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Office Partitions: Acoustical Requirements for Design and Construction

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Please note

Acoustical isolation between offices must often be such that transmitted speech is inaudible or at least unintelligible. Among the factors that determine degree of privacy are level of background noise, transmission losses of the partition separating two offices, loudest level of speech used in either office, area of partition common to both offices, and furnishings in each.

Building elements designed to reduce sound transmission are currently rated using the Sound Transmission Class (STC)[1] The STC required to provide privacy between offices may be related to the factors listed above by the expression.

$STC \geq 87 - B + 10 \log S/A_S A_R$ (1)
where

B = A-weighted background noise level in decibels (dB) in room to be protected,

S = area of part of partition common to both rooms in square metres,

A_S= absorption in metric sabins in office considered to be source of speech,

A_R= absorption in metric sabins in room receiving speech

STC equals the sound transmission class of the whole partition assembly, including doors or other components. The equation assumes normal average and peak voice levels. Together with the privacy requirement, these lead to the number 87. If inaudibility is required, the figure rises to 92.

The total absorption A_S or A_R in a furnished office may be estimated, approximately, by assuming that it is about 80 per cent of the floor area. If Noise Reduction Coefficient (NRC) data are available for the major surfaces in the room, absorption may he more accurately obtained by multiplying the area of each surface by its NRC value and summing the products.

Typical Office Environment

All office accommodations are very similar from the standpoint of acoustics. It is possible, therefore, to construct tables to simplify the task of the designer. Table I identifies some types of occupancy and associates with them typical values for speech level, recommended maximum acceptable background noise level, floor area and absorption. Applying these data in equation 1 results in the figures shown in Table II, which gives the partition STC values necessary for confidential privacy between pairs of occupancies. They take account of the variations in voice level given in Table I. Equation 1 does not apply for a partition separating closed and landscaped offices. Appropriate values for this have been inserted in Table II.

Table I. Typical Office Accommodation

Occupancy	Floor Area (m^2)	Partition Area (m^2)	Total Absorption (m^2)	Maximum Acceptable Background Noise (dB A)	Speech Level Above Normal Conversational Speech
A Large conference room	55	18	44	35	+ 10*
B Small conference room, senior executive office	35	14	28	40	+ 5
C Small office	20	10	16	45	0
D Landscaped office	very large	--	--	50	0
E Locker rooms and corridors	30	13	3	55	+ 5

* Add 5 dB when electronic speech reinforcement or audio-visual aids are used

For a pair of different occupancies, for example a Type A occupancy that shares a common partition with a Type E occupancy, the greater of the two STC values from Table II should be used to provide adequate protection in both directions so that occupants will have freedom from intrusive speech as well as freedom from being overheard. The values in Table II may be amended as follows:

Table II. STC Value Required to Provide Confidential Privacy Between Occupancies of Table I

Source of intruding speech		A*	B	C	D	E
Room receiving speech	A	42	37	34	45	47
	B	38	35	31	40	44
	C	34	31	28	35	40

D	45	40	35	--	--
E	32	29	25	--	38

* Increase column values by 5 dB when electronic speech reinforcement or audio aids are used.

1. If the background noise level in the room receiving the speech is known to be less than the value given in Table I, the appropriate design STC in Table II should be increased by the difference in background levels. Similarly, if the background noise level is known to be greater, then the design STC may be reduced, although it is much better to take steps to reduce background noise. Otherwise local communication in the office might suffer.
2. If speech is required to be inaudible, STC values should be increased by 5.
3. Where an electronic speech reinforcing system or any type of audio-visual system is used in a conference room, an extra 5 dB should be added to the STC in Table II or to the STC calculated from equation 1.

If it is thought that the situation is not adequately described by the data in Table I, equation 1 may be used.

Example: Consider a large conference room 8 by 10 by 2.5 m sharing a strip of wall 1 by 2.5 m with an executive office 8 by 5 by 2.5 m. A loudspeaker system is installed in the conference room. Here the area S is smaller than that in Table I.

1. With the conference room as source (from Table I):

background in office B = 40 dB (A)
Taking absorption as 80 per cent of floor area, equation 1 becomes

$$STC = 87 - 40 = 10 \log[2.5/(64 \times 32)]$$
$$= 18 \text{ for normal voice level}$$

Speech level = 10 dB above normal + 5 dB for loudspeaker system

$$STC >= 18 + 15 = 33$$

2. With the executive office as source (from Table 1):

B = 35 dB(A) for conference room $STC \geq 87 - 35 + 10 \log[2.5/(64 \times 32)]$
$= 23$ for conversational speech

Practical Installations

Partitions and Ceilings

When a partition is tested in the laboratory it is set carefully into a test opening and any small peripheral gaps are caulked. This is very important, for if a partition is to achieve its maximum rating, small air leaks must be carefully sealed. Sound energy will always seek out the easiest path through or round a partition, and performance will be severely downgraded unless all weak elements are identified and strengthened.

A sound leak amounting to one-tenth of one per cent of a partition area will limit the effective STC to about 30, whether the basic partition is rated at STC 40 or STC 60. In a wall of area 10 m² such a gap would have an area of 10 cm². It would be quite obvious as a square or round hole, but a crack 1 mm wide by 1 m long at the top of the wall is just as detrimental and can often exist unobserved where caulking has been omitted. Office installations are unavoidably more complex than those in the laboratory, but unless efforts are made to duplicate the laboratory installation then performance will not be duplicated. Thus, the best way to achieve good acoustical performance is to construct a wall that is complete from floor slab to floor slab and caulked around the periphery.

