|---|
| **3mm Glass Pane** | 28.8 / 30 |
| **3mm Glass Pane with 6mm Air Space then another 3mm Glass Pane** | 31.9 / 28 |
| **3mm Glass Pane with 9mm Air Space then another 3mm Glass Pane** | 33.1 / 31 |
| **3mm Glass Pane with 0.75mm Plastic then another 3mm Glass Pane** | 34.3 / 35 |
| **6mm Glass Pane** | 31.3 / 31 |
| **6mm Laminated Glass Pane with 9mm Air Space then a 5mm Glass Pane** | 37.6 / 37 |

| | |
|---|---|
| **6mm Glass Pane with 0.75mm Plastic then another 6mm Glass Pane** | 38.5 / 38 |
| **13mm Glass Pane** | 37.1 / 36 |
| **13mm Laminated Glass Pane with 50mm Air Space then a 9mm Glass Pane** | 46.2 / 46 |
| **13mm Laminated Glass Pane with 100mm Air Space then a 9mm Glass Pane** | 49.6 / 49 |

TL(avg) and STC values for regular and acoustic doors of various types are presented in Table 10a and b. Doors are identified steel or wood.

**Table 10a - TL(avg) and STC values for Steel Doors**

| Construction | TL(avg) /STC values |
|---|---|
| **Acoustic STC 40, 6.6 LB/FT2 Magnetic Noise Control Seals** | 39.6 / 40 |
| **Acoustic STC 46, 12.7 LB/FT2 Magnetic Noise Control Seals** | 45.1 / 46 |
| **Acoustic STC 49, 12.7 LB/FT2 Magnetic Noise Control Seals** | 48.3 / 49 |
| **Acoustic STC 40, 6.8 LB/FT2 Compression Noise Control Seals** | 41.0 / 40 |
| **Acoustic STC 52, 19.0 LB/FT2 Compression Noise Control Seals** | 51.3 / 52 |
| **Regular, Hollow metal 18 gauge 5.4 LB/FT2, No Seals** | 17.0 / 17 |
| **Regular, Hollow metal 18 gauge 5.4 LB/FT2, Foam Weatherstrip** | 26.4 / 28 |
| **Vestibule, 2 x Hollow metal 18 gauge 5.4 LB/FT2, No Seals** | 31.3 / 34 |
| **Vestibule, 2 x Hollow metal 18 gauge 5.4 LB/FT2, Magnetic Seals** | 50.6 / 49 |

**Table 10b - TL(avg) and STC values for Wood Doors**

| Construction | TL(avg) /STC values |
|---|---|
| **Acoustic STC 39, Rated Wood Door Without Threshold** | 38.2 / 39 |
| **Acoustic STC 42, Rated Wood With Drop Seal, No Threshold** | 40.4 / 42 |
| **Acoustic STC 45, Rated Wood With Threshold** | 45.3 / 45 |
| **Regular, Solid Core 4.9 LB/FT2, No Seals** | 22.6 / 22 |

| | |
|---|---|
| **Regular, Solid Core 4.9 LB/FT2, Foam Weatherstrip** | 26.8 / 26 |

TL(avg) and STC values for various types and thicknesses of concrete floors are presented in Table 11. Concrete is either monolithic as used in buildings with concrete structure or over corrugated steel deck as used in steel framed buildings.

**Table 11 - TL(avg) and STC values for 5 types of concrete floors**

| Construction | TL(avg) /STC values |
|---|---|
| **40 mm Concrete, 0.4mm corrugated steel deck and 203mm SteelC-joists** | 42.7 / 42 |
| **100 mm Concrete** | 50.7 / 47 |
| **75-150 mm Concrete over steel deck (75 mm topping)** | 53.4 / 51 |
| **150 mm Concrete** | 56.6 / 52 |
| **200 mm Concrete** | 57.6 / 58 |

## 8.5. Most common causes of failure in terms of SPC

Listed below are some of the most common causes of failure to achieve high levels of SPC in terms of construction. One also needs to consider causes due to process and decision making as outlined elsewhere in this document:

### 8.5.1. Doors

Leakage around doors is the primary cause of failure to achieve high SPC. Door frames are typically not square and plumb unless carefully installed and inspected, meaning that door seals do not block sound all around the door frame, or that when adjusted, doors are too hard to close. Door frame are required to be installed to within 1.6 mm of level and plumb. Doors need to have latches that pull the door tight against the seals. Doors cannot be warped as this prevents seals from properly contacting the door all around. Door seals need to be of a type that can be adjusted, and that have been tested to achieve a given STC. Door thresholds are required to be level and parallel to the bottom of the door. Concrete floors need to be levelled before the thresholds are installed, and thresholds are required. Sealing to a carpet floor is not sufficient. Adjustable drop bottom threshold seals need to be parallel to the threshold and evenly sweep across the threshold, sealing all along the length of the door bottom with no gaps. Where vestibules cannot be used, doors would be required to be acoustically rated, and installed by contractors experienced in the installation of such rated doors. Even acoustically rated doors are commonly a point of failure due to improper adjustment and installation or specification. Even when vestibules are used, for high SPC values, one of the doors should be acoustically rated. Double doors are also to be avoided as the seal at the astragal is particularly problematic, as is incorrect alignment of the doors where they meet in the centre. Double doors have twice the length of door seal and thus twice the likelihood of failure. Double doors should only be used as part of a vestibule.

#### 8.5.2. Window Mullions

Walls terminating at the exterior of a building's perimeter onto lightweight aluminum window mullions cannot provide high levels of SPC. Curtain wall construction does not provide a necessary condition for adequately isolating sound. Only moderate sound isolation can be provided at such window mullions. As it is not possible to fully seal a wall at a mullion, intervening spaces or rooms such as those used for storage need to surround the room to be isolated. This is very space inefficient, unless adequate planning is made to locate such buffer rooms in a secure suite around rooms requiring high levels of SPC.

#### 8.5.3. Glazing

Any glazing or sidelights need to have a rating in terms of sound transmission almost equal to that of the wall. This means double glazing using laminated glass and large airspaces. It is very difficult and expensive to provide glazing that has a rating equal to the wall. As a general rule, unless significant precautions are taken, glazing is not to be included in the design of walls surrounding rooms with high values of SPC.

#### 8.5.4. Ductwork

Sound travels very easily through ductwork. Sound goes in directly through air openings such as diffusers and return grilles. Sound also enters directly through ductwork walls, as the sound isolation performance of a duct wall is very much lower than that of a high TL drywall or masonry wall. Consider that a wall made of a single layer of sheet metal as used for ductwork would have a very poor level of sound isolation. Thus duct design needs to be made in such a manner as to prevent sound leakage between rooms. This means that terminal boxes cannot feed any room outside the room being sound isolated, or outside the suite being isolated. Ductwork needs to be lined with minimum 25 mm thick duct liner, and be provided with elbows to attenuate sound adequately. Un-lined duct is extremely poor at preventing sound from travelling through it. One large duct will attenuate sound much less than multiple small ducts due to the effect of the perimeter/area on duct attenuation. One of the most problematic areas for duct design is the routing of long supply ducts over spaces to be protected, and common return air plenums. This causes significant sound leakage between rooms. High levels of SPC are generally only possible when ducts feed along corridors or service spaces and then branch off toward terminal units such as VAV or fan powered boxes serving protected rooms. Duct layout plans need to consider speech security requirements for both the supply and return paths. The floor plan needs to allow for adequate room to route ducts outside of the rooms or suites being protected.

#### 8.5.5. Perimeter Induction and Convector Units

These are very problematic as there are air ducts running between induction units that can leak sound from room to room and floor to floor. Convector covers need to be cut and the wall run slab to slab and edge to edge. It is not possible to achieve high levels of SPC when induction or convector units run continuously between rooms, unless buffer rooms are placed around rooms to be protected. The only benefit from induction units is the high noise they produce which improves speech privacy. However, this is offset by the high sound leakage.

### 8.5.6. Building Connectivity, Conduits and Cable Trays

Requirements for large amounts of electronic services such as IT and AV in some rooms mean that many cables are run to many patch panels, devices or junction boxes. These often require large amounts and sizes of conduits and cable trays. Any room with a cable tray or large open conduits traversing the wall will have very poor SPC performance. Cable trays cannot traverse walls of high SPC rooms. These trays need to be interrupted and cables passed through the wall via multiple small conduit stubs sized in the range of 25 mm diameter, and spaced such that they can be sealed all around, and cables sealed to the conduit stubs once installed. For rooms with large amounts of electrical boxes, chase walls are required to effectively place the boxes and conduits on the surface of a high performance wall, with a second wall over the main wall to cover the conduits and frame the boxes. Another point of failure is an excessive amount of electrical boxes and large numbers of boxes in a single wall or multiple boxes in a single stud cavity. The more boxes there are, the higher the degradation of the wall. The larger the electrical boxes are, the more degradation of the wall. It is very easy to lose 5 to 10 dB in terms of transmission loss due to the presence of an excessive number of electrical boxes. A single box on each side of a 3-4 metre section of wall will not cause significant degradation of performance, but as the number and size of boxes increases, performance is reduced. Short sections of walls have been observed with over 20 single gang boxes total, and this type of condition is not conducive to high levels of SPC.

### 8.5.7. Stud Gauge and Stud Spacing and Bracing

Many types of walls require heavy gauge studs. These studs very significantly reduce the acoustical performance of a wall, and this is not common knowledge. It is imperative that the stud gauge be indicated on all of the building drawings and details and that the installed stud gauge is confirmed. Where heavy gauge studs are required for wind resistance, height requirements or intrusion protection, resilient channel or double stud construction needs to be used. Walls with studs spaced at 600 mm O.C. will provide the highest level of SPC. When stud spacing is reduced to 400 mm O.C., sound isolation performance is reduced. However, on site, multiple studs are often added in a wall to provide support for drywall in corners, for conduits and electrical boxes, for door frames and glazing frames, or for other devices to be supported. The more studs are added over the base design of a 600 mm nominal spacing, the stiffer the wall gets and the lower its performance. Walls are commonly observed on site with more than double the number of studs per linear dimension than intended in the design. All unnecessary studs have to be removed. Box sections of studs which are extremely stiff particularly should be avoided in walls. When this is not possible, even with light gauge studs, resilient channel need to be used or double stud construction.

### 8.5.8. Gaps in Drywall

Drywall needs to be installed with gaps kept to a minimum at the perimeter to the floor, ceiling and corners, and between all edges. When any large gaps are present and simply covered over with drywall tape, significant sound leaks will occur, and these are often difficult to find. Thus all drywall gaps are to be inspected before any taping occurs, and any gaps over 6 mm corrected with new pieces of drywall. Each layer of drywall needs to be inspected before taping, and after taping and caulking.

#### 8.5.9. Ceiling Tile and Plenum Barriers

Walls which are not built slab to slab generally have very poor levels of SPC. This is true for any wall where the ceiling tile runs continuously between rooms, or where a raised floor runs continuously between rooms. The gap at the T-bar ceiling and through the lightweight ceiling tile are both very significant leaks of sound, independent of how well a plenum barrier is built and sealed above the ceiling tile. And plenum barriers are extremely difficult to build well, due to limited access and interference with the T-bar. High levels of SPC are simply not possible when the acoustic ceiling runs through between rooms. Only slab to slab walls should be considered. Experience with floor plenums is limited, but performance is generally poor due to return openings in floor which let sound travel from room to room. While raised floors use significantly heavier materials than do T-bar ceilings, gaps at the floor make it difficult to achieve an adequate sound seal. Moderate values are possible for SPC, but until more research is done and tests performed on such raised floors, caution is best. Under-floor plenum barriers are difficult to build and seal adequately, and limit flexibility. Again for these types of constructions, it is best to remove the floor tiles, build slab to slab walls, and cut and re- install the floor tiles.

#### 8.5.10. Steel Deck Profiles

Steel decks provide a particularly difficult challenge to high SPC construction. The profiled shape of the deck makes it very difficult to obtain an adequate sound seal. When the deck is covered in concrete, the main issues are sealing at the deck and all around the building’s structural elements such as joists and beams and all the required cross-bracing. The best solution is to provide continuous drywall sections pre-cut to the deck profile and placed over the last layer of drywall on each side, and to caulk these strips to the other drywall and to the deck. Pre-formed deck foam fillers and strips are generally not adequate to provide high levels of transmission loss. Profiled steel decks without concrete on top such as for building roofs in steel and other buildings are even more problematic. Even when fully sealed with strips of drywall on both sides, sound will enter the deck and pass over the wall via the deck through a process referred to as flanking. No matter how good the wall is, performance is limited by sound travelling through the steel over the wall. In this case it is best to shield the deck from sound with at least an acoustical tile ceiling on both sides of the wall, or with a drywall ceiling below the deck. Tests of SPC generally give much better results in concrete buildings than steel framed buildings, as there is very little flanking via the concrete slabs, and it is much easier to seal the walls to a flat concrete surface than to a profiled steel deck and all the intervening steel structural elements.

#### 8.5.11. Low Background Noise

As noise is just as important to the value of SPC obtained as is wall performance, low levels of noise in any room will lead to lower levels of SPC. Noise levels need to be balanced between those required to obtain desired levels of SPC for a particular transmission loss of the construction and those levels of noise which may cause discomfort or even reduction of productivity or difficulty in communicating. One can assume that perhaps the higher levels of noise for any type of space as recommended by ASHRAE are the maximum limits to be used. It is also of note that mechanical noise in the lower 1/3 octave frequency bands of 125 and 63 Hz listed in AHSRAE are of no consequence to the value of SPC obtained, and thus noise in these bands can be low to help with noise comfort issues while noise in the upper bands might be a little higher to aid the SPC value. When background noise is uncertain, variable or simply too low to obtain adequate levels of SPC, one should add noise masking, designed selectively to optimize the values of SPC where required.

## 8.6. Design Examples

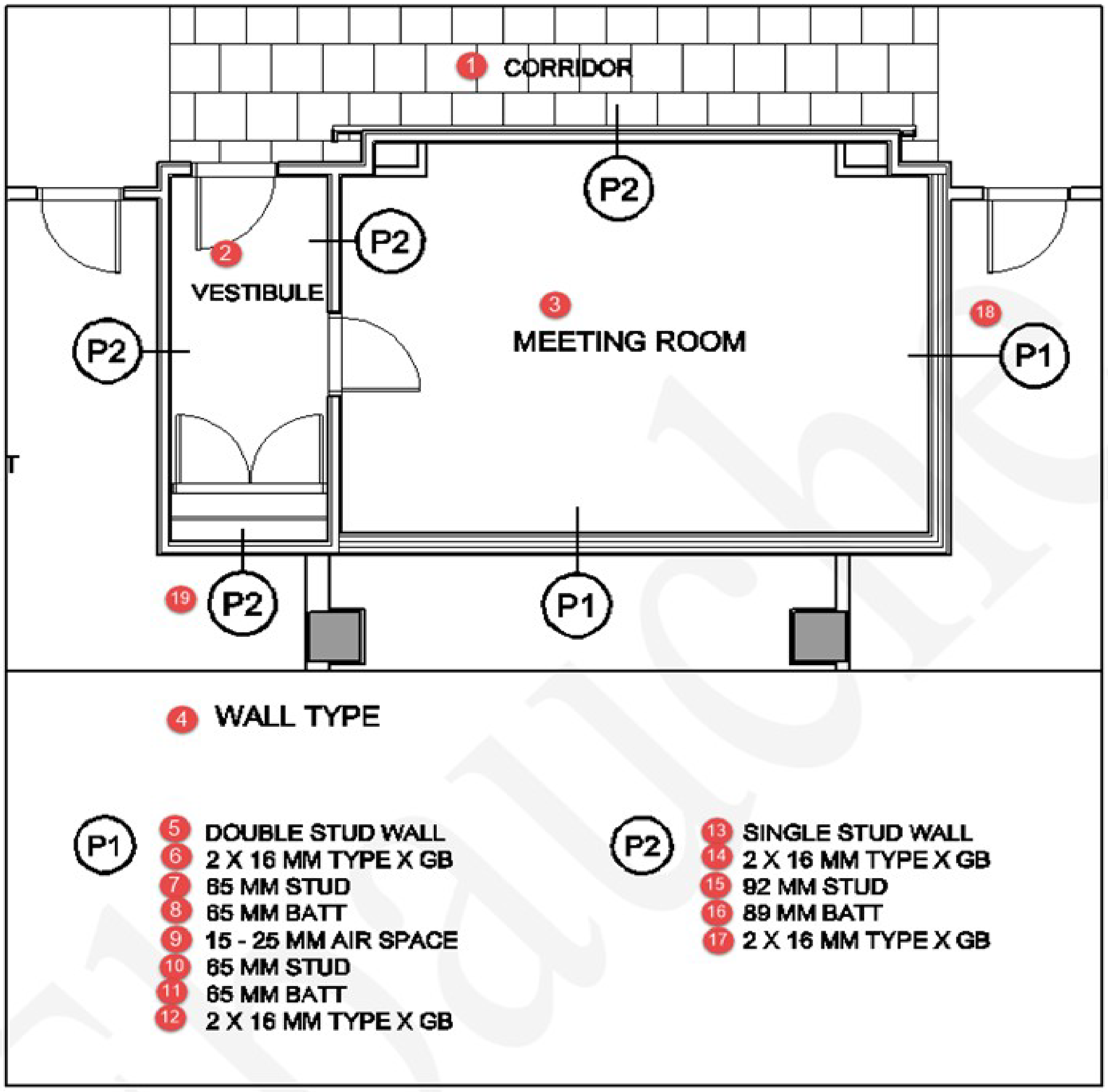
This section uses three building examples to illustrate some of the many design details that were necessary to achieve high speech privacy.

