ANSI S12.35-1990
(ASA 90-1990)
[Revision of ANSI S1.35-1979]

AMERICAN NATIONAL STANDARD

PRECISION METHODS FOR THE DETERMINATION OF SOUND POWER LEVELS OF NOISE SOURCES IN ANECHOIC AND HEMI-ANECHOIC ROOMS

Accredited Standards Committee S12, Noise

Standards Secretariat
c/o Acoustical Society of America
335 East 45th Street
New York, New York 10017-3483

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Precision Methods for the Determination of Sound Power Levels of Noise Sources in Anechoic and Hemi-Anechoic Rooms

ACCREDITED STANDARDS COMMITTEE S12, NOISE

ABSTRACT

This standard describes a precision method for determination of the sound power levels of noise sources in laboratory anechoic or hemi-anechoic rooms. The standard contains information on instrumentation, installation, and operation of the source; methods for determination of the sound pressure level on the measurement surface; procedures for the calculation of sound power level, directivity index, and directivity factor; and techniques that may be used to qualify the laboratory facilities used for the measurements.

AMERICAN NATIONAL STANDARDS ON ACOUSTICS

The Acoustical Society of America provides the Secretariat for Accredited Standards Committees S1 on Acoustics, S2 on Mechanical Shock and Vibration, 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.

This standard was approved by the American National Standards Institute as ANSI S12.35-1990 on 2 August 1990.

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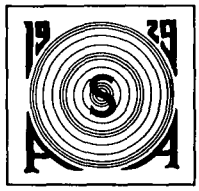

Published by the Acoustical Society of America through the American Institute of Physics

FOREWORD

[This Foreword is not a part of American National Standard Precision Methods for the Determination of Sound Power Levels of Noise Sources in Anechoic and Hemi-Anechoic Rooms, ANSI S12 35-1990 (ASA Catalog No 90-1990)]

This standard comprises a part of a group of definitions, standards, and specifications for use in acoustical work. It has been developed under the American National Standards Institute by the Accredited Standards Committee Procedure under the Secretariat of the Acoustical Society of America

Accredited Standards Committee S12, Noise, under whose jurisdiction this standard was developed, has the following scope:

> 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, originally developed in Accredited Standards Committee S1, Acoustics, as ANSI S1.35-1979 (ASA 15-1979) now comes under the jurisdiction of Accredited Standards Committee S12, Noise. It has therefore been redesignated as ANSI S12.35-1990, the year of its approval by ANSI, with its editorially revised text, to include references to the series of sound power standards, all of which now bear S12 designations (ANSI S12.30-ANSI S12.36)

This standard is in harmony with International Standard ISO 3745-1977 Acoustics—Determination of the Sound Power Levels of Noise Sources—Precision Methods for Anechoic and Hemi-Anechoic Rooms which was originally developed by Working Group 6 of Technical Committee 43/Subcommittee 1 of the International Organization for Standardization (ISO/TC 43/SC1/WG6).

This standard introduces a series of six standards specifying various methods for determining the sound power levels of machines and equipment. Taken together, the six standards specify the acoustical requirements for measurements appropriate for test environments as shown in the table on p. iv.

In order to conduct a test in accordance with one of the six methods, it is necessary to decide which one is most appropriate for the conditions and purposes of the test. The operating and mounting conditions of the machine or equipment to be tested must be in accordance with the general principles stated in the six standards. Guidelines for making these decisions are provided in this standard.

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

W. Melnick, *Chairman*
R. K. Hillquist, *Vice-Chairman*
A. Brenig, *Secretary*

Acoustical Society of America ● W Melnick, W Hillquist (*Alt*)
Acoustical Systems, Inc. ● R Goodwin, R Seitz (*Alt*)
Air-Conditioning and Refrigeration Institute ● R Harold, J. C Clukey (*Alt*)
ALCOA ● S I Roth
American Academy of Otolaryngology, Head and Neck Surgery, Inc. ● R F Naunton, L A Michael (*Alt*)

American National Standards and International Standards specifying various methods for determining the sound power levels of machines and equipment.

