Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

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This standard has been approved for use by agencies of the U.S. Department of Defense.

INTRODUCTION

This test method is part of a set for evaluating the sound-insulating properties of building elements. It is designed to measure the transmission of sound through a partition or partition element in a laboratory. Others in the set cover the measurement of sound isolation in buildings (Test Method E336), the laboratory measurement of impact sound transmission through floors (Test Method E492), the measurement of impact sound transmission in buildings (Test Method E1007), the measurement of sound transmission through building facades and facade elements (Guide E966), the measurement of sound transmission through a common plenum between two rooms (Test Method E1414), a quick method for the determination of airborne sound isolation in multiunit buildings (Practice E597), and the measurement of sound transmission through door panels and systems (Test Method E1425).

1. Scope

1.1 This test method covers the laboratory measurement of airborne sound transmission loss of building partitions such as walls of all kinds, operable partitions, floor-ceiling assemblies, doors, windows, roofs, panels, and other space-dividing elements.

1.2 Laboratories are designed so the test specimen constitutes the primary sound transmission path between the two test rooms and so approximately diffuse sound fields exist in the rooms.

1.3 Laboratory Accreditation—The requirements for accrediting a laboratory for performing this test method are given in Annex A4.

1.4 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

2.1 ASTM Standards:

C423 Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
C634 Terminology Relating to Building and Environmental Acoustics
E336 Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings
E413 Classification for Rating Sound Insulation
E492 Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine
E966 Guide for Field Measurements of Airborne Sound Attenuation of Building Facades and Facade Elements
E1111 Test Method for Measuring the Interzone Attenuation of Open Office Components
E1289 Specification for Reference Specimen for Sound Transmission Loss
E1332 Classification for Rating Outdoor-Indoor Sound Attenuation
E1414 Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum
E1425 Practice for Determining the Acoustical Performance of Windows, Doors, Skylight, and Glazed Wall Systems
E2235 Test Method for Determination of Decay Rates for Use in Sound Insulation Test Methods

2.2 ANSI Standards:
S1.6-1984 (R2006) American National Standard Preferred Frequencies, Frequency Levels, and Band Numbers for Acoustical Measurement
S1.10 Pressure Calibration of Laboratory Standard Pressure Microphones
S1.11 Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters
S1.40 Specifications and Verification Procedures for Sound Calibrators
S1.43 Specifications for Integrating-Averaging Sound-Level Meters
S12.51 Acoustics—Determination of Sound Power Levels of Noise Sources Using Sound Pressure—Precision Methods for Reverberation Rooms

2.3 ISO Standards:
ISO 717 Rating of Sound Insulation for Dwellings
ISO 3741 Acoustics—Determination of Sound Power Level of Noise Sources—Precision Methods for Reverberation Rooms

2.4 IEC Standards:
IEC 60942 Electroacoustics—Sound Calibrators
IEC 61672 Electroacoustics—Sound Level Meters—Part 1: Specifications

3. Terminology

3.1 The following terms used in this test method have specific meanings that are defined in Terminology C634.

<table>
<thead>
<tr>
<th>acoustical barrier</th>
<th>reverberation room</th>
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<tbody>
<tr>
<td>airborne sound</td>
<td>sound attenuation</td>
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<tr>
<td>average sound pressure level</td>
<td>sound energy</td>
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<tr>
<td>background noise</td>
<td>sound insulation</td>
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<tr>
<td>damp</td>
<td>sound level</td>
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<tr>
<td>decay rate</td>
<td>sound power</td>
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<td>decibel</td>
<td>sound pressure</td>
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<tr>
<td>diffraction</td>
<td>sound pressure level</td>
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<tr>
<td>diffuse sound field</td>
<td>sound transmission level</td>
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<tr>
<td>direct sound field</td>
<td>sound transmission class</td>
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<tr>
<td>flanking transmission level</td>
<td>sound transmission coefficient</td>
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<tr>
<td>octave band</td>
<td>sound transmission loss</td>
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<tr>
<td>pink noise</td>
<td>source room</td>
</tr>
<tr>
<td>receiving room</td>
<td>unit</td>
</tr>
</tbody>
</table>