Achieving high STC results in typical office buildings is very difficult. If it is to be accomplished, the entire design team, including communications and AV need to cooperate to achieve the results. The requirement for high sound isolation will drive the design to a large extent. However, if it is a client requirement, there is no other demonstrated methodology for creating high isolation spaces within standard office construction. The building illustrated in the following section does not have glass curtain wall, which poses particular challenges and will generally require separating the speech private space from the curtain wall with buffer spaces along the perimeter or the addition of drywall walls along the window wall in the critical space.

The following details and notes result from various successful projects in the National Capital area, for which details were designed by acoustic, architectural and mechanical specialists. These details were very carefully inspected during the construction process and the rooms were thoroughly tested after construction, using both SPC and STC (Sound Transmission Class) test methodologies. The construction consistently delivered the sound isolation required to meet the most stringent requirements of speech privacy and sound isolation. The details and design approach represent a tested system of components, all of which are required to meet the challenge of providing high sound isolation in a standard office building. Dropping or changing some elements, for example, deleting vestibules or connecting rooms through ductwork in ways other than illustrated will normally result in seriously degraded performance.

#### 8.6.1. Example 1: Meeting Room

**Figure 2**



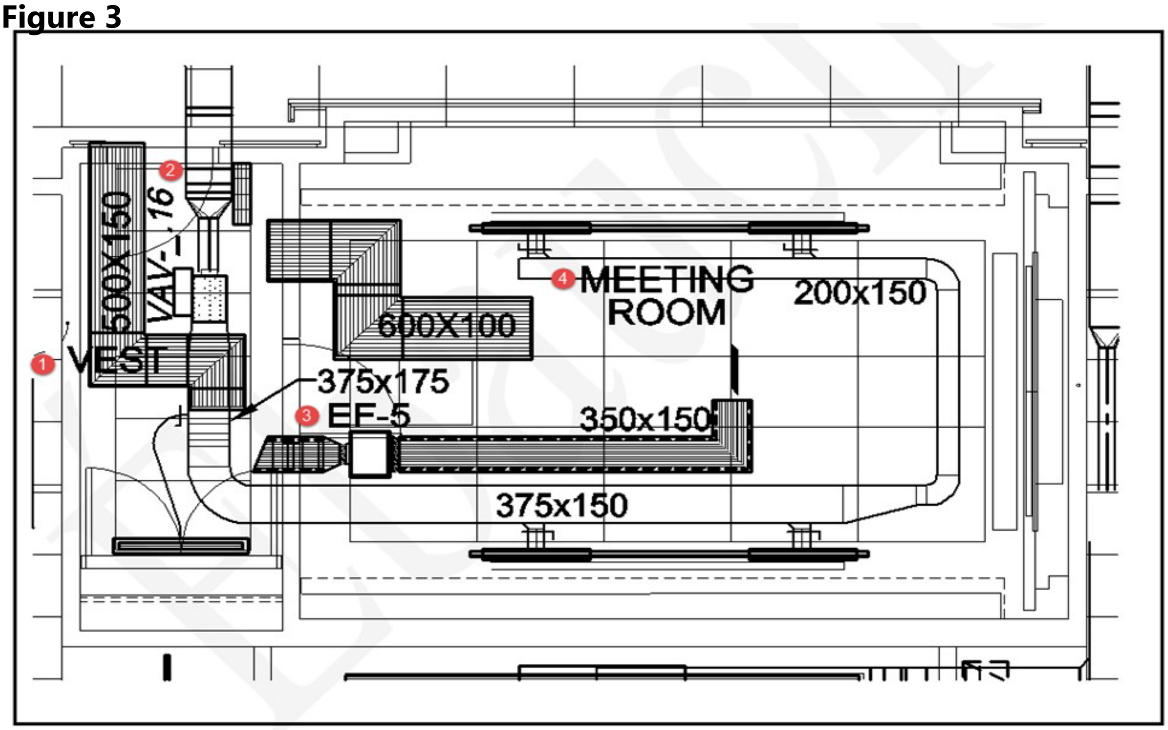

*Alt Text Figure 2 depicts Typical meeting room arrangement with wall types*

This plan arrangement uses double stud partition walls against other adjacent, occupied spaces. The double wall (P1) has a lab STC in the range of STC 65 (TL-93-286) and with no mechanical penetrations it tested in the range of ASTC 60 in the field. It allows for a number of electrical boxes without serious degradation of the sound isolation. It also allows for blocking on one side of the wall as required, usually replacing the inner layer of drywall with plywood, without affecting the other side of the wall. The two faces of the wall cannot be bridged with any component in order to retain the STC rating. In this wall type, there is less risk of compromising the isolation due to extra studs, blocking or conduit placement as stiffening one side of the wall does not compromise the other side.

Note that the wall type on the vestibule and corridor sides is a single wall, having an STC in the range of 56 (TL-93-351). Walls that face onto the corridor can be less secure than walls onto adjacent occupancies as the corridor is easily surveyed for eavesdroppers and the corridor in this mechanical design has a higher background sound level (NC level) due to the presence of mechanical devices in the corridor (i.e. vav boxes, motorized dampers etc.). The vestibule cannot be replaced with a single sound rated door without degrading the performance of the isolation. The vestibule serves both as a buffer zone for sound leakage through doors and as a buffer zone for sound leakage through the ducts. The vestibule does not have to be as large as in this example, but in this case it is
large enough for a closet and some storage. However, it has to be large enough to provide space for the entire length of the return air ductwork and other HVAC elements.

Note that the supply ductwork enters the suite through the vestibule only, no other perimeter walls have duct penetrations. A single duct penetration in any of the other walls will result in at least a 10 point (STC) drop in performance due to the relatively low STC of the ductwork.

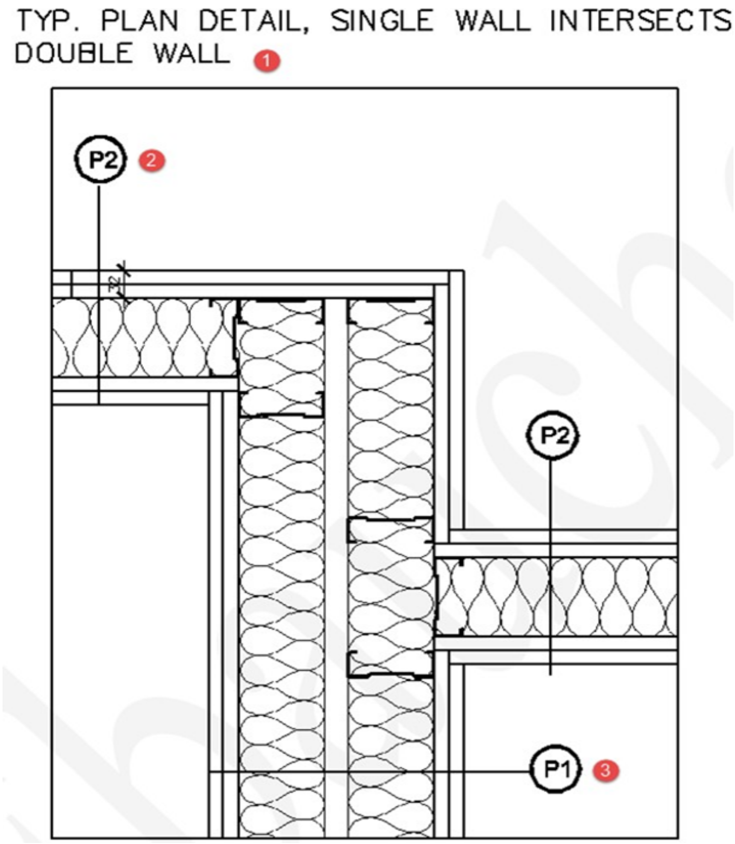
**Figure 3**




*Alt Text Figure 3 depicts a mechanical plan of a Meeting Room*

The supply, entering through the vestibule in the vicinity of the door, in order to concentrate the potential sound leakage at one position only, then moves through the vestibule into the meeting room itself. The return air is transferred via a fully lined (25 mm Type II rigid ductliner board), double elbow type return duct and is constrained in height to 150 mm including lining in order to reduce crosstalk. The return air transfers into the vestibule and then from the vestibule into the corridor, thus doubling the attenuation.

**Figure 4**

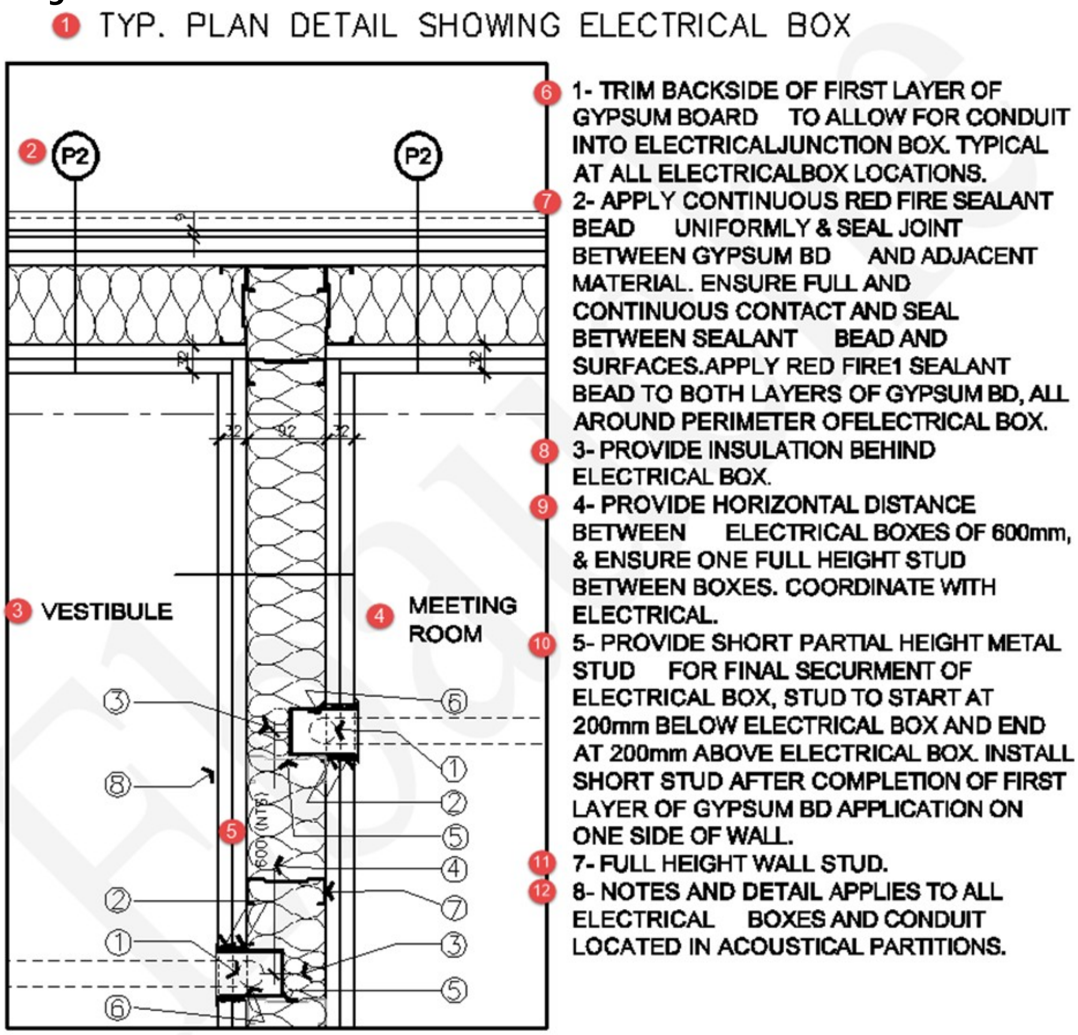



*Alt Text Figure 4 depicts a typical plan detail*

The above detail illustrates a typical junction of single to double walls. It is critical that the interior cavity of the wall is maintained and not breached by extending drywall across the junction. It is critical that the number of studs in a wall be kept to an absolute minimum and that the stud gauge is kept to 25 ga for a single stud wall. The acceptable stud spacing will be as close as possible to 600 mm. The presence of drywall or other elements bridging the cavity for any reason will seriously degrade the performance of the wall due to flanking transmission (this was confirmed by testing on site). The walls need to extend from slab to slab as a continuous partition. Each layer of drywall is taped, with tight joints all around. Deflection joints are not permitted unless they have the same STC as the wall below. Similarly, these results cannot be achieved when sealing to a metal deck without the addition of a drywall layer installed to the underside of the deck over the space to enhance the sound isolation of the wall by reducing flanking noise transmission through the deck. The tested assemblies were between concrete slabs only.

The recommended sealant is red fire caulk, for ease of inspection as well as efficacy. Sealant is required at the top and bottom perimeters on every layer of drywall, where it can be easily inspected. Sealant is not required under the tracks.

**Figure 5**

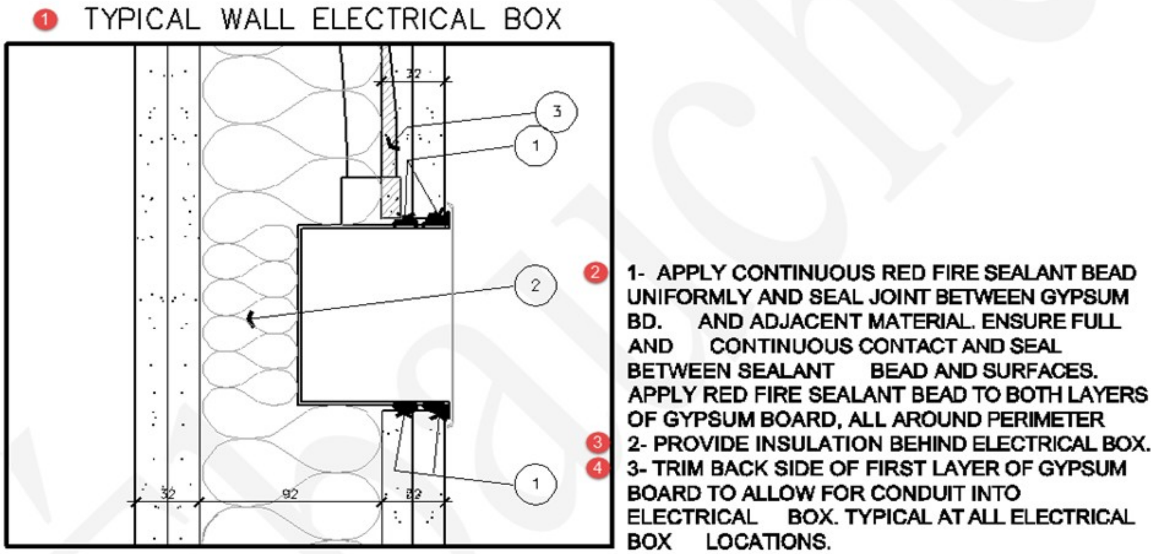



*Alt Text Figure 5 depicts a typical junction of single stud wall to single stud wall, showing electrical box notes.*

In this detail, note that the drywall does not run through any junction of walls, maintaining the cavity clear of bridging elements including drywall is critical. Note also the presence of an electrical box, with insulation run behind and around the box and sealant as noted.