When a wall is complete and suspended ceilings are used, they can be of any convenient type, for they are not factors in determining the isolation between adjacent offices. Services in the plenum above suspended ceilings can be routed to and from the office via the corridor.

This avoids any holes in the separating wall for ducting, conduits, etc., since these would provide easy transmission paths for sound. For conduit and other fairly heavy or small-diameter pipes this arrangement is not strictly necessary so long as the holes are filled to restore the integrity of the walls. Ductwork connecting offices can act as a speaking tube and all privacy between them may be lost. To reduce this effect to acceptable levels glass fibre lined bends should be introduced into the duct run to provide some attenuation. Even where the ductwork is routed via main trunks in the corridor, it is still advisable to use duct liner.

This method of construction represents the ideal, and where STC values higher than, say, 45 are needed it should be used. In practice, however, offices are often constructed with a completed "lay-in" ceiling system and plenum with all necessary services installed. Partitions are erected as needed to abut the under side of the suspended ceiling and a quite different situation results. Sound may now penetrate the ceiling to the plenum space and reach adjacent offices by this route. The transmission losses for the ceiling system are therefore of importance.

Sound transmission losses for sound passing through a single ceiling layer may be measured by means of an ASTM standard procedure that gives an STC value.[1]Manufacturers of acoustical ceiling boards often use a different test procedure where sound travels from a source room, through the ceiling into a plenum and down through the ceiling again into an adjacent room. This results in a different rating, the Ceiling Attenuation Class (CAC). To maintain the over-all performance of a partition-ceiling system the published CAC should be 6 dB greater than the STC specified by equation 1 or Table II. The area S, in this case, includes the cross-sectional area of the plenum. The equivalent minimum single-transmission STC for the ceiling should be one-half of the STC specified for the system.

Transmission through ceilings is normally measured without the many penetrations necessary to provide light, power and ventilation. Clear openings to the plenum space will, of course, reduce the ceiling performance and should be reduced as much as bible or eliminated. Leakage round the edges of ceiling panels, air diffusers and light fixtures can easily be the equivalent of a total open area of 5 per cent, limiting the ceiling to a single-pass transmission loss of 13 dB. This, in turn, limits overall system performance to about 31 dB, assuming a perfect wall. A wall with finite STC rating will reduce over-all performance further.

As poor construction practice can limit the field performance of office partitions, the following points should be observed.

1. Partitions should be mounted and caulked on the bare floor, not the carpet, and should abut acoustically effective partitions round the periphery; otherwise sound may circumvent the partition by way of alternative paths. This situation is similar to that of the ceiling partition junction.
2. Where the partition extends only to the under side of the ceiling, the junction must be properly sealed.
3. Continuous cavities such as heating units, light troffers, back-to-back power outlets, and short runs of straight unlined ductwork should be avoided.

If problems arise, all these points should be checked. If, in an open plenum system, more attenuation is necessary in the plenum path, the gap between the top of the wall and the ceiling slab may be blocked with some easily worked board material such as wood fibreboard, gypsum board, plywood or sheet lead. If the gap can be reduced to one-tenth of its former value, the attenuation for the plenum path will be increased by about 10 dB. If blocking cannot be used, then the attenuation in the plenum path can be increased by a few decibels by laying a couple of inches of glass fibre batt, one layer of board and another layer of glass fibre on top of the ceiling panels. This sandwich should extend for a metre or so on either side of the wall. The procedure is not recommended for new construction but only as a possible improvement for an already existing troublesome situation. These measures will, of course, be effective only if all other sound leaks have been stopped.

Often a large hole that permits the passage of several pipes must be sealed to maintain partition performance. Fitting a board material round several pipes is difficult and a more effective method is to use plaster. It can be applied and built up round some suitable supporting material.

Doors and Windows

In some cases it may be necessary to provide both privacy between offices and a connecting door or window, or both; for example, for a translator's booth. This can be a problem because typical doors and windows have quite low STC values. In addition, because doors must be operable, the sealing around the edges becomes extremely important.

The simplest method of maintaining over-all performance when combining components is to require that all have the same STC value. This can be quite expensive, however, if the design requirement is STC 45. Few readily available doors have such high ratings. Table III may be used to ease the requirements on the weaker components by a compensating increase in the major component.

(a) Design requirement = STC 35
Door area/partition area = 0.19
(from Table 3, area 0.18 to 0. 22)
Wall STC = 35 + 2 = 37
Door STC = 35 - 4 = 31

For two or more subsidiary components, their areas may be summed.

(b) Design requirement = STC 40
Door 15 per cent of total area
Observation window 25 per cent of total area

Total area of subsidiary components is 0.4 of total area.

(from Table 3)
Wall STC = 40 + 1 = 41
Window/door STC = 40 - 1 = 39

The STC 39 requirement for the door is difficult to meet and the problem can be reworked by considering the window as part of the wall as follows:

Door area = 0.15 of total area (from Table 3)
Door STC = 40 - 5 = 35
Wall and window STC = 40 + 3 = 43

This gives a slightly less stringent requirement for the door.

Table III. Corrections to be Added to Design STC to Obtain Component STC

(Area of smaller component/total area of partition)									
Less than	0.07 to	0.09 to	0.11 to	0.14 to	0.18 to	0.22 to	0.28 to	0.35 to	0.45 to

	0.07	0.09	0.11	0.14	0.18	0.22	0.28	0.35	0.45	0.56
Correction for Wall	3	3	3	3	3	2	2	1	1	0
Correction for Component	-9	-8	-7	-6	-5	-4	-3	-2	-1	0

References

1. ASTM E413-73. Determination of Sound Transmission Class.
2. ASTM E-90-75. Laboratory measurement of airborne sound transmission loss of building partitions.