ANSI S1.26-1995
(ASA 113-1995)

Revision of
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AMERICAN NATIONAL STANDARD

METHOD FOR CALCULATION OF THE ABSORPTION OF SOUND BY THE ATMOSPHERE

ANSI S1.26-1995 (ASA 113-1995)

Accredited Standards Committee S1, Acoustics

Standards Secretariat
Acoustical Society of America
120 Wall Street, 32nd Floor
New York, New York 10005-3993

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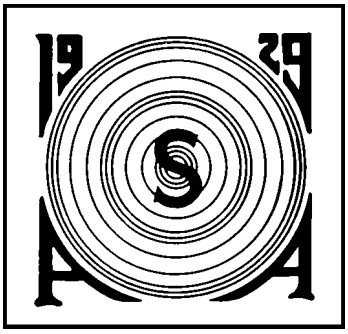

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Method for Calculation of the Absorption of Sound by the Atmosphere

Secretariat

Acoustical Society of America

Approved: 24 July 1995

American National Standards Institute, Inc.

Abstract

This Standard provides the means to calculate atmospheric absorption losses of sound from any source, moving or stationary, for a wide range of meteorological conditions. The atmosphere is assumed to be still, homogeneous moist air of normal composition. Non-homogeneous atmospheres may be divided into horizontal layers within which homogeneous conditions may be assumed. Attenuation coefficients for pure-tone sounds are calculated by means of equations (or a table) over ranges of frequency, and the humidity, pressure, and temperature of the atmosphere. For sounds analyzed by fractional-octave-band filters (e.g., one-third-octave-band filters), alternative methods are provided in annexes to calculate the attenuation caused by atmospheric absorption from that specified for pure-tone sounds.

AMERICAN NATIONAL STANDARDS IN ACOUSTICS

The Acoustical Society of America (ASA) provides the Secretariat for Accredited Standards Committees S1 on Acoustics, S2 on Mechanical Vibration and Shock, S3 on Bioacoustics, and S12 on Noise. These committees have wide representation from the technical community (manufacturers, consumers, and general-interest representatives). The standards are published by the Acoustical Society of America through the American Institute of Physics as American National Standards after approval by their respective standards committees and the American National Standards Institute.

These standards are developed and published as a public service to provide standards useful to the public, industry, and consumers, and to Federal, State, and local governments.

Each of the Accredited Standards Committees (operating in accordance with procedures approved by ANSI) is responsible for developing, voting upon, and maintaining or revising its own standards. The ASA Standards Secretariat administers committee organization and activity, and provides liaison between the accredited standards committees and ANSI. After the standards have been produced and adopted by the accredited standards committees, and approved as American National Standards by ANSI, the ASA Standards Secretariat arranges for their publication and distribution.

An American National Standard implies a consensus of those substantially concerned with its scope and provisions. Consensus is established when, in the judgment of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that a concerted effort be made toward their resolution.

The use of an American National Standard is completely voluntary. Their existence does not in any respect preclude anyone, whether he has approved the standards or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standards.

CAUTION NOTICE: This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken periodically to reaffirm, revise, or withdraw a standard.

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Foreword

[This foreword is for information only and is not an integral part of ANSI S1.26-1995 *American National Standard Method for Calculation of the Absorption of Sound by the Atmosphere* (ASA Catalog No. 113-1995).]

This American National Standard, like the original version first published in 1978, provides an analytical method to calculate absorption losses experienced by sound from any source propagating through the atmosphere. This issue of ANSI S1.26-1995 supersedes ANSI S1.26-1978. The calculation method was modified as a result of additional data on absorption of sound in air and better understanding of vibrational relaxation of nitrogen molecules than were available for the 1978 issue.

This standard is the American National Standard counterpart of International Standard ISO 9613-1:1993, "Acoustics – Part 1: Calculation of the absorption of sound by the atmosphere." The technical requirements in this American National Standard are identical to those in ISO 9613-1.

This standard contains five informative annexes.