Electrical and AV boxes need to be in separate stud cavities and the number and size of the boxes will have to be restrained. Similarly, the number and size of conduit needs to be minimized. In this project, conduit was kept to 25 mm, with more conduits being added to accommodate the volume of wiring. Controlling box numbers and conduit size should begin early in the project, with all involved parties being made aware of the potential loss of sound isolation integrity that is at risk. If achieving an STC rating in the field of over STC 50 is a client requirement, box numbers, sizes and conduit numbers and sizes will have to be sacrificed to achieve it. It is very common to have walls fail to meet the target STC's if too many boxes or too large boxes or conduit are placed in a wall.

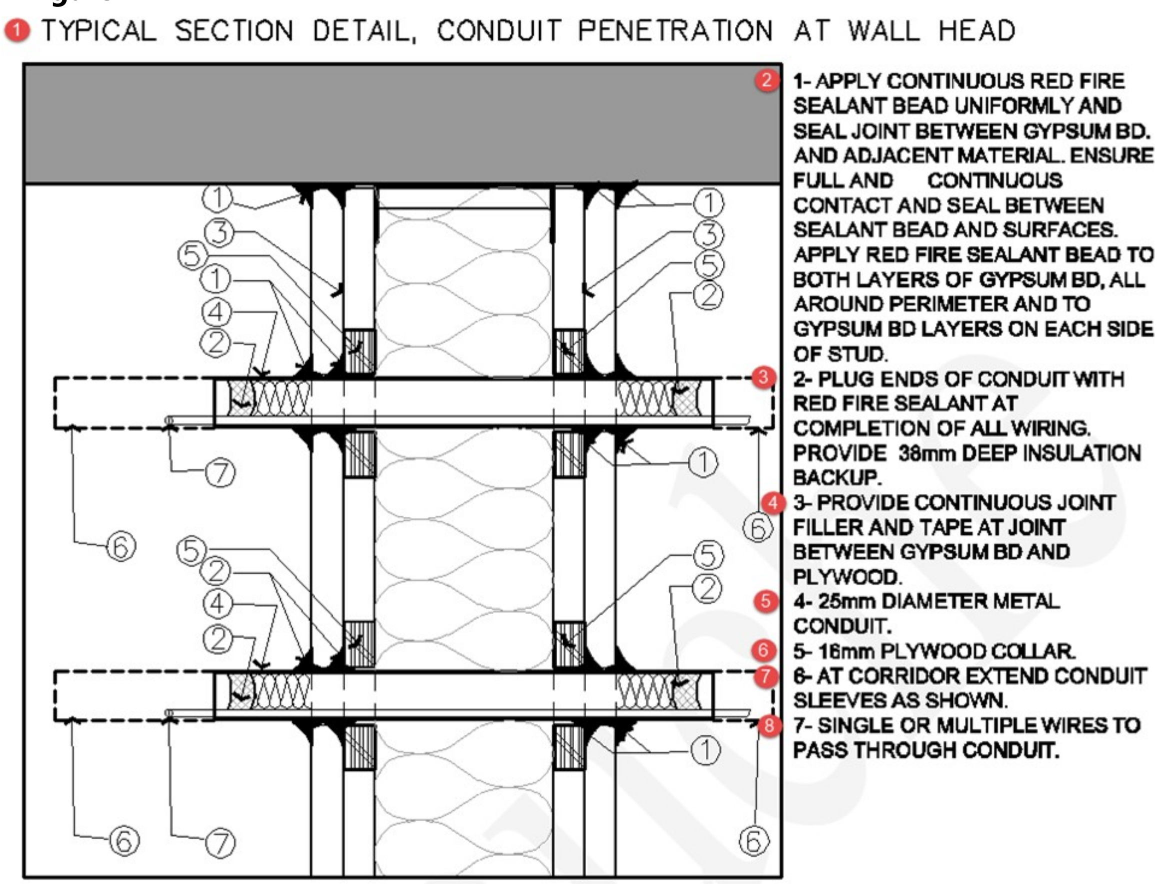
**Figure 6**




*Alt Text Figure 6 depicts a typical electrical box with notes*

The optimum box choice for these applications would be a masonry box, which has less open area than a standard box and higher mass and thus a higher transmission loss.

**Figure 7**

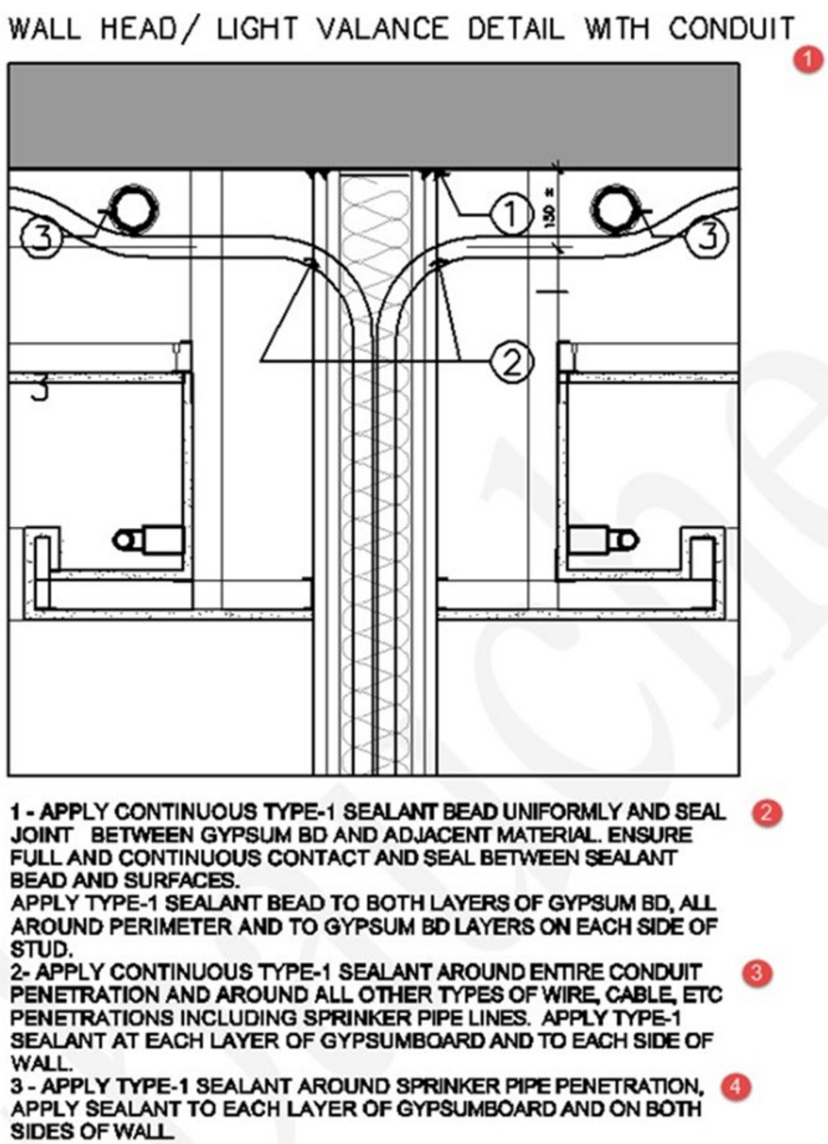



*Alt Text Figure 7 depicts Typical Conduit Penetration*

This detail shows the approach at the wall head to conduit penetrations (see also Figure 12). The conduit have been restrained to 25 mm size, and collars are created for each side of the wall by drilling matching holes in plywood, sized for the number of conduits and replacing drywall on the inner layer. The conduit spacing can then be tightly controlled and each hole can be sealed with caulk. No conduit is placed tight to the slab where it cannot be completely sealed. The sealant used is the red fire caulk, for ease of inspection.

Conduits and all pipe penetrations should be positioned such that it is possible to access the space all around to install gypsum board covering all gaps and to access all gaps for caulking fully. Conduits cannot be placed in banks, nor tight to the slab.

**Figure 8**




*Alt Text Figure 8 depicts conduit exiting rated wall at ceiling slab*

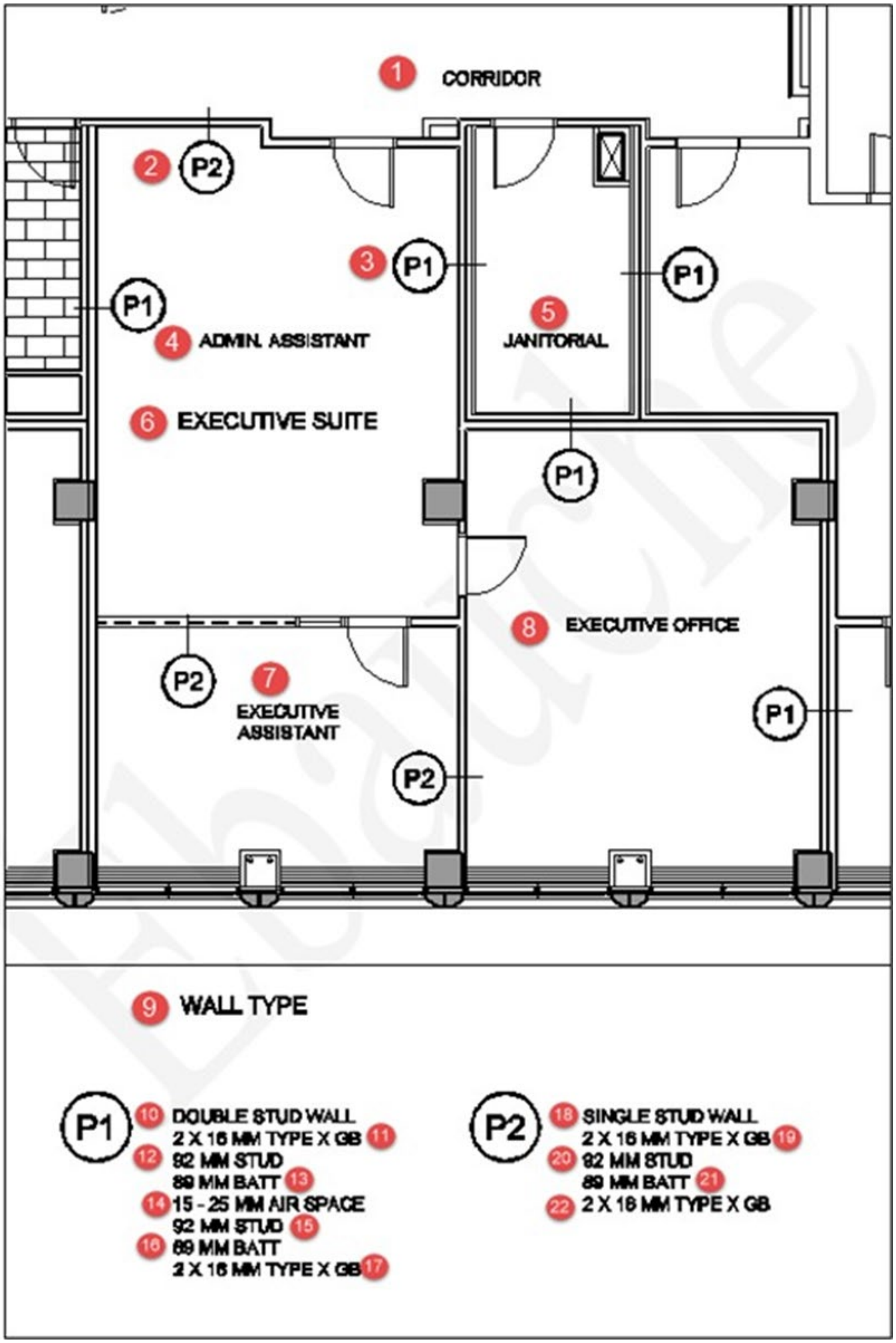
In the detail above, note that the radius bend of the conduit needs to be accommodated in the wall for single conduit. This detail also shows the approach to the wall head where the drywall makes a tight fit to the concrete and is sealed at the face of each layer. Any additional drywall details such as light valances are created over the rated wall with no interruption to the drywall of the rated wall, and as little blocking as possible. Single stud partitions perform best if they are constructed with as few, and as light, studs as possible. Increasing the number of studs and especially increasing the stud stiffness is very detrimental to the sound isolation rating and needs to be avoided in single stud walls. No elements such as drywall bulkheads or valances can be constructed so as to breach the rated walls.

### 8.6.2. Example 2: Executive Office Suite, Configuration 1

In the plan example of Figure 9, the executive suite is composed of an outer office for the administrative assistant, a secondary office for the executive assistant and the executive office itself. In this layout, the admin area serves as the buffer zone for speech privacy in the executive office. The assumption behind the organization is that the admin can be privy to some conversation leakage from the executive office. Thus, this plan protects the executive from eavesdropping in the corridor. The plan does not rely on sound rated doors, which are difficult to use in practice, being heavy and hard to close if well fitted. However, the doors are solid core wood, fitted with STC rated sound seals all around and carefully installed and inspected to reduce seal gapping due to out of square installation or warping. To reduce the sound leakage to the admin area, sound masking can be added to the admin area to make conversation difficult to understand. Sound masking should not be added to the critical room, as it will cause the speaking person to raise their voice in order to preserve the same signal to noise ratio.

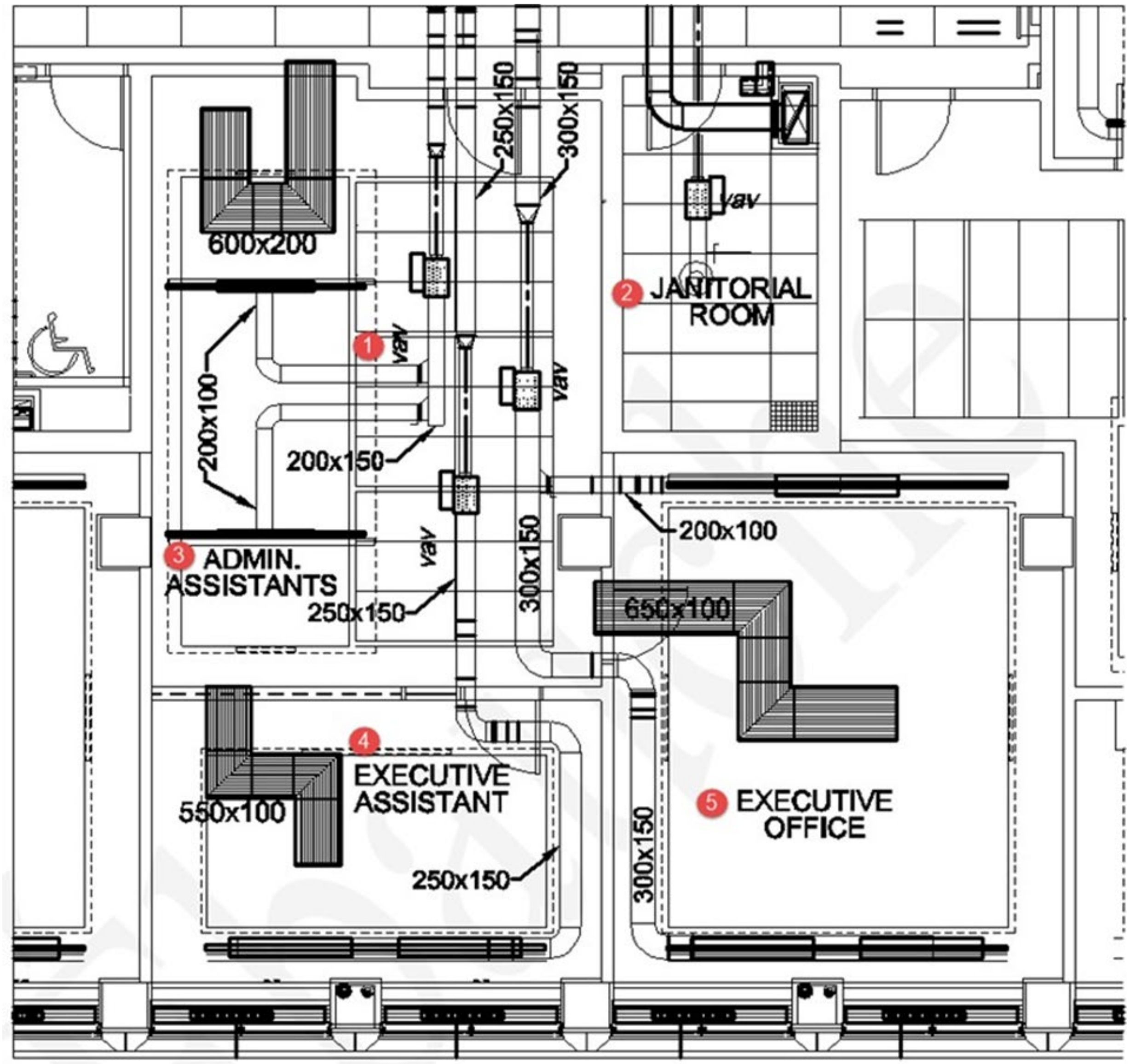
This example also contains a janitorial room, which poses a risk for eavesdropping, and is thus enclosed with a high performing double stud wall. The double wall type is also used to separate the executive from adjacent occupancies and the admin and assistant from adjacent occupancies. The demising walls to other occupancies are also penetration free to maintain their high rating. In particular, there are no ducts of any kind traversing these walls. Note also that the walls end at solid pilasters on the exterior, to maximize the sound isolation at the window. If the building did not have solid pilasters on the exterior wall, other strategies would have to be used to prevent sound leakage at the window walls. Under no circumstances, could perimeter heating units penetrate these walls, if their sound isolation rating is to be maintained. Perimeter piping can penetrate the walls if necessary, but cabinets and radiator fins have to be cut back to the wall faces and no control valving can be allowed to breach the critical walls. If the building had glass curtain wall, an interior wall would have to be created along the window wall to restrain sound leakage through the mullions. Mullions alone have almost no ability to block sound and ending a wall at a mullion will generally result in ASTC test results in the 20’s, regardless of the wall type or configuration.