3.1.1 For the purposes of this test method, transmission loss is operationally defined as the difference in decibels between the average sound pressure levels in the reverberant source and receiving rooms, plus ten times the common logarithm of the ratio of the area of the common partition to the sound absorption in the receiving room (see Eq 5).

\[ TL = 10\log(1/\tau) \]  
\[ \tau = 10^{-\frac{TL}{10}} \]  

4. Summary of Test Method

4.1 Two adjacent reverberation rooms are arranged with an opening between them in which the test partition is installed. Care is taken that the only significant sound transmission path between rooms is by way of the test partition. An approximately diffuse sound field is produced in one room, the source room. Sound incident on the test partition causes it to vibrate and create a sound field in the second room, the receiving room. The space- and time-averaged sound pressure levels in the two rooms are determined. In addition, with the test specimen in place, the sound absorption in the receiving room is determined. The sound pressure levels in the two rooms, the sound absorption in the receiving room and the area of the specimen are used to calculate sound transmission loss as shown in Section 11. Because transmission loss is a function of frequency, measurements are made in a series of frequency bands.

4.2 In theory, it is not important which room is designated as the source and which as the receiving room. In practice, different values of sound transmission loss may be measured when the roles are reversed. To compensate for this, the entire measurement may be repeated with the roles reversed; the source room becomes the receiving room and vice versa. The two sets of transmission loss values are then averaged to produce the final result for the laboratory.

4.3 Additional procedures that may be followed when testing doors are given in Test Method E1425.

5. Significance and Use

5.1 Sound transmission loss as defined in Terminology C634, refers to the response of specimens exposed to a diffuse incident sound field, and this is the test condition approached by this laboratory test method. The test results are therefore most directly relevant to the performance of similar specimens exposed to similar sound fields. They provide, however, a useful general measure of performance for the variety of sound fields to which a partition or element may typically be exposed.

5.2 In laboratories designed to satisfy the requirements of this test method, the intent is that only significant path for sound transmission between the rooms is through the test specimen. This is not generally the case in buildings where there are often many other paths for sounds—flanking sound transmission. Consequently sound ratings obtained using this test method do not relate directly to sound isolation in buildings; they represent an upper limit to what would be measured in a field test.

5.3 This test method is not intended for field tests. Field tests shall be performed according to Test Method E336.

Note 1—Sound transmission coefficient and sound transmission loss are related by either of the two equations:

\[ TL = 10\log(1/\tau) \]  
\[ \tau = 10^{-\frac{TL}{10}} \]  

Note 2—The comparable quantity measured using Test Method E336 is called the apparent sound transmission loss because of the presence of flanking sound transmission.

6. Test Rooms

6.1 The test rooms shall be so constructed and arranged that the test specimen constitutes the only important transmission path between them. Laboratories must investigate their flanking limit and prepare a report as described in Annex A5.

6.2 The spatial variations of sound pressure level measured in the each room shall be such that the precision requirements in Annex A2 are satisfied at all frequencies.

6.3 Volume of Rooms—The minimum volume of each room is 80 m³.

Note 3—See Appendix X1 for recommendations for new construction.

6.4 Room Absorption—The sound absorption in the receiving room should be low to achieve the best possible simulation of the ideal diffuse field condition, and to minimize the region dominated by the direct field of the test specimen. In the frequency range that extends from \( f = \frac{2000}{V^{1/3}} \) to 2000 Hz, the absorption in the receiving room (as furnished with diffusers) should be no greater than:

\[
A = V^{2/3}/3
\]

where:

- \( V \) = the room volume, m³, and
- \( A \) = the sound absorption of the room, m².

6.4.1 For frequencies below \( f = \frac{2000}{V^{1/3}} \), somewhat higher absorption may be desirable to accommodate requirements of other test methods (for example, ISO 3741); in any case, the absorption should be no greater than three times the value given by Eq 3.

