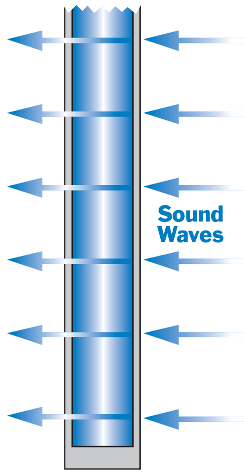
The Mechanics of Sound Transmission

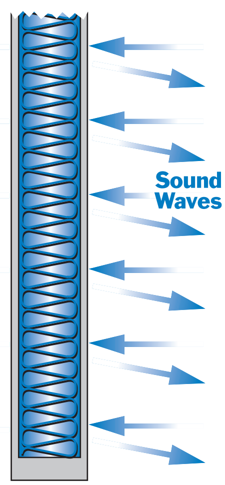
When sound comes in contact with a barrier, such as a door, some of the energy from the vibrations transfers to the door. The resulting vibrations in the door itself then set the air in motion on the other side of the door—creating more sound vibrations.



without sound core

The mass, damping and stiffness of the barrier determine its resistance to the passage of sound waves. The greater the ***mass***, the less sound is transmitted through the barrier. Mass is especially important for blocking sound at lower frequencies.

Sound vibrations can be reduced using ***damping*** materials, which are typically limp-mass materials. Damping material is sometimes used as core material in doors designed to provide the highest levels of sound control.

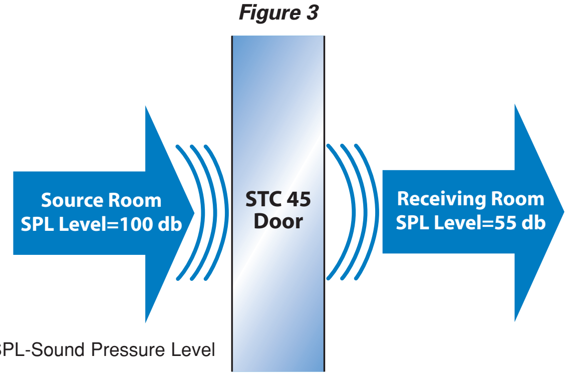


with sound core

The ***stiffness*** of the barrier is also a factor in sound transmission. Although more flexible barriers transmit less sound, for practical reasons sound-control doors are generally made from very dense, stiff materials. Unless they contain inner layers of damping material, some sound will inevitably be transmitted through the door. On the other hand, those dense, stiff materials also work well at reflecting sound back to its source. Most acoustical doors are constructed of wood or steel with stiffness and barrier batts added to any hollow cavity inside the door.

Naturally, the effectiveness of sound-control doors varies with different combinations of materials. With so many variables, how can we determine how well a particular door will block sound? And how can we compare the effectiveness of different doors?

Figure 3



Sound Transmission Loss (TL)

A door's ability to reduce noise is called its sound transmission loss (TL) effectiveness. TL is a value given in decibels, which is determined by measuring sound pressure levels at a given certain frequency in the source and receiving rooms. The calculation also factors in the area of the partition shared by the two rooms, and adjusts for the receiving room's acoustic "liveness" (known as "reverberation time"). The adjusted difference between the two levels is the TL of the door. The higher the TL, the better the result.

Leaving out the adjustments to illustrate using a simple example, if the source room measurement is 100 dB at 300 Hz and the receiving room measurement is 60 dB at 300 Hz, the TL of the barrier is 40 dB at 300 Hz.

TL is measured in test laboratories according to ASTM E90 "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions."

Sound Transmission Class (STC)

TL measurements for a door are taken across a range of frequencies, which makes it difficult to compare the effectiveness of different doors. ***Sound transmission class*** (STC) ratings solve that problem by giving a single value to acoustical performance for a door. STC is determined by a weighted average of TL values taken over 16 frequencies, which are fitted to a curve in a method defined by the ASTM E413 Classification Standard for Rating Sound Insulation. The higher the STC value, the better the rating—and the better the performance, as shown in Figure 2.

SOUND TRANSMISSION CLASS (STC) TABLE

STC	PERFORMANCE	DESCRIPTION
50 -60	Excellent	Loud sounds heard faintly or not at all.
40 - 50	Very Good but not understood.	Loud speech heard faintly
35 - 40	Good	Loud speech heard but hardly intelligible.
30 - 35	Fair	Loud speech understood fairly well.
25 - 30	Poor	Normal speech understood easily and distinctly.
20 - 25	Very Poor	Low speech audible.