**Figure 9**




*Alt Text Figure 9 depicts Plan 2, showing executive suite demising janitorial space*

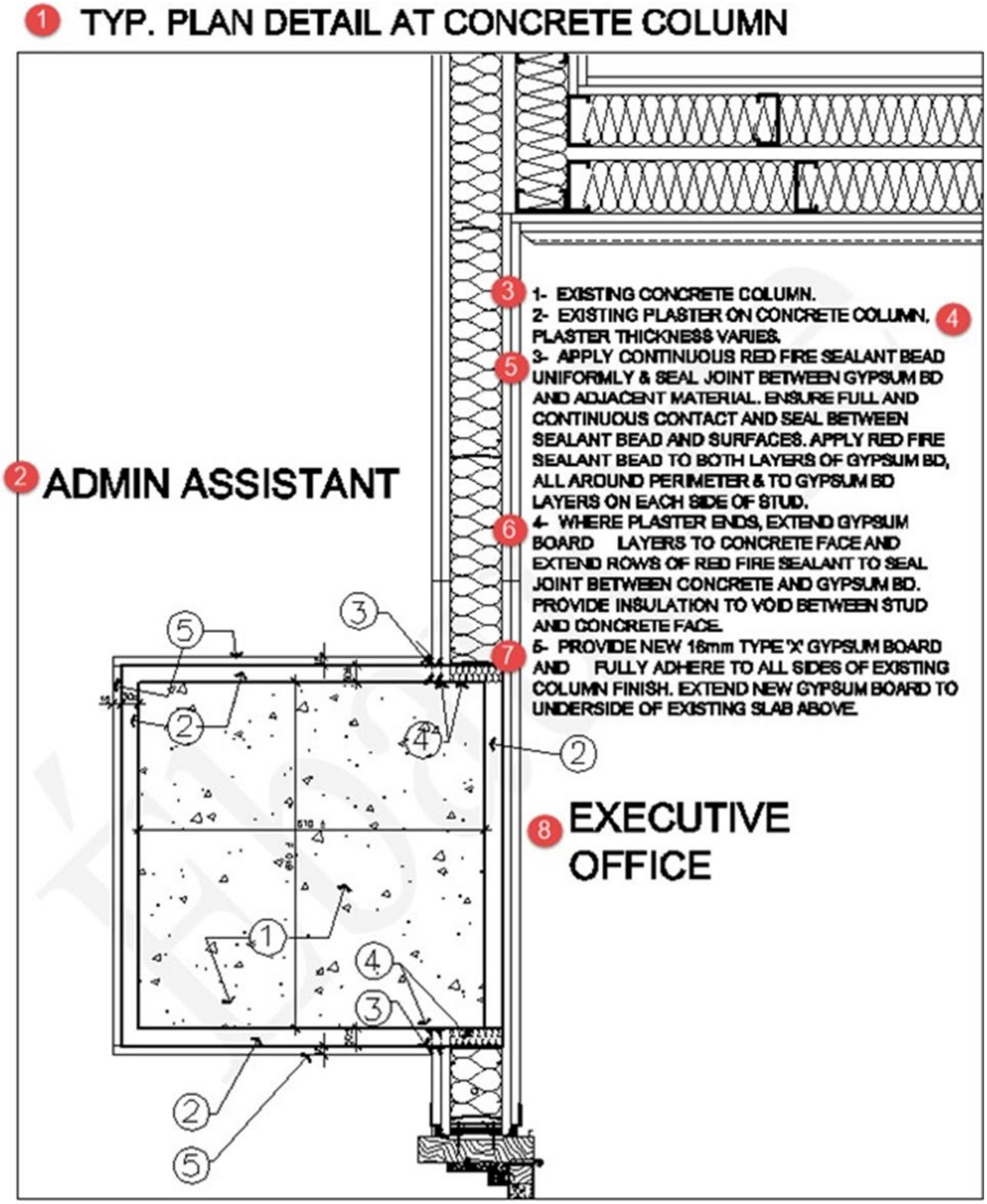
**Figure 10**




*Alt Text Figure 10 depicts a mechanical plan of an office area*

In the mechanical layout for the suite, the supply and return duct enters only from the corridor, and no ductwork breaches the critical demising walls. The supply ducting is split in the corridor for each of the included rooms which reduce crosstalk in the supply. The VAV boxes are located in the admin area to serve as masking background sound to enhance speech privacy to the executive office. The return air transfers are constrained to 100 mm in height for the executive and assistant, fully lined with 25 mm Type II rigid duct liner and of significant length. The air transfer from the admin area is 200 mm high.

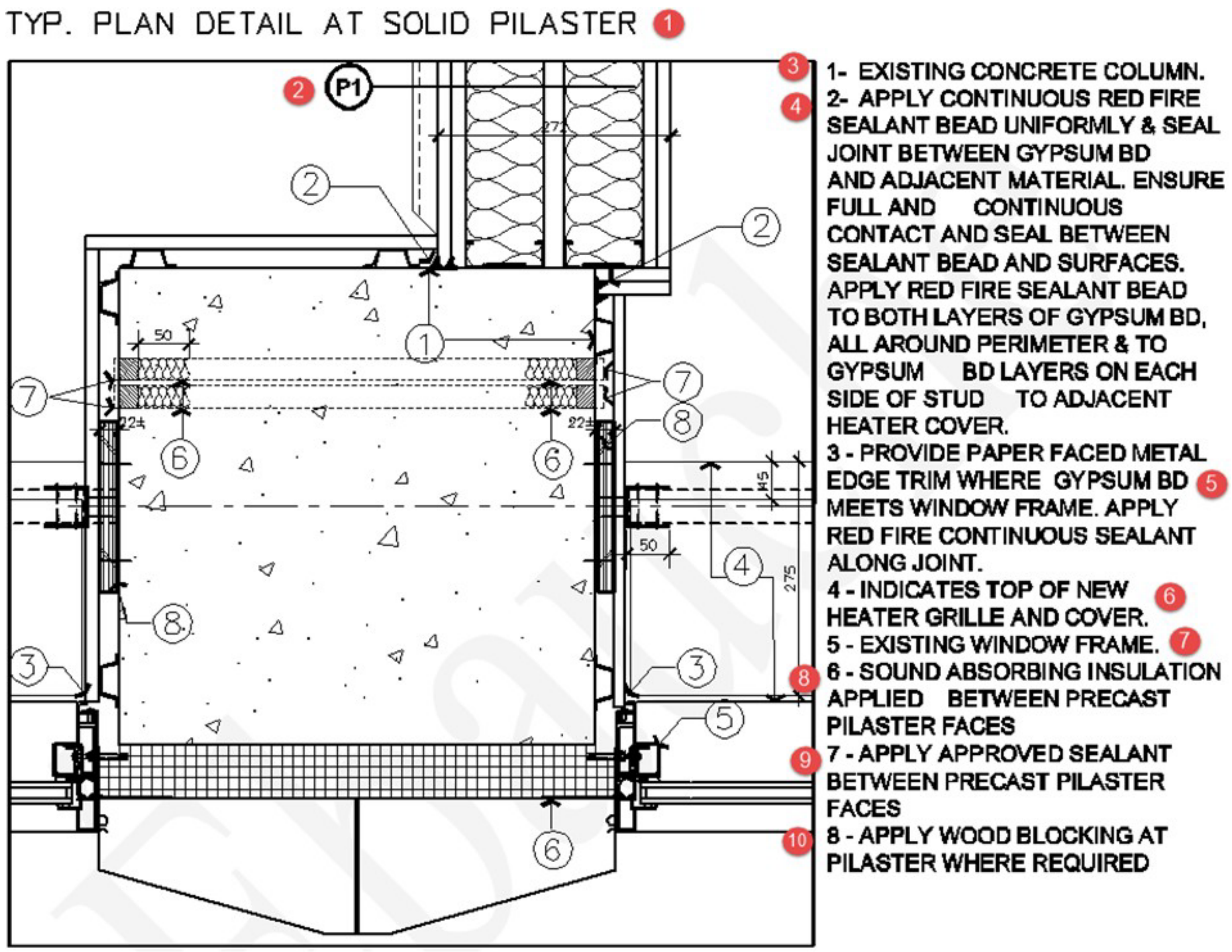
**Figure 11**




*Alt Text Figure 11 depicts a junction of double wall to single wall and single wall to column*

In this detail, note that framing has been stripped off the concrete column, so that there is no void surrounding the column. Rigid fiberglass insulation has been added to the void at the junction of the wall to the column and drywall has been used to fill the void around the column elsewhere.

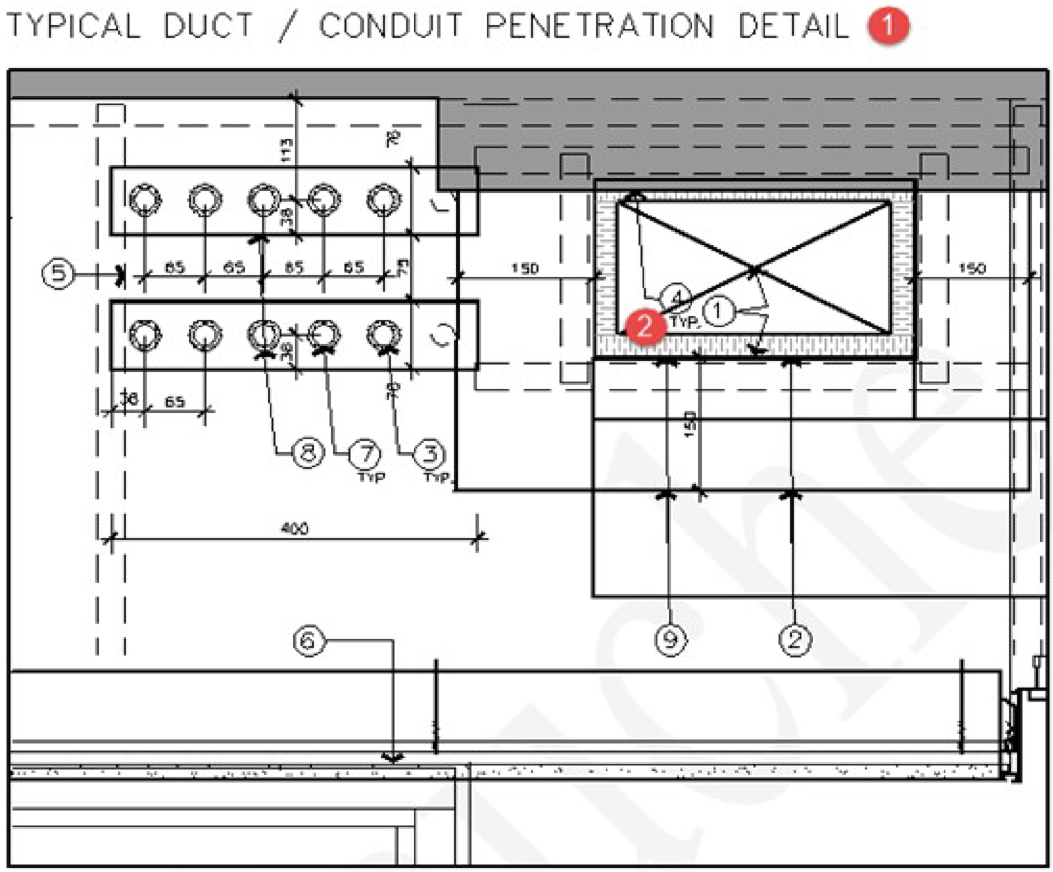
**Figure 12**




*Alt Text Figure 12 depicts a junction of double wall to solid pilaster*

Note that the wall ends at the concrete pilaster which has been stripped back to bare concrete. Any void areas in the pilaster are filled with insulation and sealed before being covered with gypsum board. This treatment applies from floor to ceiling slab

