**ANSI/ASA S12.51-2012 / ISO 3741:2010**
(a revision of ANSI S12.51-2002 / ISO 3741:1999)

**Reaffirmed by ANSI**
**March 2, 2017**

# AMERICAN NATIONAL STANDARD

## Acoustics – Determination of sound power levels and sound energy levels of noise sources using sound pressure – Precision methods for reverberation test rooms

(a Nationally Adopted International Standard)

ANSI/ASA S12.51-2012 / ISO 3741:2010

Accredited Standards Committee S12, Noise

Standards Secretariat
Acoustical Society of America
35 Pinelawn Road, Suite 114 E
Melville, NY 11747-3177

The American National Standards Institute, Inc. (ANSI) is the national coordinator of voluntary standards development and the clearinghouse in the U.S.A. for information on national and international standards.

The Acoustical Society of America (ASA) is an organization of scientists and engineers formed in 1929 to increase and diffuse the knowledge of acoustics and to promote its practical applications.

**ANSI/ASA S12.51-2012 / ISO 3741:2010**

AMERICAN NATIONAL STANDARD

# Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Precision methods for reverberation test rooms

**(a nationally adopted international standard)**

**Secretariat:**

**Acoustical Society of America**

**Approved on February 23, 2012 by:**

**American National Standards Institute, Inc.**

## Abstract

This American National Standard specifies methods for determining the sound power level or sound energy level of a noise source from sound pressure levels measured in a reverberation test room. The sound power level (or, in the case of noise bursts or transient noise emission, the sound energy level) produced by the noise source, in frequency bands of width one-third-octave, is calculated using those measurements, including corrections to allow for any differences between the meteorological conditions at the time and place of the test and those corresponding to a reference characteristic impedance. Measurement and calculation procedures are given for both a direct method and a comparison method of determining the sound power level and the sound energy level.

## AMERICAN NATIONAL STANDARDS ON 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, S3/SC 1 on Animal Bioacoustics, and S12 on Noise. These committees have wide representation from the technical community (manufacturers, consumers, trade associations, organizations with a general interest, and government representatives). The standards are published by the Acoustical Society of America as American National Standards after approval by their respective Standards Committees and the American National Standards Institute (ANSI).

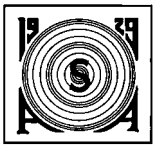
These standards are developed and published as a public service to provide standards useful to the public, industry, and consumers, and to Federal, State, and local governments.

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 towards their resolution.

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

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 this Standard.



Acoustical Society of America
ASA Secretariat
35 Pinelawn Road, Suite 114E
Melville, New York 11747-3177
Telephone: 1 (631) 390-0215
Fax: 1 (631) 390-0217
E-mail: asastds@aip.org

# Contents

## Tables

## Foreword

*[This Foreword is for information only, and is not a part of the American National Standard ANSI/ASA S12.51-2012 / ISO 3741:2010 American National Standard Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Precision methods for reverberation test rooms.]*

This standard comprises a part of a group of definitions, standards, and specifications for use in noise. It was developed and approved by Accredited Standards Committee S12, Noise, under its approved operating procedures. Those procedures have been accredited by the American National Standards Institute (ANSI). The Scope of Accredited Standards Committee S12 is as follows:

> *Standards, specifications, and terminology in the field of acoustical noise pertaining to methods of measurement, evaluation, and control, including biological safety, tolerance, and comfort, and physical acoustics as related to environmental and occupational noise.*

This standard is a revision of ANSI S12.51-2002 (R 2007) / ISO 3741:1999, which has been technically revised.

This Standard is identical to International Standard ISO 3741, Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Precision methods for reverberation test rooms, which was prepared by Technical Committee ISO/TC 43 Subcommittee SC 1, Noise. However, in conformance with ANSI and ISO rules, the words "American National Standard" replace the words "International Standard" where they appear in the ISO document, decimal points were substituted in place of the decimal commas used in ISO documents, and American English spelling is used in place of British English spelling.

The ANSI or ANSI/ASA equivalents for the ISO standards in the ISO 3740 series and other referenced nationally adopted standards are given below:

- ANSI S12.5 / ISO 6926 is an identical national adoption of ISO 6926;
- ANSI/ASA S12.50/ISO 3740 is an identical national adoption of ISO 3740;
- ANSI/ASA S12.51/ISO 3741 is an identical national adoption of ISO 3741;
- ANSI/ASA S12.53/Part 1/ISO 3743-1 is an identical national adoption of ISO 3743-1;
- ANSI/ASA S12.53/Part 2/ISO 3743-2 is an identical national adoption of ISO 3743-2;
- ANSI/ASA S12.54/ISO 3744 is an identical national adoption of ISO 3744;
- ANSI S12.55/ISO 3745 is an identical national adoption of ISO 3745;
- ANSI/ASA S12.56/ISO 3746 is an identical national adoption of ISO 3746; and
- ANSI/ASA S12.57/ISO 3747 is an identical national adoption of ISO 3747.

