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Standard Terminology Relating to Building and Environmental Acoustics¹

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INTRODUCTION

In some of the entries, those that are measures of physical quantities, the term is followed by three items: symbol, dimensions, and unit. The symbol, in italics, stands for the magnitude of the quantity in mathematical expressions. The dimensions of a quantity express its measure in terms of three fundamental quantities: M for mass, L for length, and T for time. Speed, for instance, is the quotient obtained when the distance an object moves is divided by the time involved. The dimensions are $[LT^{-1}]$, the negative exponent indicating division. The unit is consistently in SI, Le Système International d'Unités. Those still using the cgs (centimetre-gram-second) or the inchpound system of units are referred for most of the conversion factors to **IEEE/ASTM SI 10**. A few conversion factors are listed in Section 4 of this terminology.

The dimensions of a quantity are the same regardless of the units in which the quantity is measured. Speed has the dimensions $[LT^{-1}]$ whether it is measured in miles per hour, feet per second, or metres per second. Quantities with different dimensions are not the same. Flow resistance and specific flow resistance, for instance, are quantities of different kinds even though the names are similar. On the other hand, quantities with the same dimensions are not necessarily of the same kind. Sound energy density, for instance, has the same dimensions as sound pressure, $[ML^{-1}T^{-2}]$, but it is not a kind of sound pressure. Nor is absorption with the dimensions $[L^2]$ a kind of area.

1. Scope

1.1 This terminology covers terms and definitions related to environmental acoustics. Only definitions common to two or more standards under the jurisdiction of Committee E33 are listed here. The purpose of this terminology is to promote uniformity of key definitions. Definitions pertinent to only one standard and exceptions to the definitions listed below are contained in the individual standards and should be used when following those standards.

2. Referenced Documents

2.1 ASTM Standards:²

- [C423 Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method](#)
- [C367 Test Methods for Strength Properties of Prefabricated Architectural Acoustical Tile or Lay-In Ceiling Panels](#)
- [C384 Test Method for Impedance and Absorption of Acoustical Materials by Impedance Tube Method](#)
- [C522 Test Method for Airflow Resistance of Acoustical Materials](#)
- [C634 Terminology Relating to Building and Environmental Acoustics](#)
- [C635 Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings](#)
- [C636 Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels](#)
- [C667 Specification for Prefabricated Reflective Insulation Systems for Equipment and Pipe Operating at Temperatures above Ambient Air](#)

¹ This terminology is under the jurisdiction of ASTM Committee E33 on Building and Environmental Acoustics and is the direct responsibility of Subcommittee E33.07 on Definitions and Editorial.

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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.