**Figure 13**

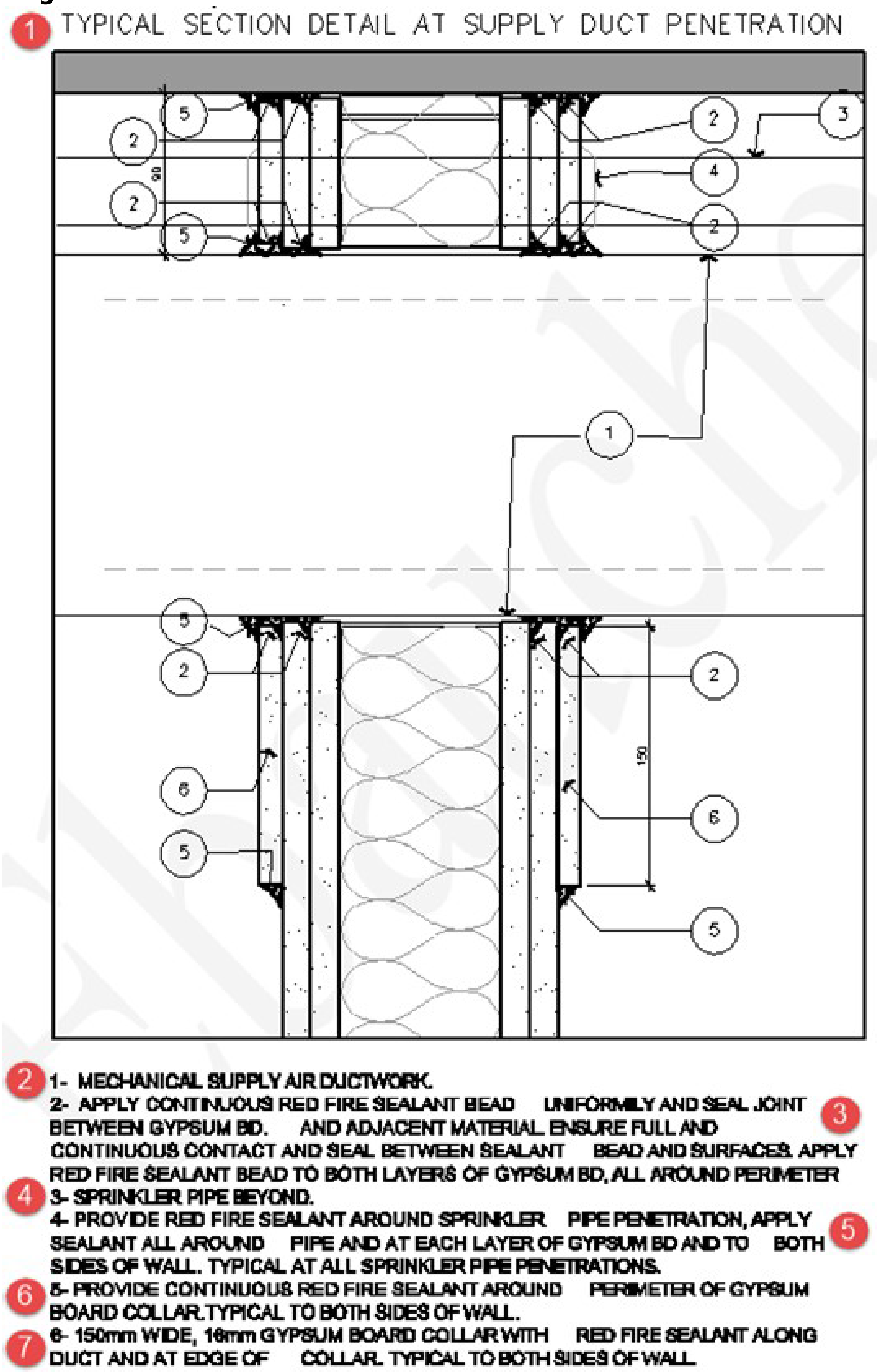



1- DUCTWORK 3
2- PROVIDE CONTINUOUS RED FIRE SEALANT AROUND PERIMETER OF GYPSUM BD COLLAR 4
3- APPLY CONTINUOUS RED FIRE SEALANT AROUND ENTIRE CONDUIT PENETRATION AND AROUND ALL OTHER TYPES OF WIRE, CABLE, ETC PENETRATIONS INCLUDING SPRINKLER PIPE LINES. 5
APPLY RED FIRE SEALANT AT EACH LAYER OF GYPSUM BD AND TO EACH SIDE OF WALL.
4- PROVIDE CONTINUOUS RED FIRE SEALANT AT EDGE AND SEAL BETWEEN TOP OF DUCT AND UNDERSIDE OF CONCRETE SLAB. 6
5- PROVIDE STUD FRAMING AROUND CONDUITS AND AT EDGE OF PLYWOOD CONDUIT COLLAR. 7
6- SUSPENDED ACOUSTIC TILE. 8
7- PLUG ENDS OF CONDUIT WITH RED FIRE SEALANT AT COMPLETION OF ALL WIRING. 9
8- PLYWOOD COLLAR AND CONDUIT SLEEVES 10
9- 150 MM WIDE, 16 MM GYPSUM BD COLLAR WITH RED FIRE SEALANT ALONG DUCT AND AT EDGE OF COLLAR, BOTH SIDES OF WALL. 11

*Alt Text Figure 13 depicts a conduit collar plate and duct penetration*

This detail illustrates the plywood conduit collar plate with the whole spacing as shown previously in Figure 6. The holes are sized slightly larger than the conduit and spaced so that they can each be sealed all around. A similar, gypsum board collar is cut and fitted for each duct, to support the duct and allow it to be completely sealed.

**Figure 14**

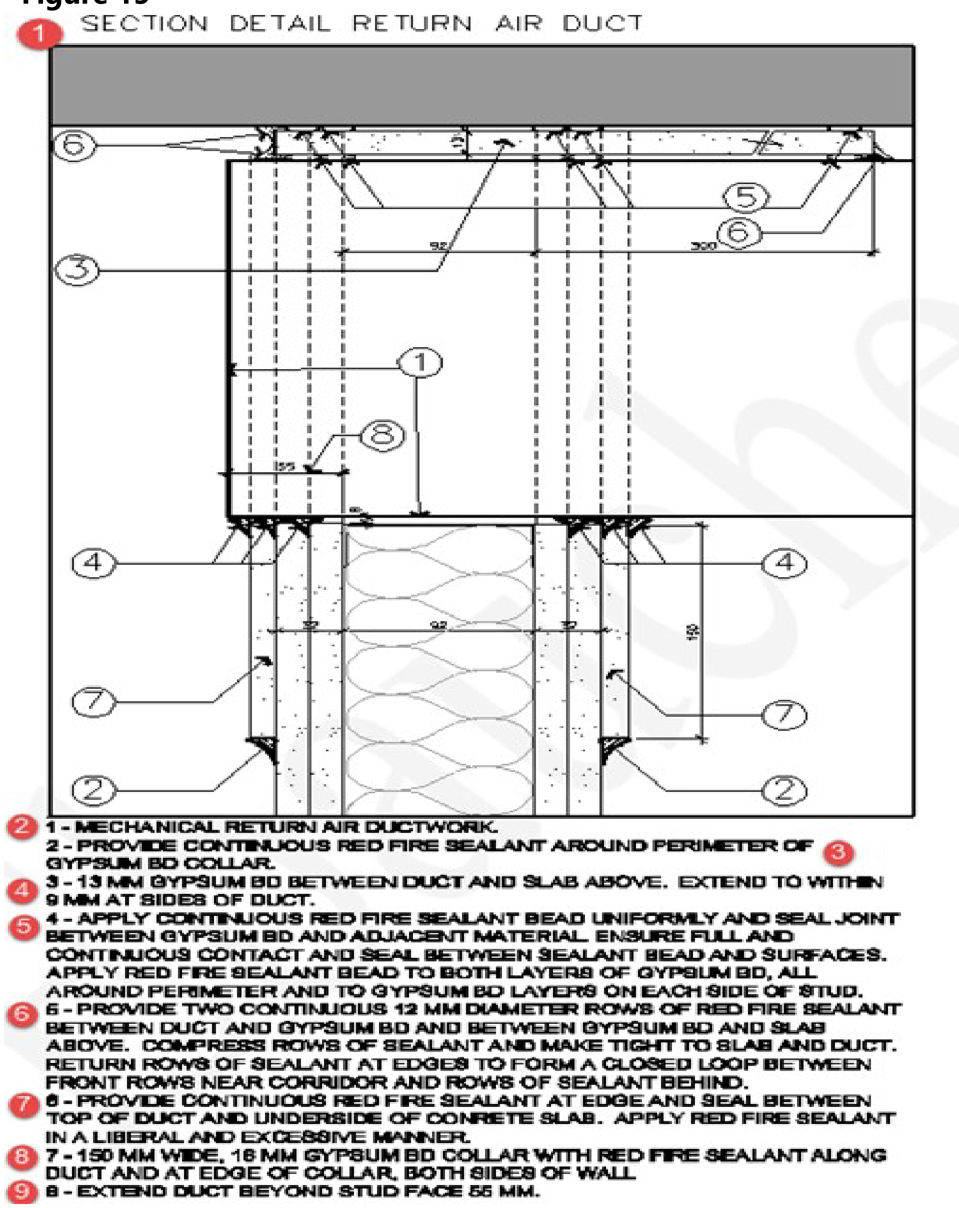



*Alt Text Figure 14 depicts a typical section at supply duct penetration*

This detail shows a typical wall head with the duct penetration 90 mm below the slab. The wall is completed above the duct, leaving sufficient space to allow the duct to be sealed to the gypsum board using a collar and red fire caulk all around.

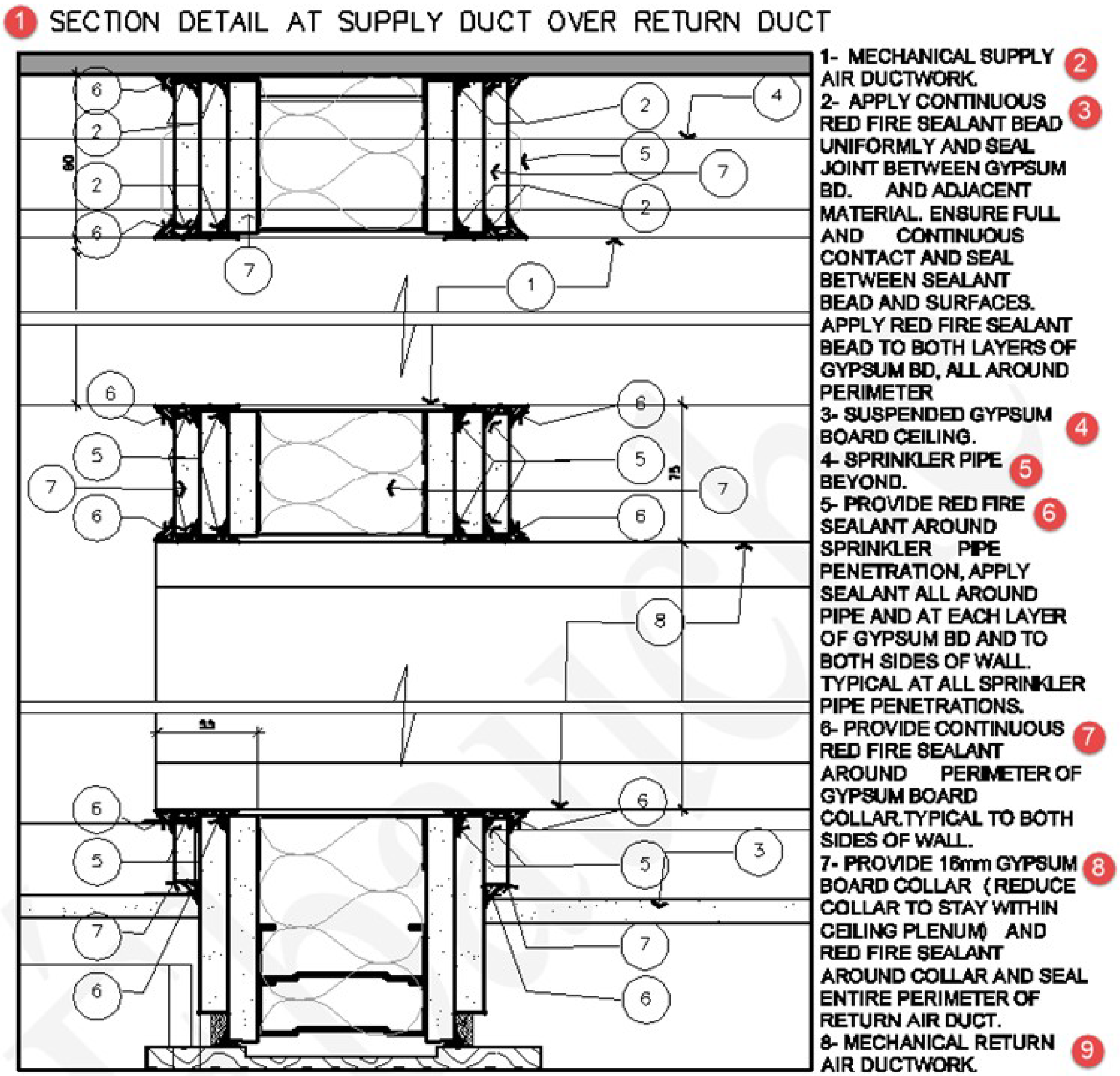
The duct in the example below could not be dropped sufficiently to allow it to be sealed adequately above and thus a gypsum board patch was installed above the duct with caulking applied as the duct was installed to seal above the duct, and the collar positioned at the side and bottom of the duct. This approach should only be used where it is not possible to leave space above the duct and should only be used where it can be completely sealed above the duct.

**Figure 15**




*Alt Text Figure 15 depicts a typical section at return air duct*

**Figure 16**

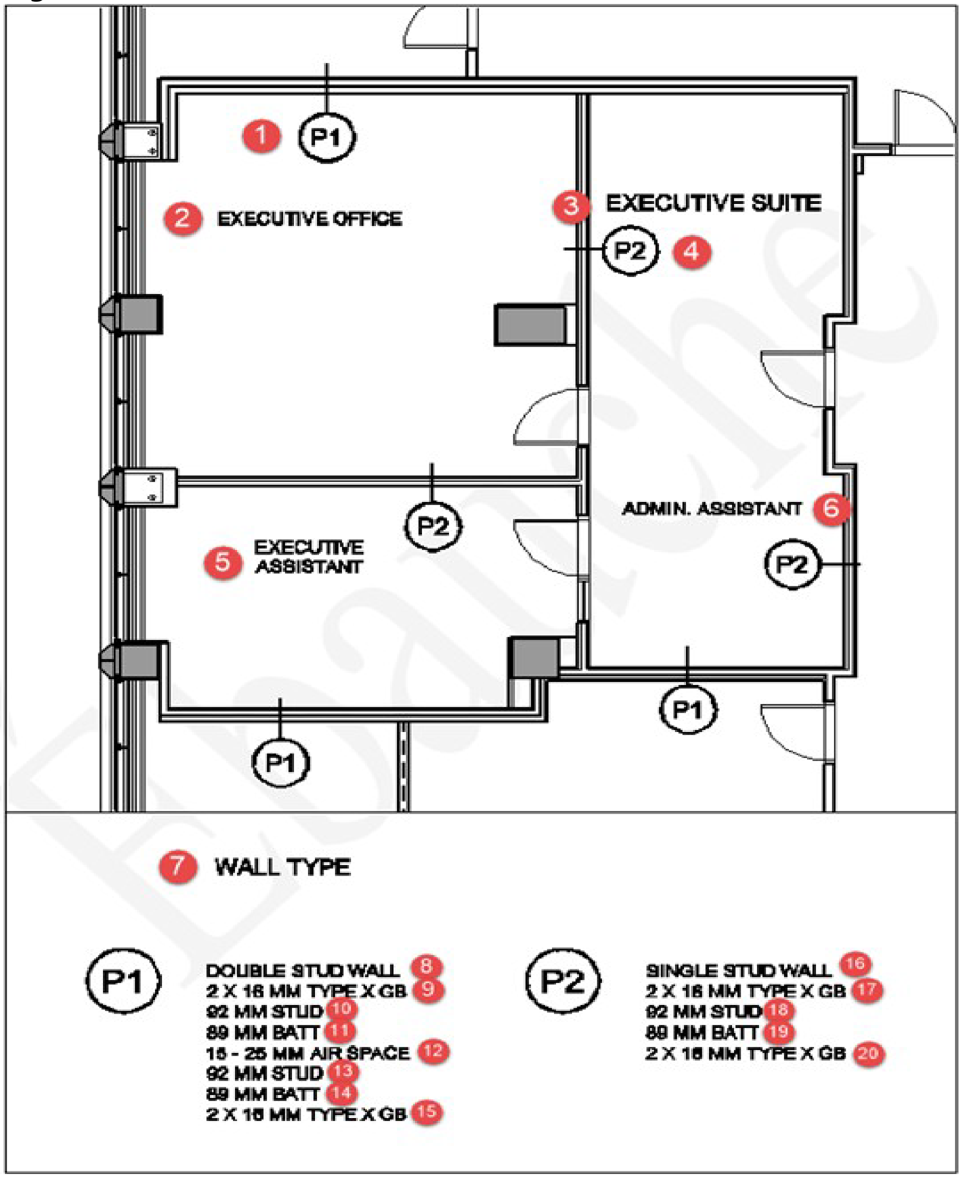


*Alt Text Figure 16 depicts a section detail at supply duct over return duct*

This detail illustrates the approach where ducts are required to be stacked. Note that wall space is left between the ducts for complete sealing and the addition of collars.

