
AMERICAN NATIONAL STANDARD

Acoustics – Measurement of airborne noise emitted and structure-borne vibration induced by small air-moving devices – Part 1: Airborne noise measurement (a nationally adopted international standard)

ANSI/ASA S12.11-2013/Part 1 /
ISO 10302-1 :2011

Accredited Standards Committee S12, Noise

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and structure-borne vibration induced by small air-
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Secretariat:

Acoustical Society of America

Approved on April 2, 2013 by:

American National Standards Institute, Inc.

Abstract

ANSI/ASA S12.11-2013/Part 1 / ISO 10302-1:2011 specifies methods for measuring the airborne noise emitted by small air-moving devices (AMDs), such as those used for cooling electronic, electrical, and mechanical equipment where the sound power level of the AMD is of interest.

Examples of these AMDs include propeller fans, tube-axial fans, vane-axial fans, centrifugal fans, motorized impellers, and their variations.

This part of this American National Standard describes the test apparatus and methods for determining the airborne noise emitted by small AMDs as a function of the volume flow rate and the fan static pressure developed by the AMD on the test apparatus. It is intended for use by AMD manufacturers, by manufacturers who use AMDs for cooling electronic equipment and similar applications, and by testing laboratories. It provides a method for AMD manufacturers, equipment manufacturers and testing laboratories to obtain comparable results. Results of measurements made in accordance with this part of this American National Standard are expected to be used for engineering information and performance verification, and the methods can be cited in purchase specifications and contracts between buyers and sellers. The ultimate purpose of the measurements is to provide data to assist the designers of electronic, electrical or mechanical equipment which contains one or more AMDs.

Based on experimental data, a method is given for calculating the maximum volume flow rate of the scaled plenum up to which this part of this American National Standard is applicable.

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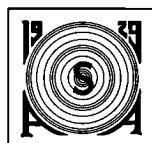
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Foreword

[This Foreword is for information only, and is not a part of the American National Standard ANSI/ASA S12.11-2013 Part 1/ISO 10302-1:2011 American National Standard Acoustics – Measurement of airborne noise emitted and structure-borne vibration induced by small air-moving devices – Part 1: Airborne noise measurement. As such, this Foreword may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to the standard.]

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 an identical national adoption of ISO 10302-1:2011. It revises and replaces ANSI/ASA S12.11-2003/Part 1 / ISO 10302:1996 (MOD) (R 2008) *American National Standard Acoustics – Measurement of noise and vibration of small air-moving devices – Part 1: Airborne noise emission*, which was a Modified Nationally Adopted International Standard. ISO 10302-1:2011 was prepared by Technical Committee ISO/TC 43 Subcommittee SC 1, Noise.

In conformance with ANSI and ISO rules, the words "this part of this American National Standard" replace the words "this part of ISO 10302" 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/ASA equivalents for some of the ISO standards referenced in this standard are given below:

- ANSI/ASA S12.51/ISO 3741 is an identical national adoption of ISO 3741;
- ANSI/ASA S12.54/ISO 3744 is an identical national adoption of ISO 3744; and
- ANSI/ASA S12.55/ISO 3745 is an identical national adoption of ISO 3745.

At time of publication, BSR/ASA S12.11-201x/Part 2 / ISO 10302-2:2011 is expected to be approved as the identical national adoption of ISO 10302-2:2011.

ANSI/ASA S12.10-2010/Part 1 is essentially identical to ISO 7779:2010 as they are both adoptions of 10th Edition of ECMA-74 (2008).

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

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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 part of this American National Standard specifies in detail methods for determining and reporting the airborne noise emissions of small air-moving devices (AMDs) used primarily for cooling electronic equipment, such as that for information technology and telecommunications.

To provide compatibility with measurements of acoustical noise emitted by such equipment, this part of this American National Standard uses the noise emission descriptors and sound power measurement methods of ISO 7779. The descriptor of overall airborne noise emission of the AMD under test is the A-weighted sound power level. The one-third-octave-band sound power level is the detailed descriptor of the noise emission. Octave-band sound power levels may be provided in addition to the one-third-octave-band sound power levels.

American National Standard

Acoustics – Measurement of airborne noise emitted and structure-borne vibration induced by small air-moving devices – Part 1: Airborne noise measurement (a nationally adopted international standard)

1 Scope

This part of this American National Standard specifies methods for measuring the airborne noise emitted by small air-moving devices (AMDs), such as those used for cooling electronic, electrical, and mechanical equipment where the sound power level of the AMD is of interest.

Examples of these AMDs include propeller fans, tube-axial fans, vane-axial fans, centrifugal fans, motorized impellers, and their variations.

This part of this American National Standard describes the test apparatus and methods for determining the airborne noise emitted by small AMDs as a function of the volume flow rate and the fan static pressure developed by the AMD on the test apparatus. It is intended for use by AMD manufacturers, by manufacturers who use AMDs for cooling electronic equipment and similar applications, and by testing laboratories. It provides a method for AMD manufacturers, equipment manufacturers and testing laboratories to obtain comparable results. Results of measurements made in accordance with this part of this American National Standard are expected to be used for engineering information and performance verification, and the methods can be cited in purchase specifications and contracts between buyers and sellers. The ultimate purpose of the measurements is to provide data to assist the designers of electronic, electrical or mechanical equipment which contains one or more AMDs.