- C871 Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions
- 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
- E413 Classification for Rating Sound Insulation
- E477 Test Method for Laboratory Measurements of Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers
- E492 Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine
- E497 Practice for Installing Sound-Isolating Lightweight Partitions (Withdrawn 2008)³
- E557 Guide for Architectural Design and Installation Practices for Sound Isolation between Spaces Separated by Operable Partitions
- E596 Test Method for Laboratory Measurement of Noise Reduction of Sound-Isolating Enclosures
- E756 Test Method for Measuring Vibration-Damping Properties of Materials
- E795 Practices for Mounting Test Specimens During Sound Absorption Tests
- E966 Guide for Field Measurements of Airborne Sound Attenuation of Building Facades and Facade Elements
- E989 Classification for Determination of Impact Insulation Class (IIC)
- E1007 Test Method for Field Measurement of Tapping Machine Impact Sound Transmission Through Floor-Ceiling Assemblies and Associated Support Structures
- E1014 Guide for Measurement of Outdoor A-Weighted Sound Levels
- E1042 Classification for Acoustically Absorptive Materials Applied by Trowel or Spray
- E1050 Test Method for Impedance and Absorption of Acoustical Materials Using a Tube, Two Microphones and a Digital Frequency Analysis System
- E1110 Classification for Determination of Articulation Class
- E1111 Test Method for Measuring the Interzone Attenuation of Open Office Components
- E1123 Practices for Mounting Test Specimens for Sound Transmission Loss Testing of Naval and Marine Ship Bulkhead Treatment Materials
- E1129/E1129M Specification for Thermocouple Connectors
- E1124 Test Method for Field Measurement of Sound Power Level by the Two-Surface Method
- E1130 Test Method for Objective Measurement of Speech Privacy in Open Plan Spaces Using Articulation Index
- E1179 Specification for Sound Sources Used for Testing Open Office Components and Systems
- E1222 Test Method for Laboratory Measurement of the Insertion Loss of Pipe Lagging Systems
- E1264 Classification for Acoustical Ceiling Products
- E1265 Test Method for Measuring Insertion Loss of Pneumatic Exhaust Silencers
- E1289 Specification for Reference Specimen for Sound Transmission Loss
- E1332 Classification for Rating Outdoor-Indoor Sound Attenuation
- E1374 Guide for Open Office Acoustics and Applicable ASTM Standards
- E1408 Test Method for Laboratory Measurement of the Sound Transmission Loss of Door Panels and Door Systems (Withdrawn 2009)³
- E1414 Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum
- E1433 Guide for Selection of Standards on Environmental Acoustics (Withdrawn 2010)³
- E1503 Test Method for Conducting Outdoor Sound Measurements Using a Digital Statistical Sound Analysis System
- E1573 Test Method for Evaluating Masking Sound in Open Offices Using A-Weighted and One-Third Octave Band Sound Pressure Levels
- E1574 Test Method for Measurement of Sound in Residential Spaces
- E1686 Guide for Applying Environmental Noise Measurement Methods and Criteria
- E1704 Guide for Specifying Acoustical Performance of Sound-Isolating Enclosures
- E1779 Guide for Preparing a Measurement Plan for Conducting Outdoor Sound Measurements (Withdrawn 2012)³
- E1780 Guide for Measuring Outdoor Sound Received from a Nearby Fixed Source
- E2179 Test Method for Laboratory Measurement of the Effectiveness of Floor Coverings in Reducing Impact Sound Transmission Through Concrete Floors
- E2202 Practice for Measurement of Equipment-Generated Continuous Noise for Assessment of Health Hazards
- E2235 Test Method for Determination of Decay Rates for Use in Sound Insulation Test Methods
- E2249 Test Method for Laboratory Measurement of Airborne Transmission Loss of Building Partitions and Elements Using Sound Intensity
- E2459 Guide for Measurement of In-Duct Sound Pressure Levels from Large Industrial Gas Turbines and Fans

³ The last approved version of this historical standard is referenced on www.astm.org.

E2638 Test Method for Objective Measurement of the Speech Privacy Provided by a Closed Room
 IEEE/ ASTM SI 10 Standard for Use of the International System of Units (SI): The Modern Metric System

2.2 ANSI Standard:

ANSI S1.4 Specification for Sound Level Meters⁴

ANSI S1.6 Preferred Frequencies, Frequency Levels, and Band Numbers for Acoustical Measurements

ANSI S1.11 Octave-Band and Fractional Octave-Band Analog and Digital Filters, Specifications for

3. Terminology

3.1 If the term sought by the user cannot be found in 3.2, it may be found in 4.1.

3.2 Definitions:

acoustic impedance, $Z \equiv R + jX$; [ML⁻⁴T⁻¹]; mks acoustic ohm (Pa·s/m³)—*of a surface, for a given frequency*, the complex quotient obtained when the sound pressure averaged over the surface is divided by the volume velocity through the surface. The real and imaginary components are called, respectively, **acoustic resistance** and **acoustic reactance**.

acoustical barrier—contiguous objects such as solid walls, buildings, or earthen berms that substantially block the direct path of sound between a source and receiver, and which, if they have an open edge or edges allowing diffraction around them, are sufficiently wide and high to cause significant reduction of the sound traveling from the source to the receiver.