### 8.6.3. Executive Office Suite, Configuration 2

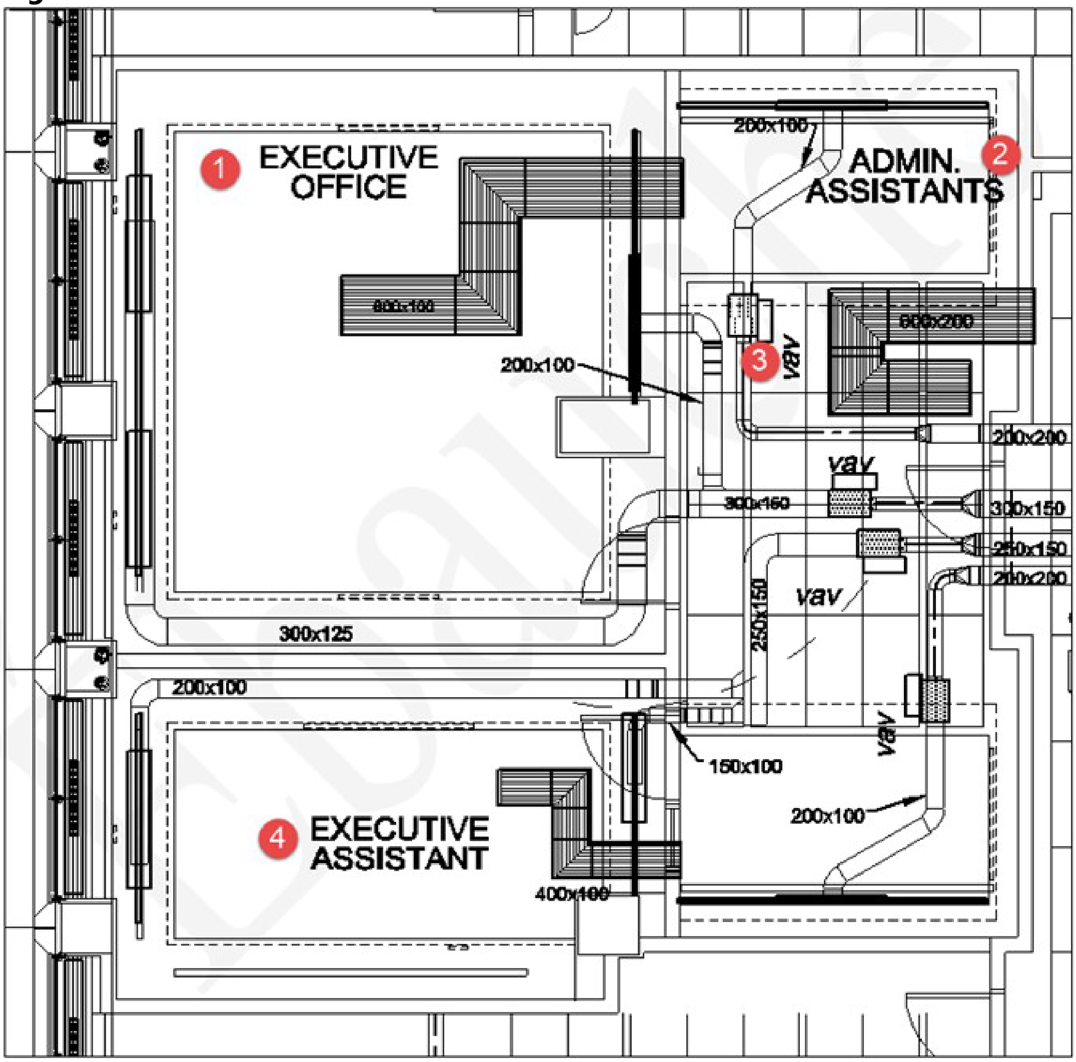
**Figure 17**




*Alt Text Figure 17 depicts Part Plan 3 showing executive suite, configuration 2*

This plan shows the correct approach to offsetting a wall from a pilaster in order to achieve the space desired. In this plan, the double wall type is used to separate the executive office from adjacent occupancies, but not the executive assistant or administrative assistant, as their speech privacy requirements are lower. As with the previous plan, the executive is protected from eavesdropping in the corridor, but not necessarily from the admin assistant area, which serves as a buffer zone for speech privacy. The walls extend to the pilasters and not to the mullions, in order to maintain the sound isolation integrity.

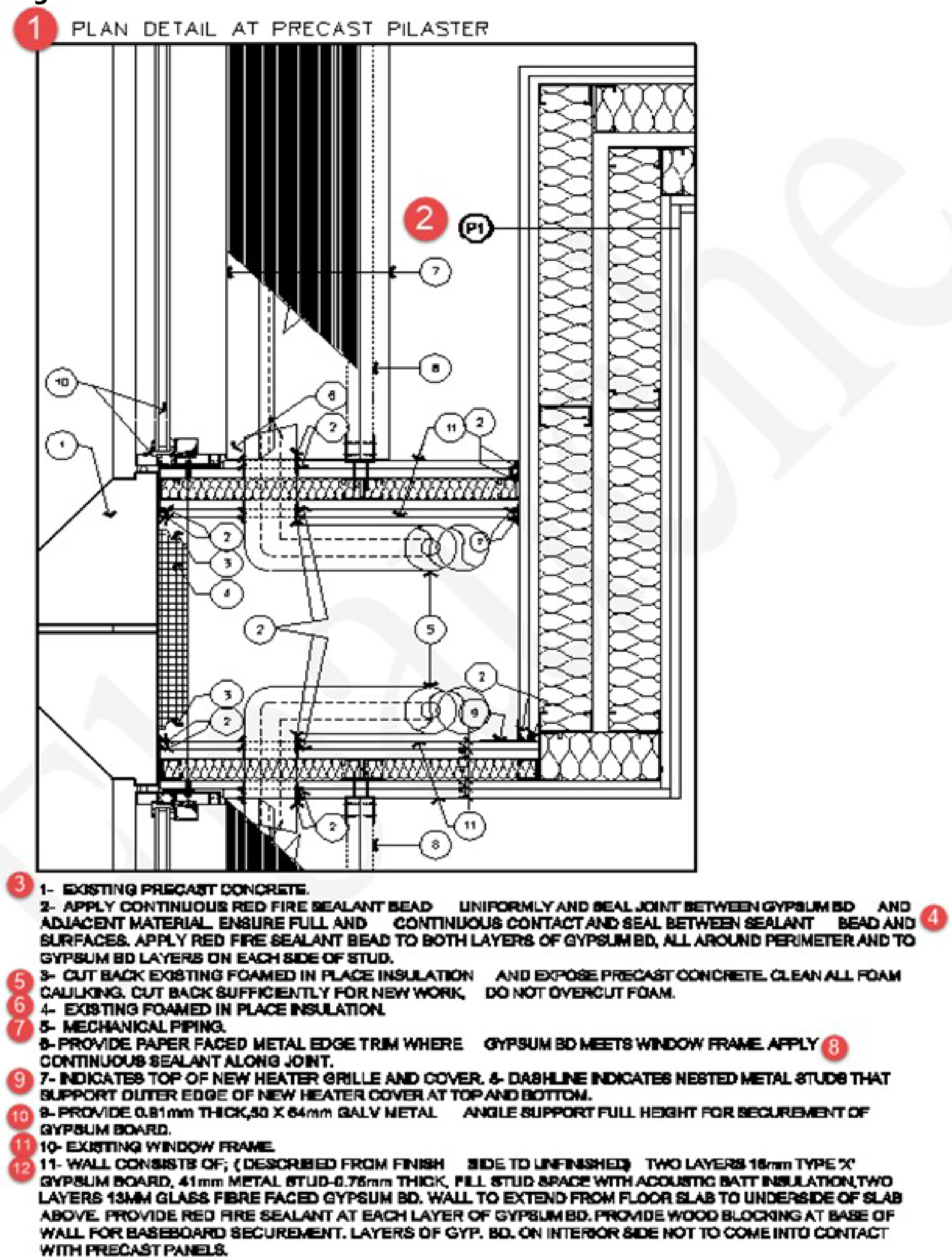
**Figure 18**




*Alt Text Figure 18 depicts a mechanical plan for Part Plan 3*

As with the previous example, the supply ducting for the three rooms within the suite is separated at the main supply in the corridor and enters the suite from the admin assistant buffer zone. The side walls to the suite have no mechanical penetrations. The return air transfers are restrained in height to 100 mm for the executive and executive assistant and 200 mm for the admin assistant area. The return air ducts are double elbow configuration, fully lined with 25 mm Type II rigid duct liner and of considerable length. The return air from the executive office transfers into the admin area and then from the admin area to the corridor, thus adding to the path length for more attenuation. VAV boxes are located only in the admin area to provide masking and enhance speech privacy for the executive office.

**Figure 19**




*Alt Text Figure 19 depicts a double wall offset to meet pilaster*

This offset wall terminates at a hollow pilaster, which contains induction piping. Note that the wall surrounding the pilaster has both inner and outer layers of gypsum board to enhance sound isolation.

## 8.7. Design Tips

The following table provides suggestions for details that have proven successful in the past. The services of an Acoustical Consultant should always be retained for projects where speech security is a requirement.

**Table 12 - Design tips for Speech Security**

| **Mechanical:** |
|---|
| • Minimize penetrations of acoustically rated partitions<br>• Use silencers or Z shaped transfer ducts lined with 25mm rigid neoprene or scrim coated duct linerboard to limit sound transfer through ducts.<br>• Where possible place silencers or transfer ducts over doors to limit sound leakage to one location. Typically, most doors have a higher degree of natural surveillance. Avoid using silencers or transfer ducts near waiting areas.<br>• Use caulking, preferably red fire rated for all penetrations through walls.<br>• Where the use of Z shaped transfer ducts is not possible use L-shaped ducts.<br>• Constant Air Volume (CAV) systems provide more consistent background noise levels than Variable Air Volume (VAV)<br>• Where an acoustic partition abuts a perimeter heating convector, details need to be developed to achieve noise isolation across the convector. Often requires disassembly of the convector. Mock-up highly recommended.<br>• Acoustic details need to be developed for each type of wall penetration. |
| **Electrical:** |
| • Minimize electrical, data, communications wiring, and outlets in speech secure partitions.<br>• Collect electrical services together and enclose in a services plenum, built so as to be acoustically separate from the acoustic partition.<br>• Back-to-back electrical outlets cannot be in the same stud cavity. Separate outlets on opposite sides of partitions for power, data and communications by at least one stud, minimum 300mm separation.<br>• Walls including electrical boxes on both sides require to have stud cavities filled with porous sound absorbing material.<br>• Ensure proper insulation and caulking is used around all penetrations.<br>• Provide conduit for anticipated future wiring needs, to limit damage to acoustic insulation. |
| **Architectural:** |
| • Assign speech security requirements to only those spaces that require them.<br>• Use spatial separation wherever possible to distance noise sensitive locations from potential eavesdroppers.<br>• Minimize use of high acoustical performance components.<br>• Investigate flanking transmission through exterior walls (especially heritage buildings), and through exterior window frames between offices<br>• Ensure that design drawings and specifications fully address all construction details for proper speech security (See the attached sketches).<br>• Avoid glazing in partitions of speech secure spaces.<br>• Use sill seal or other treatment to seal framing to adjacent surfaces.<br>• Provide insulation clips or other structural support every 24 inches vertically for insulation, which has a thickness less than the size of the studs.<br>• Do not allow gaps over 10mm between the gypsum board and any other elements such as the |

| |
|---|
| structural slab or mechanical system.<br>• In addition to caulking use a backer rod for gaps between 10mm and 6mm.<br>• Use caulking, preferably red fire rated, for all joints between drywall and other elements for gaps only up to 10mm.<br>• Increases in the gauge of steel studs can dramatically decrease the acoustic properties of the wall.<br>• The addition of steel mesh or sheet steel may decrease the acoustic properties of the wall. |
| **Doors and Door Hardware** |
| • When a single door is required to provide acoustic isolation, use an acoustically rated door.<br>• Multiple (non-rated) doors that are fully weather-stripped including drop bottoms typically in the form of an acoustically treated vestibule can be most effective.<br>• Avoid double doors wherever possible. Always use vestibules if double doors are required.<br>• Ensure adequate latch set operator setback/offset (particularly for knob type hardware) to avoid hitting your hand on the jamb seals/gaskets when opening the door.<br>• When specifying a door with a drop threshold ensure a flat metal threshold or sill is provided since this device cannot seal properly against carpet or uneven floor<br>• Ensure all seals/gaskets are adjustable and that they are adjusted properly after installation to match minor warps in the door, frame or floor. |
| **General:** |
| • Maintain and update an "Acoustic SSDL" during construction<br>• Ensure any Change Orders do not decrease the acoustic isolation. |

## 8.8. Verification of speech security designs

To be certain that rooms do have the intended speech privacy it is essential to test them using the measurement procedure described in ASTM E2638-10. This procedure includes measuring ambient noise levels and sound transmission from each source room to adjacent spaces. From these measurements SPC ratings can be calculated and compared with those of the design goals. Where the design criteria are not met, the cause should be determined and the problems rectified.

## 8.9. Conclusions

The construction detailing illustrates a successful approach to high sound isolation and high speech privacy. This approach has been successfully tested and resulted in STC values that closely matched the laboratory ratings of the walls in most instances as well as very high SPC values. Critical to the success of the detailing is regular inspection by the acoustic consultant, whose function it is during construction to track the implementation of acoustic detailing. Also critical is a systems approach to detailing. Choosing to implement some, but not all of the details will often result in the failure to achieve speech privacy as the remaining areas of sound leakage, however small, can completely compromise the result.

Achieving a successful result in the construction of speech secure rooms requires the cooperation of the entire design team including communications and Audio Visual, and the dedication of the design team and the client to the goal.

# 9. Assessment of the Architectural Speech Privacy and Speech Security of Closed Rooms

This section describes a framework for interpreting, assessing, and rating the speech privacy and speech security of closed meeting rooms and offices. The document provides a concise technical overview of the underlying concepts and defines categories for rating and setting criteria. This guide also contains a detailed measurement procedure to be followed by technicians or consultants performing field measurements, and guidance for specifying suitable constructions at the design stage. The measurement procedure follows the steps described in a new ASTM measurement standard (ASTM 2638-10).

The approach to assessing speech privacy of closed meeting rooms and offices is based on estimating the likelihood that conversations occurring within the closed room will be audible or intelligible to bystanders outside the room. Whether speech is audible or intelligible depends on the speech signal-to-noise ratio, i.e. how loud the speech is relative to the noise at the listener position. How loud the speech is at a bystander's position depends on how loud the speech is inside the room (which generally cannot be controlled, but can be estimated), as well as the attenuation provided by the sound insulation of the building structure. The background noise at the bystander's position is usually generated by building mechanical systems or other machinery, but could also be generated by occupants or masking sound systems. The current approach uses measurements or design estimates of the sound insulation and background noise, together with statistical estimates of speech levels, to directly estimate the likelihood that speech will be audible or intelligible to bystanders.

The relevant measure of sound insulation is the sound level difference, LD, observed between a uniform test sound field (inside the room) and the received level at spot locations (outside the room). This approach has the benefit of being applicable for talkers who could be located anywhere inside the room, for minimizing the acoustical effect of the receiving space, and for assessing specific weak spots in the sound insulation. The relevant measure of background noise is simply the average sound level at the spot receiver (potential bystander) position, Ln. The sum of the frequency-average of these two quantities is called the Speech Privacy Class, SPC = LD + Ln, which is a single number rating, in decibels, and is a property of the building. The value of SPC determines the protection against a speech privacy lapse, and therefore is used to rate the speech privacy. For design, the level difference LD is estimated from the nominal transmission loss TL of the specified partitions, using LD = TL + 1, and noise needs to be estimated or assumed.

Ranges of SPC corresponding to different categories of speech privacy are defined in this document, along with a description of the likelihood of a speech privacy lapse for each. Users can use this information to define criteria to meet their operational needs.

## 9.1. Speech Privacy/Security

This section describes methods to assess the architectural speech privacy of closed offices and meeting rooms. Included in the scope is what is frequently termed speech security, which means very high degrees of speech privacy. The aim is to assess the degree to which conversations within an enclosed room would be heard or understood outside the room. The term "architectural" speech privacy is used to indicate the privacy provided by the building structure and background noise. The background noise includes that due to the building systems, and also any intentionally added masking noise. The procedures are applicable to any enclosed room, and any adjoining space that might be the location of a potential eavesdropper. These methods are not suitable for use in evaluating speech privacy in open plan spaces. Potential eavesdroppers outside the room are assumed to not be using overt methods (such as touching the walls) or electronic aids (such as microphones or amplifiers), but rather are listening naturally. The criteria for interpretation of the degree of privacy or security are based on the probability of speech being audible or intelligible to attentive bystanders.

Speech privacy and speech security are descriptions of how audible or intelligible speech sounds are likely to be outside of a closed room. This is a 'signal-to-noise' problem where at the listener's position, the signal is the transmitted speech sound, and the noise is the background noise. The intelligibility or audibility of the speech depends on how loud it is, relative to the noise.