American National Standard	International Standard	Classification of method	Test environment	Size of source	Character of noise	Sound power levels obtainable	Optional information obtainable
S12.31 (revision of S1.31-1980)	**ISO 3741**	Precision (Grade 1)	Reverberation room meeting specified requirements	Volume of source preferably less than 1% of test room volume	Steady, broad-band	In one-third octave or octave bands	A-weighted sound power level
S12.32 (revision of S1.32-1980)	**ISO 3742**				Steady, discrete-frequency or narrow-band		
S12.33 (revision of S1.33-1982)	**ISO 3743**	Engineering (Grade 2)	Special reverberant test room		Steady, broad-band narrow-band, discrete-frequency	A-weighted and in octave bands	Other weighted sound power levels
S12.34 (revision of S1.34-1980)	**ISO 3744**	Engineering (Grade 2)	Outdoors or in large room	Greatest linear dimension less than 15 m; otherwise limited only by available test environment	Any	A-weighted and in one-third octave or octave bands	Directivity information and sound pressure levels as a function of time; other weighted sound power levels
S12.35 (revision of S1.35-1979)	**ISO 3745**	Precision (Grade 1)	Anechoic or hemi-anechoic room	Volume of source preferably less than 0.5% of test room volume	Any		
S12.36 (revision of S1.36-1979)	**ISO 3746**	Survey (Grade 3)	No special test environment	No restrictions; limited only by available test environment	Steady, broad-band narrow-band, discrete-frequency	A-weighted	Sound pressure levels as a function of time; other weighted sound power levels
---	**ISO 3747**	Survey (Grade 3)	No special test environment	No restrictions	Steady, broad-band narrow-band, discrete-frequency	A-weighted	Sound power levels in octave bands

American Industrial Hygiene Association ● C D Bohl
American College of Occupational Medicine ● P F Bronson, J Sataloff *(Alt)*
American Otological Society ● R F. Naunton
American Society of Heating, Refrigerating, and Air-Conditioning Engineers ● H S Pei, G. F. Hohn *(Alt)*
American Speech-Language-Hearing Association ● R Kasten
American Welding Society ● (Vacant), M E Kennebeck, Jr *(Alt)*
Audio Engineering Society ● M R Chial
Bruel & Kjaer Instruments, Inc. ● (Vacant), G C Michel *(Alt)*
Compressed Air and Gas Institute ● J H Addington
Computer and Business Equipment Manufacturers Association ● L F Luttrell
Edison Electronic Institute ● (Vacant), M C Mingoia *(Alt)*
Fastener Industry Noise Control Research Program ● E H Toothman, J C McMurray *(Alt)*
Federal Aviation Administration ● R N Tedrick
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U.S. Air Force ● R McKinley
U.S. Army Construction Engineering Research Laboratory ● P D Schomer, M White *(Alt)*
U.S. Department of the Navy, Naval Medical Command ● J Page, L Marshall *(Alt)*

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

P K Baade
R G Bartheld
L Batchelder
R W Benson
L. Beranek
K M Eldred
R S Gales
W J Galloway
R Guernsey
W W Lang
G C Maling
A. H Marsh
L Wilber
G Winzer
R W Young

Working Group S12/WG 23 on Determination of Sound Power, which has cognizance of the subject matter in this standard, had the following membership:

P K Baade, *Chair*

R G Bartheld
G Diehl
D R Flynn
R K Hillquist
G C Maling, Jr
J Malosh
A H Marsh
R J Peppin

Suggestions for improvements in this standard will be welcomed. They should be sent to **Accredited Standards Committee S12 at the Standards Secretariat, in care of the Acoustical Society of America, 335 East 45th Street, New York, NY 10017-3483. Telephone (212) 661-9404.**

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Applicability

Noise control work, type testing, comparison of machines or equipment of the same or different types; rating apparatus in terms of its frequency weighted sound power output.

Test environment: Prescribed laboratory anechoic room providing free field or free field over a reflecting plane (hemi-anechoic room). The adequacy of the test environment is to be checked within the measurement space, in the presence of the source under test, according to one of the test procedures given. The reflecting plane on which the source is located shall not be smaller than the projection of the measuring surface on the plane. The sound absorption coefficient of the reflecting plane shall not exceed 0.06.

