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Standard Terminology Relating to Environmental Acoustics[1]

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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 Practice E 380. 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 E-33 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:*

C 423 Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method[2]

E 90 Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions[2]

E 336 Test Method for Measurement of Airborne Sound Insulation in Buildings[2]

E 380 Practice for Use of the International System of Units (SI) (the Modernized Metric System)[3]

E 413 Classification for Rating Sound Insulation[2]

E 492 Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine[2]

2.2 *ANSI Standard:*

ANSI S1.4 Specification for Sound Level Meters[4]

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 *Terms and Definitions:*

acoustic impedance, $Z \equiv R + jX$; [$ML^{-4}T^{-1}$]; mks acoustic ohm ($Pa{\cdot}s/m^3$)—*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 material—any material considered in terms of its

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[2] *Annual Book of ASTM Standards*, Vol 04.06.

[3] *Annual Book of ASTM Standards*, Vol 14.02.

[4] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

acoustical properties. *Commonly and especially,* a material designed to absorb sound.

admittance ratio, $y\rho c \equiv g\rho c - jb\rho c$; [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; [$ML^{-4}T^{-1}$]; mks acoustic ohm (Pa·s/m^3)—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; [$ML^{-3}T^{-1}$]; mks rayl/m (Pa·s/m^2)—*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.

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_0^2, is equal to $10^{L_i/10}$, average sound pressure level is calculated from the expression:

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

where:

$\bar{L}_p$ = 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 µPa, reference sound pressure, and
L_i = an individual sound pressure level, dB.

If conditions warrant, an integral expression may be used:

$$\bar{L}_p = 10 \log \left(\frac{1}{T} \int_{t1}^{t2} (p^2(t)/p_0^2)\, dt \right)$$

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 µPa, 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.

characteristic impedance of the medium, ρc; [$ML^{-2}T^{-1}$]; mks rayl (Pa·s/m)—the specific normal acoustic impedance at a point in a plane wave in a free field. It is a pure specific resistance since the sound pressure and the particle velocity are in phase and it is equal in magnitude to the product of the density of the medium, ρ, and the speed of sound in the medium, *c*. Its value when the medium is air at 20°C and 101.325 kPa is 413 mks rayl (Pa·s/m).

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 E 413 using values of field transmission loss.

field transmission loss, *FTL*—sound transmission loss measured in accordance with Annex A1 of Test Method E 336.

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

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.**

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 E 492. It provides an estimate of the impact sound insulating performance of a floor-ceiling assembly.

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 unequivoJunecally 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, [L^2]—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 E 413 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—in a specified frequency band,* the difference between the average sound pressure levels measured in two enclosed spaces or rooms due to one or more sound sources in one of them.

DISCUSSION—It is implied that in each room there is a meaningful average level; that is, that in each room the individual observations are randomly distributed about the average value, with no systematic variation with position within the permissible measurement region. Noise reduction becomes meaningless and should not be used in situations where this condition is not met.

noise reduction coefficient, NRC—a single-number rating derived from measured values of sound absorption coefficients in accordance with 11.7 of Test Method C 423. It provides an estimate of the sound absorptive property of an acoustical material.

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 E 413 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—Lpl/lf 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.