Research has identified an objective measure, calculated from speech signal and noise spectra at the listener position, which accurately predicts the degree to which the speech signal is intelligible or audible [1, 2]. This measure is a uniformly-weighted frequency-averaged signal-to- noise ratio, given by Equation #1 below,

$$SNR_{UNI32} = \frac{1}{16}\sum_{f=160}^{5000}[L_{ts}(f) - L_n(f)]_{-32} \ ,$$

***Equation 1***

where in each of the 16 1/3-octave bands centered at frequency f from 160 to 5000 Hz, Lts(f) is the level of the transmitted speech, Ln(f) is the level of the background noise, and the subscript "–32" indicates that the quantity in square brackets—the signal to noise ratio in each band—is to be limited to a minimum of –32 dB. The result is in decibels, and is larger for less private conditions of high signal to noise, and lower for more private conditions.

A condition where 50% of skilled listeners can just understand speech is the threshold of intelligibility. This corresponds to a particular value of SNRUNI32: in laboratory experiments this was –16 dB [1, 2], but in (somewhat reverberant) real rooms was –11 dB, varying about 1 dB with room reverberation [3]. At a lower signal to noise condition, there is a point where 50% of skilled listeners can just hear speech sounds. This is called the threshold of audibility, and corresponds to a higher degree of privacy. The threshold of audibility corresponds to a SNRUNI32 value of –22 dB (in both the laboratory and in real rooms) [1, 2, and 3].

To apply SNRUNI32 for assessment of closed room speech privacy, it is necessary to determine the transmitted speech levels and the background noise levels at the listener position.

For a given speaking level inside the room, the level of transmitted speech depends on the sound insulation provided by the building structure. More attenuation results in less transmitted speech signal, and therefore more privacy. The relevant measure of sound insulation is the difference in sound level between the average level of a uniform test sound field inside the room and the received level at a spot listener location outside the room [4]. If the average level of the uniform field is Ls(f) and the corresponding received level is Lr(f), then the level difference in each frequency band is LD(f) = Ls(f) – Lr(f). A uniform field is taken inside the room to represent the average of talkers that could be located anywhere, and facing any direction. The spot receiver locations outside are chosen close to the boundaries of the room to minimize the effect of the receiving space, to more realistically represent the locations of potential eavesdroppers, and to allow evaluation of weak points such as doors.

Since the level of speech varies from moment to moment, the speech levels in the room can be assessed statistically. Measurements were made of speech levels Lsp(f) in a large number of meetings, and this information has been used to determine the probability of occurrence of certain levels [5, 6]. Logging sound level meters were placed in meeting rooms, and recorded the equivalent sound level (Leq) over 10-second intervals. Analysis of these short-term levels gives information about the statistical fluctuation of speech levels in the meetings. One way to interpret these statistics is to state the percentage of time that a certain level is likely to be exceeded. For example, the median speech level (50th percentile) is exceeded 50% of the time, or one out of every two 10-second intervals (once per 20 seconds). A higher speech level, say the 90th percentile, is exceeded only 10% of the time, or one out of every ten 10-second intervals (once per 100 seconds).

The background noise at the listener position outside of a closed room also varies during the day [5]. The level of the background noise Lb(f) can be measured for a short period of time believed to be representative of the building's normal operation, or it can be logged over a longer period of time, or can be assumed from other knowledge.

Putting it all together, the value of SNRUNI32 outside the room is given by Equation # 2 below,

$$SNR_{UNI32} = \frac{1}{16}\sum_{f=160}^{5000}[L_{sp}(f) - LD(f) - L_n(f)]_{-32} ,$$

***Equation 2***

where Lsp(f) is the speech level inside the room, LD(f) is the measured level difference between the average inside the room and a listener position, and Ln(f) is the background noise at the listener position. Frequently the –32 dB limitation has minimal effect, so Eq. (2) can be simplified and rewritten as Equation # 3 Below,

$$SNR_{UNI32} = L_{sp}(avg) - LD(avg) - L_n(avg) ,$$

***Equation 3***

where (avg) indicates the arithmetic average of Lsp(f), LD(f), and Ln(f) over the 16 1/3-octave bands from 160 to 5000 Hz.

A particular speech privacy criterion such as the threshold of intelligibility corresponds to a particular value of SNRUNI32, say SNRUNI32,0. Rewriting Eq. (3) as an inequality, when the following is true of the speech level, as Equation # 4 below

$$L_{sp}(avg) \leq SNR_{UNI\ 32,0} + LD(avg) + L_n(avg)\ ,$$

***Equation 4***

then the conditions at the listening point are at least as private as the criterion conditions. The quantities LD(avg) and Ln(avg) are properties of the closed room, so Eq. (4) dictates the maximum speech level Lsp(avg) for which the conditions are adequately private. From the statistics of speech levels, this can be interpreted as the length of time in between expected privacy "lapses", which would correspond to instances for which the speech level is larger than that allowed by Eq. (4).

The privacy criterion is chosen as the threshold of intelligibility, and correspondingly the criterion value of SNRUNI32,0 is –11 dB. Then Eq. (4) yields the following relationship, as shown in Equation # 5 below,

$$LD(avg) + L_n(avg) \geq L_{sp}(avg) + 11\ ,$$

***Equation 5***

This determines the maximum speech level for which conditions at the listening point remain below the threshold of intelligibility. The likelihood of this speech level being exceeded is the likelihood that the conditions at the listening point will be above the threshold of intelligibility.

As previously stated, the quantities LD(avg) and Ln(avg) are properties of the closed room (i.e., of the building). The sum of these two terms governs the speech privacy rating of a room, and is called the Speech Privacy Class, SPC as per Equation # 6 below,

$$SPC = LD(avg) + L_n(avg)\ .$$

***Equation 6***

Speech privacy requirements can be specified in terms of SPC values. Table 13 includes a range of SPC values and descriptions of the speech privacy that each would provide.

**Table 13 - Privacy and security protection provided by some SPC values**

| Name | SPC | Description |
|---|---|---|
| Minimal speech privacy | 70 | A few words will be intelligible at most once each 3 minutes, and speech sounds will frequently be audible (at most once each 0.6 minutes). |
| Standard speech privacy | 75 | Speech sounds will be occasionally intelligible (at most once each 18 minutes) and frequently audible (at most once each 2 minutes) **Protected "B"** |
| Standard speech security | 80 | Speech sounds will very rarely be intelligible (intelligible at most once each 2.3 hours) and occasionally audible (at most once each 12.5 minutes) **Protected "C" – Secret** |
| High speech security | 85 | Speech essentially unintelligible (at most once each 15 hours) and very rarely audible (at most once each 1.5 hours) **Top Secret** |
| Very high speech security | 90 | Speech not intelligible and very rarely audible (at most once each 11 hours) |

## 9.2. Measurement Procedures

To evaluate the privacy provided by an existing closed room, measurements need to be made of the sound insulation to the listening point (LD), and of the background noise at the listening point (Ln), so that the SPC may be determined.

### 9.2.1. Summary

- A broadband noise sound field is generated at a high level in the closed room. A loudspeaker is placed successively at two or more locations within the room.
- Receiving points outside the closed room, that are potential weak spots or possible locations for an eavesdropper, are selected for measurement.
- With the source operating in each successive location in the source room, measurements of sound pressure level are made within the room to obtain source room levels, and at points outside the room to obtain received levels.
- With the source turned off, measurements of sound pressure level are made at the receiving points to obtain background noise levels, Ln(f) and Ln(avg).
- The differences in average source room levels inside the room and received levels at each receiving point are determined, and are used to calculate LD(f) and LD(avg) for each receiving point.
- SPC and the corresponding category of speech privacy at each receiving point are determined, using Eq. (6).

### 9.2.2. Measurement Equipment

- Sound Source: the sound source shall be a loudspeaker system driven by a power amplifier. The loudspeaker shall be approximately omni-directional, such as a dodecahedron with drivers mounted in each face.

- Test Signal: The input signal to the amplifiers shall be random noise containing an approximately uniform and continuous distribution of energy and frequencies over each test band. White or pink electronic noise sources satisfy this condition.
- Bandwidth and Filtering: The overall frequency response of the electrical system, including the filter or filters in the source and microphone sections, shall for each test band conform to the specifications in ANSI S1.11 for a one-third octave band filter set, class 1 or better.
- Frequency Range: The frequency range for measurement shall be the sixteen one-third octave bands from 160 to 5000 Hz.
- Microphones: Measurement quality microphones that are 13 mm or smaller in diameter and that are close to omni-directional below 5000 Hz shall be used.
- Microphones, amplifiers, and electronic circuitry to process microphone signals and perform measurements shall satisfy the requirements of ANSI S1.4 for Type 1 sound level meters, except that weighting networks are not required.

### 9.2.3. Measurement Procedure

**Source positions:**

- At least two source positions shall be selected in the central part of the closed room. These positions shall be at least 1.2 m apart and shall be representative of typical locations of talkers in the room. The source positions shall be 1.5 m above the floor in the closed room; and
- The number of source positions used will affect the uncertainty in the final result, which can be calculated according to Section 11. More source positions will result in a smaller uncertainty. Users of this method can choose to use the minimum number of source positions (i.e., 2) and obtain a result with unknown, but limited, uncertainty. Users can alternatively decide upon a maximum acceptable uncertainty and repeat measurements with additional source positions until satisfactory results are obtained.

**Receiving positions:**

- Select receiving points outside the closed room. Measurements should be made at all locations in the receiving area where possible speech privacy problems are suspected. The regions near doors, windows and other types of weak elements in the boundaries of the room are obvious locations that should be included;
- To evaluate speech transmission through walls and their components (e.g. doors), microphones should be 0.25 m from the nearest outer surface of the closed room and between 1.2 and 2 m above the floor. (If the microphone is closer than 0.25 m, the measured level is more sensitive to distance from the wall.);
- Survey for additional locations where sound leaks may occur by performing initial listening tests. Position the sound source near the middle of the closed room and generate a signal so that the average sound pressure level in the room is at least 80 dBA. With all doors closed, listen carefully outside the closed room, near the boundaries, and identify the locations of probable sound leaks where measurements should be made to assess the speech privacy. In some cases, spot measurement locations may not be adjacent to the room boundary. Where there is sound

transmission from the room via flanking sound paths such as through ducts, spot measurements should be made at locations where a potential eavesdropper might be located; and

- In addition to the locations identified as probable weak spots, select other positions around the closed room so as to provide complete and uniform coverage of the periphery. Some receiving points will be close to the bounding surfaces of the closed room. Others may be selected close to suspected weak spots such as ventilation duct openings.

**Measurement of levels:**
With the source operating at each source position in the closed room, the average sound pressure level in the room shall be measured in one of the two following ways:

- Measure the sound pressure level using at least five fixed microphone positions. The microphone positions shall be at least 1.2 m apart, at least 1.5 m from the sound source and at least 1 m from the surfaces of the closed room. The sound pressure level Lsij(f) in each frequency band, f, shall be measured for each combination of source position i and microphone position j;
- Measure the average sound pressure level in each 1/3-octave band by walking around the room with a sound level meter or equivalent analyzer set to measure the time-averaged sound levels Leq. For larger rooms, the operator shall walk slowly moving the microphone in a circular path of at least 0.5 m diameter in front of their body to evenly sample as much as practical of the measurement space. The sound level meter or microphone shall be held well away from the operator's body—at least 0.5 m (a boom serves to increase the distance). The microphone speed shall remain as constant as practical. The operator shall take care to assure that the path does not significantly sample any part of the room volume for more time than other parts. The microphone shall always be more than 1.5 m from the sound source and more than 1 m from the walls of the closed room. The integration time shall be at least 30 seconds. This measurement shall be repeated for each source position i to give Lsi(f), the average source room level in each band, for source position I; and
- The sound pressure level shall be measured at each stationary receiving point outside the room for each source position i in the closed room for at least 15 seconds. Measure the received levels with the source operating, Lrni(f), and the background levels with the source switched off, Lni(f).
- *NOTE—Measurement of the levels in the closed room by walking around with an integrating sound level meter will enable only approximate estimation of the uncertainty in the final result. The optional procedures for estimating the uncertainty are in Section 11.*

### 9.2.4. Calculations

All calculations shall be made using unrounded, measured values.

**Source room levels**

a) If source room measurements were made using fixed microphone positions, determine Lsi(f), the average sound pressure level in each band, for source position i, as follows in Equation # 7 below:

$$L_{si}(f) = 10\log\left[\frac{1}{m}\sum_{j=1}^{m} 10^{L_{sij}(f)/10}\right]$$

***Equation 7***

where m is the number of microphone positions.

b) Calculate Ls(f), the mean source sound pressure level in the closed room in each frequency band, using Equation # 8 below,

$$L_s(f) = 10\log\left[\frac{1}{n}\sum_{i=1}^{n} 10^{L_{si}(f)/10}\right]$$

***Equation 8***

where n is the number of source positions.

c) Calculate Ls(avg), the arithmetic average of source room level over the 16 1/3-octave frequency bands from 160 to 5000 Hz from using Equation # 9 below,

$$L_s(avg) = \sum_{f=160}^{5000} L_s(f)/16$$

***Equation 9***

**Received levels at each receiving point**

a) For each source position i, the received level in each frequency band f at each receiving point shall be corrected for background noise as follows:

- If the difference Lrni(f) – Lni(f) is more than 10 dB then no corrections for background noise are necessary and Lri(f) = Lrni(f).
- If the difference Lrni(f) – Lni(f) is between 5 and 10 dB, the adjusted value of the received level, Lri(f), shall be calculated as follows in Equation # 10:

$$L_{ri}(f) = 10\log(10^{L_{rni}(f)/10} - 10^{L_{ni}(f)/10})$$

***Equation 10***

- If the difference Lrni(f) – Lni(f) is less than 5 dB, then set Lri(f) = Lrni(f) – 2. In this case, the measurements provide only an estimate of the upper limit of the received level. Identify such measurements in the test report.

b) Calculate Lr(f), the average received sound pressure level in each band for each receiving point using in Equation # 11,

$$L_r(f) = 10\log\left[\frac{1}{n}\sum_{i=1}^{n}10^{L_{ri}(f)/10}\right]$$

***Equation 11***

where *n* is the number of source positions.

- If any of the Lri(f) values are limited by background noise, then the corresponding Lr(f) provides only an estimate of the upper limit of the average received level. Identify such measurements in the test report.

C) For each receiving point, calculate Lr(avg), the arithmetic average of received level over the 16 1/3-octave frequency bands from 160 to 5000 Hz from using Equation # 12 below,

$$L_r(avg) = \sum_{f=160}^{5000} L_r(f)/16$$

***Equation 12***

**Background noise levels at each receiving point**

a) Calculate Ln(f), the average background noise level in each band for each receiving point using Equation # 13 below,

$$L_n(f) = 10\log\left[\frac{1}{n}\sum_{i=1}^{n}10^{L_{ni}(f)/10}\right]$$

***Equation 13***

where n is the number of source positions.

b) For each receiving point, calculate Ln(avg), the arithmetic average of background noise level over the 16 1/3-octave frequency bands from 160 to 5000 Hz from using Equation # 14 below,

$$L_n(avg) = \sum_{f=160}^{5000} L_n(f)/16$$

***Equation 14***

**Level Differences**

a) For each receiving point, calculate the difference in average source room level and average received level in each band using Equation # 15 below,

$$LD(f) = L_s(f) - L_r(f).$$

***Equation 15***

b) For each receiving point, calculate LD(avg), the average level difference over the 16 1/3-octave frequency bands from 160 to 5000 Hz from using Equation # 16 below,

$$LD(avg) = \sum_{f=160}^{5000} LD(f)/16$$

***Equation 16***

**Speech Privacy Class**

a) For each receiving point, calculate SPC from the arithmetic sum of LD(avg) and Ln(avg) using Equation # 17 below,

$$SPC = LD(avg) + L_n(avg).$$

***Equation 17***

b) The background noise outside the closed room may vary from time to time, so the measured value Ln is representative of that during the measurement period only. For the purposes of estimating SPC for different noise conditions, the background noise may additionally be measured at different times, or assumed from other knowledge.

