Designation: C 634 – 00

An American National Standard

Standard Terminology Relating to Environmental Acoustics[1]

This standard is issued under the fixed designation C 634; 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

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·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

[1] This terminology is under the jurisdiction of ASTM Committee E-33 on Environmental Acoustics and is the direct responsibility of Subcommittee E33.07 on Definitions and Editorial.

Current edition approved February 10, 2000. Published May 2000. Originally published as C 634 – 69. Last previous edition C 634 – 99b.

[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.

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.

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.

reverberant sound field—the sound in an enclosed or partially enclosed space that has been reflected repeatedly or continuously from the boundaries.

reverberation—the persistence of sound in an enclosed or partially enclosed space after the source of sound has stopped; *by extension*, in some contexts, the sound that so persists.

reverberation room—a room so designed that the reverberant sound field closely approximates a diffuse sound field, both in the steady state when the sound source is on, and during decay after the source of sound has stopped.

sabin, [L^2]—the unit of measure of sound absorption in the inch-pound system.

self-noise, *n*—extraneous non-acoustical signals, generated or induced in a measurement system.

sound absorption—(*1*) the process of dissipating sound energy. (*2*) the property possessed by materials, objects and structures such as rooms of absorbing sound energy. (*3*) *A;* [L^2]; metric sabin—*in a specified frequency band*, the measure of the magnitude of the absorptive property of a material, an object, or a structure such as a room.

DISCUSSION—Sound energy passing through a wall or opening may be regarded as being absorbed in certain calculations.

sound absorption coefficient, α; [dimensionless]; metric sabin/m^2— *of a surface, in a specified frequency band*, the measure of the absorptive property of a material as approximated by the method of Test Method C 423. *Ideally*, the fraction of the randomly incident sound power absorbed or otherwise not reflected.

sound attenuation—the reduction of the intensity of sound as it travels from the source to a receiving location. Sound absorption is often involved as, for instance, in a lined duct. Spherical spreading and scattering are other attenuation mechanisms.

sound energy, *E;* [ML^2T^{-2}]; J—energy added to an elastic medium by the presence of sound, consisting of potential energy in the form of deviations from static pressure and of kinetic energy in the form of particle velocity.

sound energy density, *D;* [$ML^{-1}T^{-2}$]; J/m^3—the quotient obtained when the sound energy in a region is divided by the volume of the region. The sound energy density at a point is the limit of that quotient as the volume that contains the point approaches zero.

sound insulation—the capacity of a structure to prevent sound from reaching a receiving location. Sound energy is not necessarily absorbed; impedance mismatch, or reflection back toward the source, is often the principal mechanism.

DISCUSSION—Sound insulation is a matter of degree. No partition is a perfect insulator of sound.

sound intensity, *I;* [MT^{-3}]; W/m^2—the quotient obtained when the average rate of energy flow in a specified direction and sense is divided by the area, perpendicular to that direction, through or toward which it flows. The intensity at a point is the limit of that quotient as the area that includes the point approaches zero.

sound isolation—the degree of acoustical separation between two locations, especially adjacent rooms.

DISCUSSION—This qualitative term may be used in lieu of the more quantitative term **noise reduction**. Sound isolation is achieved by using sound-insulating or sound-attenuating elements.

sound level, $\mathbf{L_{AF}}$—where the A designates the frequency weighting and the F designates fast exponential time weighting (the A is replaced by C to designate C-weighting, and the F by either S or I to designate slow or impulse time weighting), [nd], (dB), *n- of airborne sound*, a sound pressure level obtained using a signal to which a standard frequency-weighting and exponential time weighting has been applied.

NOTE 1—Standard frequency-weightings designated A and C, and exponential time weightings designated fast, slow, and impulses, are defined in ANSI S1.4, Specification for Sound Level Meters.[4]

NOTE 2—The frequency-weighting and exponential time weighting must be specified unless made clear from the context.

NOTE 3—The frequency-weighting modifies the amplitude of the signal as a function of frequency to adjust for differences in perception of sound at different frequencies.

NOTE 4—In symbols, A-weighted sound level L_{AF}, at running time t is

$$L_{AF}(t) = 10\ log\ \{[1/0.125]\ \int^{t}_{-\infty} P_A{}^2(v)^{-(t-v)/0.125} dv]/Po^2$$

where 0.125 is the time constant in seconds for fast time weighting (1.0 for slow time weighting), *v* is a dummy variable of integration, $P_A{}^2(v)$ is the squared, instantaneous, time varying, A-weighted sound pressure in Pascals, and P_o is the reference sound pressure of 20 µPa.

sound level—*of airborne sound*, a sound pressure level obtained using a signal to which a standard frequency-weighting has been applied.

DISCUSSION—1—Three standard frequency-weightings designated A, B, and C are defined in ANSI S1.4, Specification for Sound Level Meters.