acoustical material—any material considered in terms of its acoustical properties. *Commonly and especially*, a material designed to absorb sound.

admittance ratio, $ypc \equiv gpc - j bpc$; [dimensionless]—the reciprocal of the impedance ratio. The real and imaginary components are called, respectively, **conductance ratio** and **susceptance ratio**.

airborne sound—sound that arrives at the point of interest, such as one side of a partition, by propagation through air.

airflow resistance, R ; [ML⁻⁴T⁻¹]; mks acoustic ohm (Pa·s/m³)—the quotient of the air pressure difference across a specimen divided by the volume velocity of airflow through the specimen. The pressure difference and the volume velocity may be either steady or alternating.

airflow resistivity, r_o ; [ML⁻³T⁻¹]; mks rayl/m (Pa·s/m²)—*of a homogeneous material*, the quotient of its specific airflow resistance divided by its thickness.

ambient noise—the composite of airborne sound from many sources near and far associated with a given environment. No particular sound is singled out for interest.

arithmetic mean sound pressure level—*of several related sound pressure levels measured at different positions or different times, or both, in a specified frequency band*, the sum of the sound pressure levels divided by the number of levels.

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

DISCUSSION—

The arithmetic mean sound pressure level is sometimes used to approximate the **average sound pressure level**. The accuracy of this approximation depends upon the range of sound pressure levels.

average sound pressure level—*of several related sound pressure levels measured at different positions or different times, or both, in a specified frequency band*, ten times the common logarithm of the arithmetic mean of the squared pressure ratios from which the individual levels were derived.

DISCUSSION—

1—An average sound pressure level obtained by averaging the A-weighted sound level continuously over a specified period is called the **time-average sound level**.

DISCUSSION—

2—Since, by definition, a squared pressure ratio, p_i^2/p_o^2 , is equal to $10^{L_i/10}$, average sound pressure level is calculated from the expression:

$$\bar{L}_i = 10 \log \left(\frac{1}{n} \sum_{i=1}^n 10^{L_i/10} \right)$$

\bar{L}_p = average sound pressure level, dB,
 n = number of individual sound pressure levels,
 p_i = rms pressure at an individual position or time, or both, Pa,
 p_0 = 20 μ Pa, reference sound pressure, and
 L_i = an individual sound pressure level, dB.

where:

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 L_i = an individual sound pressure level, dB.

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$$\bar{L}_p = 10 \log \left(\frac{1}{T} \int_{t_1}^{t_2} (p^2(t)/p_0^2) dt \right)$$

\bar{L}_p = average sound pressure level during a specified time interval, dB,
 T = $t_2 - t_1$ = a specified time interval, s, min, h, or day,
 $p(t)$ = instantaneous sound pressure, Pa, and
 p_0 = 20 μ Pa, reference sound pressure.

where:

\bar{L}_p = average sound pressure level during a specified time interval, dB,
 T = $t_2 - t_1$ = a specified time interval, s, min, h, or day,
 $p(t)$ = instantaneous sound pressure, Pa, and
 p_0 = 20 μ Pa, reference sound pressure.

background noise—noise from all sources unrelated to a particular sound that is the object of interest. Background noise may include airborne, structureborne, and instrument noise.

cutoff frequency—of an anechoic wedge or set of wedges, the lowest frequency above which the normal incidence sound absorption coefficient is at least 0.990.

damp—to cause a loss or dissipation of the oscillatory or vibrational energy of an electrical or mechanical system.

decay rate, d ; [T⁻¹]; dB/s—for airborne sound, the rate of decrease of sound pressure level after the source of sound has stopped; for vibration, the rate of decrease of vibratory acceleration, velocity, or displacement level after the excitation has stopped.

decibel, dB—the term used to identify ten times the common logarithm of the ratio of two like quantities proportional to power or energy. (See **level**, **sound transmission loss**.) Thus, one decibel corresponds to a power ratio of 10^{0.1} and n decibels corresponds to a power ratio of (10^{0.1}) ^{n} .

