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Standard Test Method for Determination of Decay Rates for Use in Sound Insulation Test Methods[1]

This standard is issued under the fixed designation E2235; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

This test method is part of a set of methods used to evaluate the sound-insulating properties of building elements. It is intended for use in conjunction with methods for measuring the transmission of sound through a partition or partition element in a laboratory or in a building. These methods include the laboratory measurement of airborne sound transmission loss of building partitions and elements (Test Method E90), 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), and the measurement of sound transmission through a common plenum between two rooms (Test Method E1414).

1. Scope

1.1 This test method covers the measurement of sound decay rate in rooms and the calculation of the sound absorption of the room and its contents. The sound absorption so calculated may be used in calculations in sound insulation test methods.

1.2 The method shall be used only in conjunction with other test methods where the logarithm of the sound absorption is used in formulas. It is not sufficiently precise for use in situations where room sound absorption is to be used without taking logarithms.

1.3 For laboratory measurements of the sound absorption of materials and objects, Test Method C423 should be used.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C423 Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method

C634 Terminology Relating to Building and Environmental Acoustics

E90 Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

E336 Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings

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

E1007 Test Method for Field Measurement of Tapping Machine Impact Sound Transmission Through Floor-Ceiling Assemblies and Associated Support Structures

E1414 Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum

[1] This test method is under the jurisdiction of ASTM Committee E33 on Building and Environmental Acoustics and is the direct responsibility of Subcommittee E33.01 on Sound Absorption.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

2.2 *ANSI Standards:*[3]
S1.4 Specification for Sound-Level Meters
S1.6 Standard Preferred Frequencies, Frequency Levels, and Band Numbers for Acoustical Measurements
S1.11 Specification for Octave-band and Fractional-Octave-Band Analog and Digital Filters

3. Terminology

3.1 Definitions of the acoustical terms used in this test method are given in Terminology C634.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *output interval, Δt;* [T]; s—*of a real-time analyzer*, the time between successive outputs of sound pressure levels during a single decay measurement.

4. Summary of Test Method

4.1 Sound decay rate in rooms is a function of frequency so measurements are made in a series of frequency bands. Bands of random electrical noise are used as signals to drive loudspeakers in the room until the sound pressure level reaches a steady state. When the sound is then turned off, the sound pressure level decays at a rate determined by the sound absorption in the room. The decay rate is measured in each frequency band by measuring the slope of a straight line fitted to the average decay curve. The absorption of the room and its contents is calculated from the Sabine formula:

$$A = 0.921\frac{Vd}{c} \tag{1}$$

where:

A = sound absorption, m^2,
V = volume of reverberation room, m^3,
c = speed of sound, m/s, and
d = decay rate, dB/s.

4.1.1 The speed of sound changes with temperature and it shall be calculated for the conditions existing at the time of test from the equation:

$$c = 20.047\sqrt{273.15+t}\ \text{m/s} \tag{2}$$

where:

t = room temperature, °C.

5. Significance and Use

5.1 Several ASTM test methods to evaluate the sound-insulating properties of building elements require the measurement of room sound absorption as part of the procedure. The room sound absorption in these standards appears in an equation in the form 10 log (x/A), where x is a quantity with the same units as A, m^2. Room sound absorption is calculated from the decay rate using Eq 1.

5.2 The requirements of this standard have been chosen so the uncertainty associated with the measurement of room sound absorption will be acceptably small so long as the logarithm of the absorption is being used in calculations.

5.3 Other test methods should specify explicitly that they make use of this test method.

5.4 Where measurement requirements in the parent standard differ from those given here, the requirements in the parent standard shall be satisfied.

5.5 This test method shall not be used when room sound absorption or decay rate is to be used directly to satisfy some criterion, for example in a room that must not be overly reverberant so speech will be intelligible.

NOTE 1—The uncertainty of the room sound absorption obtained will usually be too high and additional measurements are necessary.

5.6 Any companion standard may specify the use of the procedures in this method for determining whether the decay rates in a room are slow enough to satisfy the requirements of the companion standard. The measured decay rates shall still be used only to calculate the logarithm of the room absorption.

6. Sound Source Requirements

6.1 Sound sources shall be loudspeaker systems driven by power amplifiers.

NOTE 2—Loudspeaker systems should be omnidirectional. In practice, using multiple driver elements to cover different frequency ranges and placing sources in trihedral corners of the room will be adequate.

7. Sound Source Positions

7.1 At least one source position shall be used in the room.

NOTE 3—Where more than one source position is used, decay rate data may be collected for each source position in sequence and then the decay rates averaged. Alternatively, multiple loudspeakers may be activated simultaneously. If this is done, the sound power emitted by the loudspeaker sources should be approximately equal. Separate electronic noise generators and amplifiers for each system are not necessary.

8. Electrical Signal

8.1 The electrical signal fed to each power amplifier shall be a band of random noise with a continuous spectrum covering the frequency range over which measurements are made.

9. Frequency Range

9.1 The frequency range of the measurements shall be that specified in the companion standard for which the measurements are being made.

9.2 *Bandwidth*—For each test band, the overall frequency response of the electrical system, including the filter or filters in the source or microphone systems, shall satisfy the specifications given in ANSI Specification S1.11 for a one-third octave band filter set, Order 3 or higher, Type 1.

NOTE 4—The shape of the filter response curve can influence the minimum decay rate that can be measured. This problem is dealt with by the requirement in 13.5.

10. Microphone Requirements

10.1 A microphone used to measure decay rate shall be omnidirectional with a ±1 dB random-incidence amplitude response within any one-third octave band for all frequencies and sound pressure levels used for decay rate measurements.

11. Microphone Positions

11.1 *Stationary Microphones:*

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.