DISCUSSION—2—The frequency-weighting and method of averaging must be specified unless clear from the context.

sound power, *W;* [ML ^{2}T^{-3}]; W— *in a specified frequency band,* the rate at which acoustic energy is radiated from a source. *In general,* the rate of flow of sound energy, whether from a source, through an area, or into an absorber.

sound power level, L_W—*of airborne sound,* ten times the common logarithm of the ratio of the sound power under consideration to the standard reference power of 1 pW. The quantity so obtained is expressed in decibels.

sound pressure, *p;* [ML $^{-1}$T^{-2}]; Pa—a fluctuating pressure superimposed on the static pressure by the presence of sound. In analogy with alternating voltage its magnitude can be expressed in several ways, such as instantaneous sound pressure or peak sound pressure, but the unqualified term means root-mean-square sound pressure. In air, the static pressure is barometric pressure.

sound pressure level, L_p—*of airborne sound,* ten times the common logarithm of the ratio of the square of the sound pressure under consideration to the square of the standard reference pressure of 20 μPa. The quantity so obtained is expressed in decibels.

DISCUSSION—The pressures are squared because pressure squared, rather than pressure, is proportional to power or energy.

sound transmission class, STC—a single-number rating calculated in accordance with Classification E 413 using values of sound transmission loss. It provides an estimate of the performance of a partition in certain common sound insulation problems.

sound transmission coefficient, τ; [dimensionless]—*of a partition, in a specified frequency band,* the fraction of the airborne sound power incident on the partition that is transmitted by the partition and radiated on the other side.

DISCUSSION—Unless qualified, the term denotes the value obtained when the specimen is exposed to a diffuse sound field as approximated, for example, in reverberation rooms meeting the requirements of Test Method E 90.

sound transmission loss, *TL—of a partition, in a specified frequency band,* ten times the common logarithm of the ratio of the airborne sound power incident on the partition to the sound power transmitted by the partition and radiated on the other side. The quantity so obtained is expressed in decibels.

DISCUSSION—Unless qualified, the term denotes the sound transmission loss obtained when the specimen is exposed to a diffuse sound field as approximated, for example, in reverberation rooms meeting the requirements of Test Method E 90.

source room—*in architectural acoustical measurements,* the room that contains the noise source or sources.

specific airflow resistance, *r;* [ML^{-2}T^{-1}]; mks rayl (Pa·s/m)—the product of the airflow resistance of a specimen and its area. This is equivalent to the quotient of the air pressure difference across the specimen divided by the linear velocity, measured outside the specimen, of airflow through the specimen.

specific normal acoustic admittance, $y \equiv g - jb$; [M^{-1}L ^{2}T]; reciprocal mks rayl (m/Pa·s)—the reciprocal of the specific normal acoustic impedance. The real and imaginary components are called, respectively, **specific normal acoustic conductance** and **specific normal acoustic susceptance.**

specific normal acoustic impedance, $z \equiv r + jx$; [ML^{-2}T $^{-1}$]; mks rayl (Pa·s/m)—*at a surface,* the complex quotient obtained when the sound pressure averaged over the surface is divided by the component of the particle velocity normal to the surface. The real and imaginary components of the specific normal acoustic impedance are called, respectively, **specific normal acoustic resistance** and **specific normal acoustic reactance.**

structureborne sound—sound that arrives at the point of interest, such as the edge of a partition, by propagation through a solid structure.

time-average sound level, TAV—L_{AT} where T is the time of the interval of measurement, [nd], (dB), *n*—ten times the logarithm to the base ten of the ratio of mean-square instantaneous A-weighted sound pressure, during a stated time interval T, to the square of the standard reference sound pressure.

DISCUSSION— Time-average sound level is also termed equivalent sound level or equivalent continuous sound level with corresponding abbreviation LEQ and symbol L_{AeqT}.

thermal insulation—a material or assembly of materials used primarily to provide resistance to heat flow.

tonal, *adj—in reference to audible sound,* capable of exciting an auditory sensation having pitch.

unit—*measurement,* a precisely specified quantity in terms of which the magnitudes of other quantities of the same kind can be stated.

vibration isolation—a reduction, attained by the use of a resilient coupling, in the capacity of a system to vibrate in response to mechanical excitation.

white noise—noise with a continuous frequency spectrum and with equal power per unit bandwidth. For example, equal power in any band of 100-Hz width.

4. Compound Terms

4.1 The definitions of compound terms may be found in the alphabetical section under the word in boldface type as listed below.

A-weighted, **sound level**
absorption, **sound**
absorption coefficient, **normal** incidence sound
absorption coefficient, **sound**
acoustic admittance, **specific** normal
acoustic impedance, **specific** normal
acoustic reactance—see **acoustic** impedance
acoustic resistance—see **acoustic** impedance
admittance, **specific** normal acoustic
airflow resistance, **specific**
attenuation, **sound**
C-weighted, **sound level**
class, **field** sound transmission
class, **impact** insulation
class, **noise** isolation
class, **sound** transmission
coefficient, **noise** reduction
coefficient, **normal** incidence sound absorption
coefficient, **sound** absorption
coefficient, **sound** transmission

5. Conversion Factors

5.1 Most factors for converting from measurements in other systems to the International System, SI, are listed in Practice E 380. A few conversion factors that are not listed explicitly are listed in Table 1.

TABLE 1 Conversion Factors

Quantity	to convert from	to	multiply by
acoustic impedance	cgs acoustic ohm	mks acoustic ohm (Pa·s/m^3)	10^5
specific acoustic impedance	cgs rayl	mks rayl (Pa·s/m)	10
airflow resistivity	cgs rayl/cm	mks rayl/m (Pa·s/m^2)	10^3
absorption	sabin	metric sabin	0.0929