DISCUSSION—

Since the decibel expresses the ratio of two like quantities, it has no dimensions. It is, however, common practice to treat “decibel” as a unit as, for example, in the sentence, “The average sound pressure level in the room is 45 decibels.”

diffraction—a change in the direction of propagation of sound energy in the neighborhood of a boundary discontinuity, such as the edge of a reflective or absorptive surface.

diffuse sound field—the sound in a region where the intensity is the same in all directions and at every point.

direct sound field—the sound that arrives directly from a source without reflection.

dummy microphone—a microphone substitute which has electrical characteristics identical to a functional microphone, but which has essentially no sensitivity to incident sound pressure.

field sound transmission class, FSTC—sound transmission class calculated in accordance with Classification **E413** using values of field transmission loss.

field transmission loss, FTL—sound transmission loss measured in accordance with Annex A1 of Test Method **E336**.

flanking transmission—transmission of sound from the source to a receiving location by a path other than that under consideration.

impact insulation class, IIC—a single-number rating derived from measured values of normalized impact sound pressure levels in accordance with Annex A1 of Test Method E492. It provides an estimate of the impact sound insulating performance of a floor-ceiling assembly.

impedance ratio, $z/\rho c \equiv r/\rho c + jx/\rho c$; [dimensionless]—the ratio of the specific normal acoustic impedance at a surface to the characteristic impedance of the medium. The real and imaginary components are called, respectively, **resistance ratio** and **reactance ratio**.

impulsive sound, n —a brief, intrusive sound, such as that associated with a tire blowout, operation of a punch press, the discharge of a firearm, a door slam, or a shout, usually characterized by a rapid rise time in the initial pressure pulse of less than a few milliseconds, and by a decay time of less than a few seconds.

DISCUSSION—

No mathematical description exists to unequivocally define the presence of impulsive sound.

insertion loss, IL —of a silencer or other sound-reducing element, in a specified frequency band, the decrease in sound power level, measured at the location of the receiver, when a sound insulator or a sound attenuator is inserted in the transmission path between the source and the receiver.

interference, n —any activity or event that could produce anomalous measurements.

level, L —ten times the common logarithm of the ratio of a quantity proportional to power or energy to a reference quantity of the same kind. (See **sound power level**, **sound pressure level**.) The quantity so obtained is expressed in decibels.

level reduction, LR —in a specified frequency band, the decrease in sound pressure level, measured at the location of the receiver, when a barrier or other sound-reducing element is placed between the source and the receiver.

DISCUSSION—

Level reduction is a useful measure in circumstances when measures of transmission loss, insertion loss, or noise reduction are not possible.

maximum sound level, L_{AFmax} [nd], (dB) n —Ten times the common logarithm of the square of the ratio of the largest frequency-weighted and exponential-time-weighted (or other wise time-averaged) sound pressure during the measurement period to the square of the reference-sound-pressure of 20 micro pascals. The subscripts designate the frequency weighting (A or C), and time the weighting or averaging (F for fast, S for slow, I for impulse, or a number with proper units to indicate time interval).

DISCUSSION—

The time weighting or averaging time must be specified. The frequency weighting should be specified; otherwise, A-weighting will be understood.

measurement plan, n —a document formally describing the specific steps to be taken during a measurement, including any unique requirements.

measurement set, n —the set of acoustical measurements and related data obtained at a single measurement location during a specified time interval.

DISCUSSION—

The specified time interval may include brief documented periods during which data recording or analysis are paused for the purpose of eliminating the effects of interference.

metric sabin, [L²]—the unit of measure of sound absorption in the metre-kilogram-second system of units.

noise isolation class, NIC—a single-number rating calculated in accordance with Classification E413 using measured values of noise reduction. It provides an estimate of the sound isolation between two enclosed spaces that are acoustically connected by one or more paths.

noise reduction, NR —the difference between the average sound pressure levels either at two well defined locations based on existing conditions, or at a single location before and after some mitigation measure is implemented.