Note 4—For frequencies above 2000 Hz, atmospheric absorption may make it impossible to avoid a slightly higher value than that given in Eq 3.

6.5 Unless otherwise specified, the average temperatures in each room during all acoustical measurements shall be in the range 22 ± 5°C and the average relative humidity shall be at least 30%.

6.5.1 When testing specimens with temperature sensitive materials, such as systems that incorporate laminated glass, the average temperature of the specimen and in each room during all acoustical measurements shall be in the range 22 ± 2°C.

Note 5—The sound damping properties of viscoelastic substrates between panels (glass, metal, etc.) and of viscoelastic materials used to mount glass often depend on temperature. This requirement minimizes any effects this has on measured sound transmission loss.

6.6 During the sound pressure level and the corresponding sound absorption measurements, variations in temperature and humidity in the receiving room shall not exceed 3°C and 3% relative humidity respectively. Temperature and humidity shall be measured and recorded as often as necessary to ensure compliance.

6.6.1 If a relative humidity of at least 30% can not be maintained in the receiving room, users of the test method shall verify by calculation that changes in the 10 \( \log A_1 \) term (see 11.1) due to changes in temperature and humidity do not exceed 0.5 dB.

Note 6—Procedures for calculating air absorption are described in Test Method C423.

7. Test Specimens

7.1 Size and Mounting—Any test specimen that is to typify a wall or floor shall be large enough to include all the essential constructional elements in their normal size, and in a proportion typical of actual use. The minimum dimension (excluding thickness) shall be 2.4 m, except that specimens of doors, office screens, and other smaller building elements shall be their customary size. Preformed panel structures should include at least two complete modules (panels plus edge mounting elements), although single panels can be tested. In all cases the test specimen shall be installed in a manner similar to actual construction, with a careful simulation of normal constraint and sealing conditions at the perimeter and at joints within the field of the specimen. Detailed reporting and installation procedures for particular types of building separation elements are given in Annex A1.

7.2 Office Screens—The minimum area of an office screen specimen shall be 2.3 m². Testing an office screen according to this test method is only appropriate when the property of interest is sound transmission through the main body of the screen. Screens that incorporate electrical raceways may allow sound to pass through easily in this region. Such parts of an office screen shall be included as part of the specimen. For a complete test of the screen as a barrier, including the effects of diffraction and leakage, Test Method E1111 is recommended.

7.3 Operable Door Systems—Measurements may be in accordance with Test Method E1425 to evaluate door systems in the operable and fully sealed state, and to measure the force required to operate the door.

8. Test Signal Sound Sources

8.1 Signal Spectrum—The sound signals used for these tests shall be random noise having a continuous spectrum within each test frequency band.

8.2 Sound Sources—Sound sources shall consist of one or more loudspeakers in an enclosure.

Note 7—Sources should preferably be omnidirectional at all measurement frequencies to excite the sound field in the room as uniformly as possible. Using separate loudspeakers for high and low frequencies will make the system more omnidirectional. Aiming the loudspeakers into corners of the room can reduce the direct field from the loudspeaker system. An approximation to an omnidirectional speaker system can be obtained by mounting an array of loudspeakers on the faces of a polyhedron (cube, octahedron, dodecahedron, etc.). Sources in trihedral corners of the room excite room modes more effectively and laboratory operators may find that this orientation increases the low frequency sound pressure levels in the room.

8.3 Multiple Sound Sources—If a laboratory chooses to use multiple sound sources at different locations in the room simultaneously, they shall be driven by separate random noise generators and amplifiers.

Note 8—Measured values of sound transmission loss, especially at low frequencies, may change significantly when sound source position is changed. Multiple sound sources driven by uncorrelated noise signals have also been found to reduce the spatial variance of sound pressure level in reverberation rooms and thus make it easier to satisfy the requirements of Annex A2.