Figure 2

STC values are used to define the performance requirements for achieving a specified reduction in sound transmission from a source room to a receiving room. The STC rating of an installed door also determines how much noise reduction is possible between a given source room and receiving room. (See Figure 3)

The Vital Role of Acoustical Gasketing

Gasketing's importance derives from a fundamental property of sound: Sound waves travel through any opening with very little loss. While the amount of air flowing through a gap increases in proportion with the size of the gap, the size of the gap in a sound barrier does not matter. A tiny hole transmits almost as much sound as a much larger gap. (See Figures 5 and 6) For example, a one-square inch hole in 100 square feet of gypsum board partition can transmit as much sound as the rest of the partition.

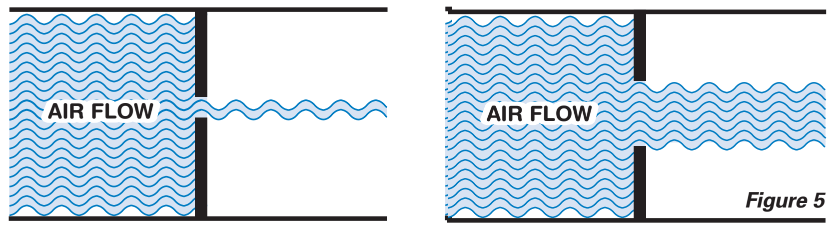


Figure 5

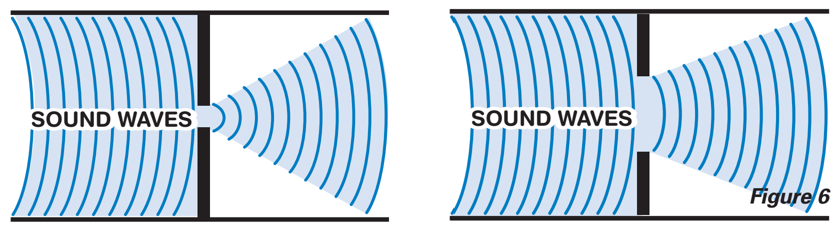
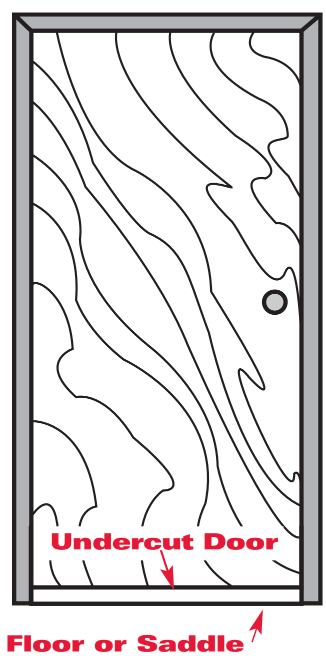


Figure 6

Because of this phenomenon, any unsealed gaps and clearances in door assemblies effectively cancel out the noise reduction benefits of sound doors. For example, one-eighth-inch clearances around the edges reduce the effective rating of an STC-52 door to 21–guaranteeing very poor acoustical performance and a great deal of discontent. The performance loss is especially serious at medium to high frequencies.



For acoustical gasketing to be effective at blocking sound, the seals around the head, jamb and sill must be complete, uninterrupted and air-tight throughout the service life of the door. For uninterrupted contact, the gasketing must be installed all on the same side of the door and frame. Performance also depends on good surface contact between the gasket and door edge or frame, which can usually be achieved using compression seals.

However, gaps caused by imperfect door alignment are a common problem in newly installed gasketing and can also surface later on as buildings shift and settle and doors cycle through changes in temperature and humidity. For consistent performance over time, the most advanced acoustical gasketing is designed with adjustable features to restore a sound-tight seal when clearances increase for any reason.

As with the door itself, the mass of the sealing material used in acoustical gasketing is a major factor in achieving a high STC rating. Combining complementary materials can also provide better performance. In addition, air trapped in a "sound lock" between a pair of doors, or between layered sets of seals in a gasket, is one of the best sound absorbers.

Ultimately, the quality of the acoustical gasketing is the biggest factor in overcoming any installation deficiencies and determining how close the actual sound performance of an assembly will come to the published rating of the door. Improving the quality of the gasketing brings the STC value of the functioning opening closer to its theoretical maximum.

It is important to understand that STC values are not proportionate units of measurement. To continue reducing sound transmission–that is, to achieve increasingly higher levels of sound control–each 10 dB increment requires ten times as much improvement as the one before. While door openings rated in the range from STC 30 to STC 40 are common, achieving STC 50 and higher ratings is extraordinarily difficult.