DISCUSSION—

Specific standards may use a more restrictive definition related to the difference either between two locations or before and after a mitigation measure, and some standards may require the noise reduction to be measured in specified frequency bands.

noise reduction coefficient, NRC [*nd*]~~—a single-number rating derived from measured values of rating, the average, rounded to the nearest 0.05, of the sound absorption coefficients in accordance with 11.7 of Test Method of a material C423. It provides an estimate of the sound absorptive property of an acoustical material for the four one-third octave bands at 250 Hz, 500 Hz, 1000 Hz, and 2000 Hz, inclusive, measured according to the test method described in Test Method C423.~~

normal incidence sound absorption coefficient, α_n ; [dimensionless]~~— of a surface, at a specified frequency, the fraction of the perpendicularly incident sound power absorbed or otherwise not reflected.~~

normal mode~~—of a room, one of the possible ways in which the air in a room, considered as an elastic body, will vibrate naturally when subjected to an acoustical disturbance. With each normal mode is associated a resonance frequency and, in general, a group of wave propagation directions comprising a closed path.~~

normalized noise isolation class, NNIC—a single-number rating calculated in accordance with Classification E413 using measured values of normalized noise reduction. (See **normalized noise reduction**.)

normalized noise reduction, NNR~~—between two rooms, in a specified frequency band, the value that the noise reduction in a given field test would have if the reverberation time in the receiving room were 0.5 s. NNR is calculated as follows:~~

$$NNR = NR + 10 \log(T/0.5)$$

where:

NR = noise reduction, dB and

T = reverberation time in receiving room, s.

DISCUSSION—

The normalized noise reduction is intended to approximate the noise reduction that would exist between two ordinarily furnished rooms.

octave band, n —a band of sound frequencies for which the highest frequency in the range is (within 2%) twice the lowest frequency. The position of the band is identified by the rounded geometric mean of the highest frequency and the lowest frequency of the band. The nominal mid-band frequencies of “preferred” octave bands as defined in ANSI S1.6 fall in the series 16, 31.5, 63, 125, 250, 500, 1000 Hz etc.

octave band sound pressure level, OBSPL— L_p/f where f indicates the nominal center frequency of a specific band if applicable, [*nd*], (dB), n —sound pressure level for sound filtered using an octave-band filter meeting the requirements of ANSI S1.11.

outdoor-indoor transmission loss, OITL~~—of a building facade, in a specified frequency band, ten times the common logarithm of the ratio of the airborne sound power incident on the exterior of the facade to the sound power transmitted by the facade and radiated to the interior. The quantity so obtained is expressed in decibels.~~

particle velocity, u ; [LT^{-1}]; m/s—a fluctuating velocity superimposed by the presence of sound on the other velocities the particles of the medium may have. In analogy with alternating voltage its magnitude can be expressed in several ways, such as instantaneous particle velocity or peak particle velocity, but the unqualified term means root-mean-square particle velocity. In air, the other velocities are those due to thermal agitation and wind currents.

peak sound pressure level, $L_{PK}[nd]$, (dB), n —ten times the common logarithm of the square of the ratio of the largest absolute value of the instantaneous sound pressure in a stated frequency band during a specified time interval to the reference sound pressure of 20 micropascals.

percentile level $L_x[nd]$, (dB), n —of a time varying level, the level exceeded \times percent of the time during the stated measurement period.

DISCUSSION—

Percentile levels are affected by measurement parameters such as bandwidth, frequency weighting, time weighting, and sampling rate that must be explicitly stated.

pink noise—noise with a continuous frequency spectrum and with equal power per constant percentage bandwidth. For example, equal power in any one-third octave band.

receiving room—in architectural acoustical measurements, the room in which the sound transmitted from the source room is measured.