Annex E in this American National Standard is not contained in ISO 9613-1. This new annex describes a practical method to compute the atmospheric attenuation applicable to fractional-octave-band sound pressure levels measured at a large distance from a sound source or under highly absorptive conditions, or a combination of distance and absorptive conditions. Also, the scope of this American National Standard is not limited to sound propagation outdoors as is ISO 9613-1, but also includes room acoustics.

This standard was developed under the jurisdiction of Accredited Standards Committee S1, Acoustics, which has the following scope:

> *Standards, specifications, methods of measurement and test, and terminology, in the fields of physical acoustics, including architectural acoustics, electroacoustics, sonics and ultrasonics, and underwater sound, but excluding those aspects which pertain to safety, human tolerance and comfort.*

At the time this standard was submitted to Accredited Standards Committee S1, Acoustics, for final approval, the membership was as follows:

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Individual Experts of Accredited Standards Committee S1, Acoustics, were:

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D.R. Flynn	W.W. Lang	G.S.K. Wong
W.J. Galloway	G.C. Maling, Jr.	R.W. Young
E.E. Gross, Jr.	A.H. Marsh	

Working Group S1-2, Attenuation of Sound in the Atmosphere, which assisted Accredited Standards Committee S1, Acoustics, in the preparation of this Standard, had the following membership:

A.H. Marsh, *Chairman*

H.E. Bass	N.L. Haight	J.E. Piercy	A.J. Zuckerwar
D.T. Blackstock	P.D. Joppa	L.C. Sutherland	

Suggestions for improvement will be welcomed. Send suggestions for improvement to Accredited Standards Committee S1, Acoustics, in care of the ASA Standards Secretariat, 120 Wall Street, 32nd floor, New York, New York 10005-3993. Telephone: +1 212 248 0373; FAX: +1 212 248 0146.

American National Standard

Method for Calculation of the Absorption of Sound by the Atmosphere

1 Scope

1.1 This Standard specifies an analytical method to calculate the attenuation of sound as a result of atmospheric absorption for a variety of meteorological conditions when the sound from any moderate-amplitude source propagates through the atmosphere. The calculation method of the Standard applies for molar concentrations of water vapor in the atmosphere from less than 0.005 percent to greater than 5 percent and for ratios of the frequency of the sound to the atmospheric pressure from as low as 4×10^{-4} Hz/Pa (40 Hz per atmosphere) to as great as 10 Hz/Pa (1 MHz per atmosphere).

1.2 For pure-tone sounds, attenuation, in decibels, owing to atmospheric absorption is specified by formulae in terms of an attenuation coefficient, in decibels per unit sound-propagation distance, as an analytical function of four variables: the frequency of the sound, and the temperature, humidity, and pressure of the atmosphere. Computed attenuation coefficients are provided in tabular form for ranges of the variables commonly encountered in prediction of outdoor sound propagation.

1.3 For wideband sounds analyzed by fractional-octave band filters (e.g., one-third octave band filters), an approximate method is provided for calculating the attenuation owing to atmospheric absorption from that specified for pure-tone sounds at the midband frequencies. The spectrum of the sound may be wideband with no significant discrete-frequency components or it may be a combination of wideband and discrete frequency sounds.

1.4 This Standard applies to an atmosphere with uniform meteorological conditions and to a stratified atmosphere in which the meteorological conditions may be considered to be uniform within layers. The procedures described in the Standard may be used to determine adjustments to be applied to measured sound pressure levels to account for differences between atmospheric absorption losses under different meteorological conditions. The calculation method may also be applied to assess the contribution of atmospheric absorption to the decay of sound pressure level in a reverberant sound field.

1.5 This Standard accounts for the principal absorption mechanisms present in an atmosphere devoid of significant fog or atmospheric pollutants. It does not cover sound attenuation by mechanisms other than atmospheric absorption such as wave divergence, refraction, scattering by turbulence, ground reflection, or non-linear propagation effects.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents listed below.

2.1 American National Standards

ANSI S1.11-1986 (R1993), American National Standard Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters.

2.2 International Standards

IEC 1260:1995, Octave-band and fractional-octave-band filters.

ISO 2533:1975, Standard atmosphere.

ISO 9613-1:1993, Acoustics – Attenuation of sound during propagation outdoors - Part 1: Calculation of the absorption of sound by the atmosphere.