



Standard Test Method for Measurement of Normal Incidence Sound Transmission of Acoustical Materials Based on the Transfer Matrix Method¹

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1. Scope

1.1 This test method covers the use of a tube, four microphones, and a digital frequency analysis system for the measurement of normal incident transmission loss and other important acoustic properties of materials by determination of the acoustic transfer matrix.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.3 *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:²

C634 Terminology Relating to Building and Environmental Acoustics

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

E1050 Test Method for Impedance and Absorption of Acoustical Materials Using a Tube, Two Microphones and a Digital Frequency Analysis System

2.2 ISO Standards:

ISO 140-3 Acoustics—Measurement of Sound Insulation in Buildings and of Building Elements—Part 3: Laboratory Measurement of Airborne Sound Insulation of Building Elements³

¹ This test method is under the jurisdiction of ASTM Committee E33 on Building and Environmental Acoustics and is the direct responsibility of Subcommittee E33.03 on Sound Transmission.

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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.

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

3. Terminology

3.1 **Definitions**—The acoustical terminology used in this test method is intended to be consistent with the definitions in Terminology C634.

3.1.1 **reference plane**—an arbitrary section, perpendicular to the longitudinal axis of the tube that is used for the origin of linear dimensions. Often it is the upstream (closest to the sound source) face of the specimen but, when specimen surfaces are irregular, it may be any convenient plane near the specimen.

3.1.2 **sound transmission coefficient, τ** —(dimensionless) of a material in a specified frequency band, the fraction of airborne sound power incident on a material that is transmitted by the material and radiated on the other side.

$$\tau = \frac{W_t}{W_i}$$

where:

W_t and W_i = the transmitted and incident sound power.

3.1.3 **sound transmission loss, TL** —of a material in a specified frequency band, ten times the common logarithm of the reciprocal of the sound transmission coefficient. The quantity so obtained is expressed in decibels.

$$TL = 10 \log_{10} \left(\frac{W_i}{W_t} \right) = 10 \log_{10} \left(\frac{1}{\tau} \right)$$

3.1.3.1 **Discussion**—In this standard the symbol TL_n will be applied to sound which impinges at an angle normal to the test specimen, as opposed to an arbitrary or random angle of incidence.

3.2 Symbols:

c = speed of sound, m/s.

ρ = density of air, kg/m³.

f = frequency, hertz, (Hz).

G_{11} , G_{22} , etc. = auto power spectra (autospectrum) of the acoustic pressure signal at microphone locations 1, 2, and so on.

G_{21} , G_{32} , etc. = cross power spectrum (cross spectrum) of the acoustic pressure signals at location 2 relative to location 1, 3 relative to 1, and so on. In general, a complex value.

$\bar{H}_{21}$, $\bar{H}_{31}$, etc. = measured transfer function of the acoustic pressure signals at location 2 relative to location 1, 3 relative to