At the time this Standard was submitted to Accredited Standards Committee S12, Noise for approval, the membership was as follows:

W.J. Murphy, *Chair*
R.D. Hellweg, *Vice-Chair*

S.B. Blaeser, *Secretary*

**3M Occupational Health & Environmental Safety Division** ..... E.H. Berger

**Acoustical Society of America**..... R.D. Hellweg
..... D. Lubman (Alt.)

**Air-Conditioning, Heating and Refrigeration Institute** ..... S. Lind
..... D. Abbate (Alt.)

**Air Movement & Control Association** ..... J.A. Brooks
..... M. Stevens (Alt.)

**Alcoa Inc.** ..... W.D. Gallagher

**American Academy of Audiology** ..... D. Ostergren
..... S. Gordon-Salant (Alt.)

**American Academy of Otolaryngology - Head and Neck Surgery** ..... R.A. Dobie
..... L.A. Michael (Alt.)

**American Industrial Hygiene Association** ..... D. Driscoll
..... S.N. Hacker (Alt.)

**American Speech-Language-Hearing Association** ..... L.A. Wilber
..... V. Gladstone (Alt.)

**Caterpillar, Inc.** ..... K.G. Meitl

**Compressed Air and Gas Institute** ..... R.C. Johnson
..... D.R. Bookshar (Alt.)

**Council for Accreditation in Occupational Hearing Conservation** ..... VACANT
..... L.D. Hager (Alt.)

**Emerson Electric – Copeland Corporation** ..... A.T. Herfat
..... G. Williamson (Alt.)

**ETS – Lindgren Acoustic Systems** ..... D. Winker
..... M. Black (Alt.)

**ExxonMobil** ..... B. Moulton

**G.R.A.S. Sound & Vibration** ..... J. Sondergaard
..... B. Schustrich (Alt.)

**General Motors** ..... D.B. Moore

**Harley-Davidson Motor Company** ..... D. Jaeger

**Information Technology Industry Council** ..... W.M. Beltman
..... J. Rosenberg (Alt.)

**Institute of Noise Control Engineering** ..... R.J. Peppin
..... B. Tinianov (Alt.)

**International Safety Equipment Association** ..... J. Birkner
..... C.Z. Fargo (Alt.)

**John Deere** ..... K.B. Washburn
..... K. Cone (Alt.)

**National Council of Acoustical Consultants** ..... J. Erdreich
..... G.E. Winzer (Alt.)

**National Hearing Conservation Association** ..... J. Cissna

**National Institute for Occupational Safety and Health** ..... W.J. Murphy
..... E. Zechmann (Alt.)

**National Institute of Standards and Technology – National Voluntary Laboratory Accreditation Program** ..... B.A. Sandoval

**National Park Service** ..... G.R. Stanley
..... K. Fristrup (Alt.)

**Noise Control Engineering, Inc.** ..... M.A. Bahtiarian
..... R. Fischer (Alt.)

**Noise Pollution Clearinghouse** ..... L. Blomberg

**North American Insulation Manufacturers Association** ..... H. Alter

**PCB Group** ..... K. Cox
..... L. Harbaugh (Alt.)

**Power Tool Institute, Inc.** ..... W.D. Spencer
..... M. Hickok (Alt.)

**Quest Technologies, Inc.** ..... M. Wurm
..... P.J. Battenberg (Alt.)

**Schomer and Associates, Inc.** ..... P.D. Schomer

**Sierra Club – National Parks and Monuments Committee** ..... D.J. Hingson

**Sperian Hearing Protection, LLC** ..... B. Witt
..... T. Schulz (Alt.)

**U.S. Access Board** ..... M.K. Mazz

**U.S. Air Force** ..... R.L. McKinley
..... H. Gallagher (Alt.)

**U.S. Army Aeromedical Research Lab** ..... W.A. Ahroon

**U.S. Army Construction Engineering Research Laboratory** ..... M.J. White
..... M. Swearington (Alt.)

**U.S. Army Public Health Command** ..... C. Stewart
..... M. Grantham (Alt.)

**U.S. Army Research Laboratory, Human Research and Engineering Directorate** ..... J. Gaston
..... M.S. Binseel (Alt.)

**U.S. Department of Transportation** ..... A. Konheim

**U.S. Naval Surface Warfare Center - Carderock** ..... M. Craun
..... VACANT (Alt.)

**Université du Québec ETS** ..... J. Voix
..... F. Laville (Alt.)

Individual Experts of Accredited Standards Committee S12, Noise, were:

| | | |
|---|---|---|
| P.K. Baade | R.D. Hellweg | R.J. Peppin |
| E.H. Berger | W.W. Lang | J. Schmitt |
| B.M. Brooks | D. Lubman | P.D. Schomer |
| A.J. Campanella | D. Michaud | L.C. Sutherland |
| K.M. Eldred | N.P. Miller | W.R. Thornton |
| L.S. Finegold | W.J. Murphy | L.A. Wilber |
| R.D. Godfrey | M.A. Nobile | G.E. Winzer |

Working Group S12/WG 23, Determination of Sound Power, which assisted Accredited Standards Committee S12, Noise, in the development of this standard, had the following membership.