Type of source: Device, machine, component, subassembly.

Volume of source: Preferably less than 0.5% of test room volume.

Character of radiated noise: All types—steady, nonsteady, broad band, discrete-frequency, narrow band.

Classification of method

Precision. Measurements made in conformance with this Standard will, with very few exceptions, result in standard deviations less than or equal to 0.5 dB for anechoic rooms and 1.0 dB for hemi-anechoic rooms in the frequency range from 800 to 5000 Hz, increasing to 1.0 and 1.5 dB, for anechoic and hemi-anechoic rooms, respectively, at frequencies down to 100 Hz and up to 10 000 Hz.

Quantities to be determined

A-weighted sound power level (additionally, other frequency weightings may be used); sound power levels in octave or one-third octave bands; directivity characteristics of the source (optional).

American National Standard Precision Methods for the Determination of Sound Power Levels of Noise Sources in Anechoic and Hemi-Anechoic Rooms

1 INTRODUCTION

This standard specifies in detail two laboratory methods for determining the sound power radiated by a device, machine, component, or subassembly using a laboratory anechoic room having prescribed acoustical characteristics. While other methods could be used to measure the noise emitted by machinery and equipment, the methods specified in this standard are particularly useful for rating the sound output of sources which produce steady noise and for which directivity information on the source may be desired.

The methods specified in this standard yield physical data that may be used for the following purposes:

(a) rating apparatus according to its sound power output;

(b) establishing sound control measures;

(c) predicting the sound pressure levels produced by a device in a given enclosure or environment.

Techniques for utilizing the physical data for these special purposes are not included in this standard.

This standard specifies procedures for determination of the sound power radiated by a sound source in a free field or in a free field above a reflecting plane. This determination is based on the premise that the radiated power can be estimated, with adequate accuracy, from measurements of the mean-square sound pressure averaged in time and space over a hypothetical surface surrounding the source. For this premise to be strictly true requires that the average mean-square sound pressure over the measurement surface be directly proportional to the sound power output of the source, be inversely proportional to the area of the measurement surface, and be otherwise dependent only on the physical constants of air density and speed of sound. Strictly, the procedure utilized requires that the sound pressure at all points on the measurement surface be the result of directly radiated sound from the source and that there be no significant contributions due to ambient noise or to reflections from various surfaces (other than, in the case of measurements in a free field over a reflecting plane, the reflecting plane on which the source is located). These conditions are best met under laboratory conditions such as can be achieved in an anechoic room (with or without a hard reflecting floor) of sufficient size that the measurement surface can be taken as a hypothetical sphere or hemisphere having a radius much larger than either the mean radius of the source or the wavelength of sound at the lowest frequency of concern.

Ideally, the sound power emitted from a source would be determined by measuring the average sound intensity, the product of instantaneous sound pressure and instantaneous particle velocity, normal to the measurement surface. However, since appropriate instrumentation for measuring sound intensity is not at present commercially available and since there has been relatively little research on direct measurements of radiated acoustic intensity, the procedures described in this standard are limited to techniques based on the assumption that measurements are made sufficiently far from the source so that the magnitude of the local acoustic intensity can be adequately approximated from measurements of mean-square sound pressure.

This standard, together with ANSI S1.13-1971 (R1986) and the others in this series (see the Foreword), supersedes ANSI S1.2-1962.

2 SCOPE AND FIELD OF APPLICATION

2.1 General

This standard specifies two laboratory methods for determing the sound power level of a source. It gives requirements for the test room, as well as the source location, operating conditions, and instrumentation. Techniques are specified for obtaining an estimate of the surface sound pressure level from which the weighted sound power level of the source, as well as the sound power level in octave or one-third octave bands, may be calculated It is intended to prescribe techniques for acoustical measurements that may be used in test codes for particular types of equipment.

2.2 Field of application

2.2.1 Types of noise

This standard applies to sources which produce sound that is uniformly distributed in frequency over