**Precision**

a) The uncertainty in the final measured value SPC depends on the precision of the measurements of: source room average levels, received levels, and background noise levels. Precision of the measurements of the average source and received levels varies with frequency and room properties, the number of source positions, type of loudspeakers used, and the number of microphone positions.

b) The 95% confidence interval for SPC can be calculated according to Section 1. This is not mandatory. Users of this method can decide what an acceptable 95% confidence interval is, and if the initial number of source positions does not give an acceptable value, then more source positions shall be used.

c) Using the minimum specified number of source and fixed microphone positions (i.e., 2 source positions, 5 microphone positions) in a wide range of rooms, the average 95% confidence interval for Ls(avg) has been found to be ±1.1 dB using omni-directional sources, and ±1.6 dB using directional sources [4]. Uncertainty in the final value of SPC will be no smaller than this. Rooms that are smaller than 60 m3 or larger than 200 m3 with a reverberation time less than 0.6 s will likely have larger uncertainties.

**Report**

Report the following information:

- Statement of Conformance to Method—If it is true in every respect, state that the tests were conducted in accordance with the provisions of this Guide;
- Description of Test Environment— Give a general description of the closed room and furnishings. Give a sketch showing the relationship of the receiving points to the closed room. State the volume of the closed room;
- Description of Measurement Method—Identify the type of loudspeaker used and the microphone method used to measure the levels in the closed room. Indicate the source positions used on the room sketch;
- Statement of Precision—If the confidence interval for SPC was calculated, report it; otherwise state that the uncertainty of the result was not determined;
- Provide a table giving the values of Ls(f), and for each receiving point of Lr(f), LD(f) and Ln(f) at the specified frequencies, rounded to the nearest 1 dB. Identify those values of Lr(f) and LD(f) that were contaminated by background noise; and
- Provide a table giving the values of Ls(avg), and for each receiving point Lr(avg), LD(avg), Ln(avg), and SPC. Identify those values of Lr(avg), LD(avg), and SPC that were contaminated by background noise.

## 9.3. Design Procedures

At the design stage, it is necessary to specify an assembly that will, after construction, provide the desired degree of speech privacy. Usually the only information available at this stage is transmission loss (TL) data of individual specimens, measured in the laboratory according to ASTM Test Method E 90.

Research has shown that the transmission loss data can be used to estimate the level difference between a uniform sound field on one side of a partition, and the received level at 0.25 m from the other side of the partition [3]. Therefore, SPC can be estimated at the design stage. Designers should be aware that the performance of partitions in buildings is almost always degraded by flanking transmission (i.e., sound transmission via paths other than directly through the nominally separating partition), and that laboratory performance is usually not realized in the field.

Measurements for a range of walls and with a wide range of acoustical absorption in the rooms on either side of the walls have demonstrated that for a uniform field incident on one side of a wall, the received level at 0.25 m on the other side can be estimated from Equation # 18 below,

$$L_{0.25}(avg) \approx L_s(avg) - TL(avg) - 1,$$

***Equation 18***

where, L0.25(avg) is the received level at 0.25 m from the wall, Ls(avg) is the level of the uniform field on the source side of the wall, TL(avg) is the transmission loss of the wall, and (avg) means the arithmetic average over all 16 bands from 160 to 5000 Hz. Equation # 18 is correct within ± 0.5 dB for most rooms with reverberation times less than about 1.2 s, and can be rewritten to predict the required level difference as follows in Equation # 19 below,

$$LD(avg) \approx TL(avg) + 1$$

***Equation 19***

where LD(avg) = Ls(avg) – L0.25(avg).

Equation #19 can be used to predict the SPC from transmission loss data follows using Equation #20 below,

$$SPC = TL(avg) + L_n(avg) + 1,$$

***Equation 20***

Which allows designers to estimate the degree of speech privacy from published laboratory TL data, and an assumption or knowledge of the background noise Ln(avg) in the listening space. The descriptions in Table 13 can be used to set criteria for SPC.

At the design stage it is difficult to accurately estimate background noise levels at each potential listener position. In addition, background noise levels typically vary over time and require measurements over long time periods to accurately characterize conditions. As a result, it is often necessary to estimate realistic lowest likely background noise levels for designs. These values were obtained from measurements of the statistical variations of background noise levels near government meeting rooms. During the daytime (8:00 to 17:00) background noise levels were only less than 35 dBA about 1% of the time. Therefore, for the daytime period, 35 dBA or Ln(avg) = 24 dB* would be a safe lowest likely background noise level to use in a worst case design calculation in the absence of measured background noise level values. When rooms are used outside of daytime hours, one can similarly use, 30 dBA or Ln(avg) = 19 dB for a suitable lowest likely ambient level for evenings (17:00 to 24:00) and 25 dBA or Ln(avg) = 14 dB for night time hours (24:00 to 6:00).
(*The conversion from dBA to dB(avg) assumes a typical -5 dB/octave spectrum shape for background noise levels).

# 10. Determination of Confidence Intervals

## 10.1. Closed Room Levels

If the fixed microphone method was used, calculate the 95% confidence interval for the source room average according to the following.

a) For each measurement of source room levels at microphone position j for source position i, calculate the average over frequency Lsij(avg) as per equation #21,

$$L_{sij}(avg) = \sum_{f=160}^{5000} L_{sij}(f)/16$$

***Equation 21***

b) Calculate the 95% confidence interval for Ls(avg) according to equation #22,

$$\Delta L_s(avg) = \frac{1.96}{\sqrt{mn}} \sqrt{\frac{1}{mn-1} \sum_{i=1}^{n} \sum_{j=1}^{m} \left(L_{sij}(avg) - L_s(avg)\right)^2}$$

***Equation 22***

If the integrating microphone method was used, determine an approximate estimate of the 95% confidence interval for the source room average according to the following.

a) For each measurement of source room level for source position i, calculate the average over frequency Lsi(avg) equation #23,

$$L_{si}(avg) = \sum_{f=160}^{5000} L_{si}(f)/16$$

***Equation 23***

b) Estimate the 95% confidence interval for Ls(avg) according to equation #24,

$$\Delta L_s(avg) \approx \frac{1.96}{\sqrt{n}} \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} \left(L_{si}(avg) - L_s(avg)\right)^2}$$

***Equation 24***

This is equivalent to assuming a large number of receiver positions were used.

## 10.2. Received Levels

For each receiving point, calculate the frequency averaged received level Lri(avg) for source position i according to equation #25,

$$L_{ri}(avg) = \sum_{f=160}^{5000} L_{ri}(f)/16$$

***Equation 25***

Calculate the 95% confidence interval for Lr(avg) according to equation #26,

$$\Delta L_r(avg) \approx \frac{1.96}{\sqrt{n}} \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} \left(L_{ri}(avg) - L_r(avg)\right)^2}$$

***Equation 26***

### 10.3. Level Differences

For each receiving point, calculate the 95% confidence interval for LD(avg) using equation #27,

$$\Delta LD(avg) = \sqrt{[\Delta L_s(avg)]^2 + [\Delta L_r(avg)]^2}$$

***Equation 27***

### 10.4. Background Noise Levels

For each receiving point, calculate the frequency averaged background level Lni(avg) for source position i according to equation #28,

$$L_{ni}(avg) = \sum_{f=160}^{5000} L_{ni}(f)/16$$

***Equation 28***

Calculate the 95% confidence interval for Ln(avg) according to equation #29,

$$\Delta L_n(avg) \approx \frac{1.96}{\sqrt{n}} \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} \left(L_{ni}(avg) - L_n(avg)\right)^2}$$

***Equation 29***

### 10.5. SPC

For each receiving point, calculate the 95% confidence interval for SPC using equation #30,

$$\Delta SPC = \sqrt{[\Delta L_n(avg)]^2 + [\Delta LD(avg)]^2}$$

***Equation 30***

## 11. SPC Testing During the Construction Phase

Projects requiring specific values of SPC can vary considerably in terms of scale and construction schedule, from a single meeting room built over a few of months to a building full of offices requiring high speech privacy built over a couple of years. SPC testing during the construction phase when drop ceilings might not be in place or other finishes completed, and HVAC systems not powered up, poses particular difficulties in terms of determining whether SPC results meet expectations. If one chooses to perform SPC testing only in fully finished spaces, then that choice makes it difficult to remediate any problems, as finishes have to be removed to gain access to wall/ceiling junctions, ceiling tiles may need to be removed, and in some cases wall sections may possibly need rebuilding, etc.

During the construction phase, since the noise level is unknown with HVAC systems not yet turned on, one cannot determine a value for SPC since one cannot determine the noise level which is an essential part of the SPC test. Without the final noise level, one has the choice to test only for either the TL(avg) sound transmission loss part of SPC, or to test for the more conventional metric, Sound Transmission Class (STC). STC testing is not in any way equivalent to SPC testing in terms of determining speech privacy, but a good STC result will often correlate well with a good SPC result, and STC testing can be used to determine if faults are present before finishes are applied. Given experience in SPC testing in spaces still under construction it has been found that it is often impractical to test for SPC under those conditions. SPC testing without actual background noise data is also difficult to explain to contractors/clients/architects/project managers, as one can only predict what the SPC value might be if the noise turns out to be such and such a value when the building is finished. People prefer definitive answers when they have commissioned tests, and without the actual noise, one cannot give an actual value for SPC that represents the final value.

A test for STC gives a definite answer even during construction with the HVAC off that all parties can relate to independent of background noise, with an indication of what TL(avg) might be. SPC testing can be performed at the end of the construction stage for speech privacy validation. As SPC values depend on the listening locations chosen by the tester, such as near doors or junctions, it is possible for different testers to get different results for the same rooms, which can cause interpretation difficulties during the construction process, due to the common time constraints involved. One can get results more quickly with STC tests during construction since STC testing allows for more repeatable results as the procedure is much less dependent on test locations. During construction one is looking for problems and ways to solve them not only just before the client moves in, but at a point in construction as early as possible. This point is the point where all walls are fully built and sealed, doors installed with hardware and door seals adjusted. But no carpets of ceiling tile need be installed, nor any paint or millwork or other finishes applied. The STC test results can then be related to the expected STC results for the type of construction being tested, and the building team made to understand whether the construction is performing as expected or whether remedial action is required before construction advances further.

The best scenario to insure a high SPC result for a large scale project is to build and test a mock-up for both SPC and STC. Once the required SPC results have been obtained for the mock-up, one can proceed to do STC tests of the mock-up and then use those STC results as a good indicator for the expected SPC result. Then we could easily obtain STC results during the construction phase and have a very good idea of what the SPC would end up being. Mock-ups are not the norm of course, but a poor or lower than expected STC will usually indicate a poor TL(avg) and is thus a good diagnostic tool during the construction phase. Then once everything is finished, one can proceed to SPC testing.

# 12. References and Source Documents

- Speech Security: A Best Practice Guide, PSPC, RPB, March 2002
- Government of Canada Workplace Fit-up Standards (GCWFUS), PSPC, RPS, May2019
- PSPC, National Project Management System, (web link)
- MD 15000 - 2012 Mechanical Environmental Standards for Federal Office Buildings.
- Security Guide: New Construction to Provide Speech Privacy. SSB/SG12, (August, 1988).
- RCMP, "Guide to the Application of Physical Security Zones", G1-026, September 2005,https://www.rcmp-grc.gc.ca/physec-secmat/pubs/index-eng.htm

The following list identifies NMS Sections that contain direct reference to construction materials and methods that influence acoustical performance: (web link)

- 07 21 13 – BOARD INSULATION. Covers various forms of board insulation and their installation including perimeter foundation, cavity wall and roof
- 07 84 00 – FIRE STOPPING
- 07 92 00 - JOINT SEALANTS
- 08 11 19 - STAINLESS STEEL DOORS AND FRAMES. This section includes information on how steel doors and frames are to be installed, and includes information on preparation for acoustic seals. Other acoustic detailing requirements can also be included
- 08 14 16 - FLUSH WOOD DOORS. Comments as per the steel door section
- 08 35.13.13 – ACCORDION FOLDING DOORS. Includes folding doors (face, core and hinges), track and hanger assembly, hardware and finishes. Covers acoustical rated doors
- 08 35.13.33 – PANEL FOLDING DOORS. Includes folding doors (face, core and hinges), track and hanger assembly, hardware and finishes. Covers acoustical rated doors
- 08 80 50 - GLAZING
- 09 21 16 - GYPSUM BOARD ASSEMBLIES. Includes information on the types of GWB (fire etc.) and how the materials are to be applied including caulk, joint locations, maximum gap size etc.
- 09 22 16 - NON-STRUCTURAL METAL FRAMING. Includes information on the installation of framing including resilient channels, caulk and other acoustic details
- 09 51 13 – ACOUSTICAL PANEL CEILINGS. Acoustical panel ceilings consisting of acoustical lay-in panels installed in a suspended grid system
- 09 58 00 – INTEGRATED CEILING ASSEMBLIES. Suspended ceiling system that incorporates items such as acoustical, lighting, fire protection, etc.
- 09 80 00 - ACOUSTIC TREATMENT. Covers loose fill, spray-on, batt acoustical products and acoustic units including demountable, cementitious wood fibre and cellular glass
- 23 32 48 – ACOUSTICAL AIR PLENUMS. Utilizing performance requirements, select products for absorption and insulating media, silencers, and acoustic plenums. Covers installation and field quality control

- 23 33 46 – FLEXIBLE DUCTS. Covers a variety of flexible ducts including metallic and non-metallic, insulated and non-insulated, acoustic insulated (medium and high pressure).
- E2020 – MOVABLE FURNISHINGS. Contains free-standing component system furniture,

specifically furniture for workstations including acoustical panels, desk and table components, lateral and vertical file systems, steel stationary storage cabinets and seating systems

- "Gypsum Board Walls: Transmission Loss Data", R.E. Halliwell, T.R.T. Nightingale, A.C.C. Warnock, and J.A. Birta.NRC-IRC Internal Report IR-761, (March, 1998).
  (Note: This reference provides transmission loss data that can be used to calculateTL(avg) values), https://doi.org/10.4224/20331556
- "Sound Transmission Through Building Components", J.D. Quirt,Proceedings Building Science Insight '85 (1985)
- "Building Acoustics in Practice", A.C.C. Warnock, Proceedings Building Science Insight '85 (1985)
- "Transmission through Concrete Block Walls", A.C.C. Warnock, Construction Technology Update 13 (May, 1998)
- "Developments in Noise Control (in buildings), A.C.C. Warnock, Proceedings of Building Science Insight '90 (1990)
- "Factors Affecting Sound Transmission Loss", A. C. C. Warnock, NRC-IRC CBD-239 (July 1985), https://doi.org/10.4224/20328703
- "Measures for assessing architectural speech security (privacy) of closed offices and meeting rooms", B.N. Gover, and J.S. Bradley, J. Acoust. Soc. Am. 116 (6) 3480-3490 2004). https://asa.scitation.org/doi/10.1121/1.1810300
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- Bradley, J.S.; Gover, B.N., "Validation of Architectural Speech Security Results", Research Report, Institute for Research in Construction, National Research CouncilCanada, March 2006. (IRC-RR-221). http://www.nrc-cnrc.gc.ca/obj/irc/doc/pubs/rr/rr221/rr221.pdf
- Bradley, J.S.; Gover, B.N., "Measurement of Sound Transmission from Meeting Rooms", Research Report, Institute for Research in Construction, National ResearchCouncil Canada, March 2006. (IRC-RR-220) http://www.nrccnrc.gc.ca/obj/irc/doc/pubs/rr/rr220/rr220.pdf
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- The American Society of Heating, Refrigeration and Air Conditioning Engineers; "2019 Handbook on HVAC Applications", Chapter 48 - Noise and Vibration Control. Thehandbook provides other very useful design information and is an especially good reference work for Mechanical Engineers and Contractors
- ASTM1374-18e1, "Standard Guide for Open Office Acoustics and Applicable ASTM Standards" ASTM International, West Conshohocken, PA, USA (2010)
- ASTM E2638-10-R17 Edition, "Standard test method for objective measurement of the speech privacy provided by a closed room", ASTM International, West Conshohocken, PA, USA (2010)
- ASTM E336-19a, "Standard Test Method for Measurement of Airborne Sound Attenuation
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# Promulgation

**Reviewed and recommended for approval.**

I have reviewed and hereby recommend, GCPSG-017 (2024) – Special Discussion Area Construction Guide, for approval.

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I hereby approve GCPSG-017 (2024) – Special Discussion Area Construction Guide.

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