B.M. Brooks, Co-Chair
J. Schmitt, Co-Chair

| | | |
|---|---|---|
| M.C. Black | K. Cunefare | M.A. Nobile |
| S. Bly | R.D. Hellweg | M. O'Connell |
| A.J. Campanella | A.T. Herfat | P.D. Schomer |
| D.A. Collings | S. Keith | J. Weinstein |
| | G.C. Maling | |

Suggestions for improvements of this standard will be welcomed. They should be sent to Accredited Standards Committee S12, Noise, in care of the Standards Secretariat of the Acoustical Society of America, 35 Pinelawn Road, Suite 114E, Melville, New York 11747-3177. Telephone: 631-390-0215; FAX: 631-390-0217; E-mail: asastds@aip.org.

## Introduction

This American National Standard is one of the series ISO 3740[2] to ISO 3747[8], which specify various methods for determining the sound power levels and sound energy levels of noise sources including machinery, equipment and their sub-assemblies. The selection of one of the methods from the series for use in a particular application depends on the purpose of the test to determine the sound power level or sound energy level and on the facilities available. General guidelines to assist in the selection are provided in ISO 3740[2]. ISO 3740[2] to ISO 3747[8] give only general principles regarding the operating and mounting conditions of the machinery or equipment for the purposes of the test. It is important that test codes be established for individual kinds of noise sources, in order to give detailed requirements for mounting, loading, and operating conditions under which the sound power levels or sound energy levels are to be obtained.

The methods given in this American National Standard require the source under test to be mounted in a reverberation test room having specified acoustical characteristics. The methods are then based on the premise that the sound power or sound energy of the source under test is directly proportional to the mean-square sound pressure averaged in space and time, and otherwise depends only on the acoustical and geometric properties of the room and on the physical constants of air.

For a source emitting sound in narrow bands of frequency or at discrete frequencies, a precise determination of the radiated sound power level or sound energy level in a reverberation test room requires greater effort than for a source emitting sound more evenly over a wide range of frequencies, because:

a) the space- and time-averaged sound pressure along a short microphone path, or as determined with an array of a small number of microphones, is not always a good estimate of the space- or time-averaged mean-square pressure throughout the room;

b) the sound power or sound energy radiated by the source is more strongly influenced by the normal modes of the room and by the position of the source within the room.

The increased measurement effort in the case of a source emitting narrow bands of sound or discrete tones consists of either the optimization and qualification of the test room or the use of a greater number of source locations and microphone positions (or increased path length for a moving microphone). The addition of low-frequency absorbers or the installation of rotating diffusers in the test room can help to reduce the measurement effort.

The methods specified in this American National Standard permit the determination of the sound power level and the sound energy level in one-third-octave frequency bands, from which octave band data, A-weighted frequency data, and total unweighted sound can be computed.

This American National Standard describes methods of accuracy grade 1 (precision grade) as defined in ISO 12001. The resulting sound power levels and sound energy levels include corrections to allow for any differences that might exist between the meteorological conditions under which the tests are conducted and reference meteorological conditions. For applications in reverberant environments where reduced accuracy is acceptable, reference can be made to ISO 3743-1[3], ISO 3743-2[4] or ISO 3747[8].

# Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Precision methods for reverberation test rooms

## 1 Scope

### 1.1 General

This American National Standard specifies methods for determining the sound power level or sound energy level of a noise source from sound pressure levels measured in a reverberation test room. The sound power level (or, in the case of noise bursts or transient noise emission, the sound energy level) produced by the noise source, in frequency bands of width one-third-octave, is calculated using those measurements, including corrections to allow for any differences between the meteorological conditions at the time and place of the test and those corresponding to a reference characteristic impedance. Measurement and calculation procedures are given for both a direct method and a comparison method of determining the sound power level and the sound energy level.

In general, the frequency range of interest includes the one-third-octave bands with mid-band frequencies from 100 Hz to 10 000 Hz. Guidelines for the application of the specified methods over an extended frequency range in respect to lower frequencies are given in Annex E. This American National Standard is not applicable to frequency ranges above the 10 000 Hz one-third-octave band.

NOTE For higher frequencies, the methods specified in ISO 9295 can be used.

### 1.2 Types of noise and noise sources

The methods specified in this American National Standard are suitable for all types of noise (steady, non-steady, fluctuating, isolated bursts of sound energy, etc.) defined in ISO 12001.

The noise source under test can be a device, machine, component or sub-assembly. This American National Standard is applicable to noise sources with a volume not greater than 2 % of the volume of the reverberation test room. For a source with a volume greater than 2 % of the volume of the test room, it is possible that the achievement of results as defined in ISO 12001:1996, accuracy grade 1 (precision grade) is not feasible.

NOTE In specific cases, the source volume can be increased to a maximum of 5 % of the room volume. In such cases, the relevant noise test code indicates the possible consequences on the measurement uncertainty.

### 1.3 Reverberation test room

The test rooms that are applicable for measurements made in accordance with this American National Standard are reverberation test rooms meeting specified requirements (see Clause 5).