Based on experimental data, a method is given for calculating the maximum volume flow rate of the scaled plenum up to which this part of this American National Standard is applicable.

2 Normative references

The following referenced documents are indispensable for the application of this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3741, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Precision methods for reverberation test rooms*

ISO 3744, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering methods for an essentially free field over a reflecting plane*

ISO 3745, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Precision methods for anechoic test rooms and hemi-anechoic test rooms*

ISO 5801:2007, *Industrial fans — Performance testing using standardized airways*

ISO 7779:2010, *Acoustics — Measurement of airborne noise emitted by information technology and telecommunications equipment*

ISO/IEC Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

ANSI/ASA S2.32, *Methods for the experimental determination of mechanical mobility — Part 2: Measurements using single-point translational excitation*

JBMS 72:2003, *Acoustics — Method for the measurement of airborne noise emitted by micro-fans*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7779 and the following apply.

3.1 General definitions

3.1.1

air-moving device

AMD

fan

device for moving air which utilizes a rotating impeller driven by an electric motor with electronic or mechanical command

NOTE 1 An air-moving device has at least one inlet opening and at least one outlet opening. The openings can have elements for connection to ductwork or to other parts of the airflow path.

NOTE 2 Tests can be run with a particular frame, motor, and rotor, but with different accessories (e.g. finger guards). For the purposes of this part of this American National Standard, each such configuration is referred to as an air-moving device.

NOTE 3 Within some industries, including information technology, the unmodified term “fan” means “axial flow air-moving device”, and the unmodified term “blower” means “centrifugal air-moving device”. In this part of this American National Standard, the term “fan” is used to mean “air-moving device” and does not necessarily imply axial flow. Modifiers (such as axial, centrifugal or mixed flow) are added as necessary to distinguish between types.

3.1.2

micro-fan

air-moving device which has a maximum volume flow rate less than or equal to $0.015 \text{ m}^3/\text{s}$

NOTE 1 Micro-fans are a subset of fans under test according to this part of this American National Standard.

NOTE 2 ISO 5801:2007, 22.4.2, Table 4 limits the range of applicability to Reynolds numbers of 12,000 or higher. This Reynolds number corresponds to the lower limit of volume flow rate of approximately $0.01 \text{ m}^3/\text{s}$. Since lower volume fans are of interest for many cooling applications, the methodology of JBMS-72:2003, Annex A is used to measure the p - q curve of a micro-fan.

3.2 Acoustical definitions

3.2.1

sound power level

L_W

ten times the logarithm to the base 10 of the ratio of the sound power, P , to a reference value, P_0 , expressed in decibels

$$L_W = 10 \lg \frac{P}{P_0} \text{ dB} \quad (1)$$

where the reference value, P_0 , is 1 pW

NOTE If a specific frequency weighting as specified in IEC 61672-1^[6] and/or specific frequency bands are applied, this should be indicated by appropriate subscripts; e.g. L_{WA} denotes the A-weighted sound power level.

3.2.2

frequency range of interest

range extending from the 100 Hz one-third-octave band to the 10 kHz one-third-octave band

NOTE 1 The center frequencies of these one-third-octave bands are defined in ISO 266^[1].

NOTE 2 For small, low-noise fans to be measured (i.e. micro-fans), depending on the size of applicable plenum, the radius of the test hemisphere may be reduced to less than 1 m, but not less than 0.5 m (see 8.2.1). However, a radius less than 1 m could itself impose limits on the frequency range over which tests are performed. For details, reference is made to ISO 7779:2010, B.1.

3.2.3

insertion loss of test plenum

ΔL

sound power level difference due to the presence of test plenum, defined as follows:

$$\Delta L = L_{W,\text{out}} - L_{W,\text{in}} \quad (2)$$

where

$L_{W,\text{out}}$ is the sound power level of a sound source determined when installed outside the test plenum;

$L_{W,\text{in}}$ is the sound power level of a sound source determined when installed inside the test plenum

NOTE The insertion loss of the test plenum is expressed in decibels.

3.3 Aerodynamic definitions

3.3.1

test plenum

structure on to which the air-moving device under test is mounted for acoustical noise emission measurements

NOTE The plenum provides a flow resistance to the air-moving device, but permits sound from the air-moving device to radiate freely into the test room with only minimal attenuation. Thus, the sound power radiated by the air-moving device can be determined from acoustical measurements made outside the test plenum.

3.3.2

air-moving device aerodynamic performance curve

“*p-q* curve”

presentation of fan static pressure as a function of volume flow rate under standard air conditions and constant operating voltage and frequency

NOTE 1 For the purpose of this part of this American National Standard, a qualifier, “aerodynamic”, before “performance curve” is inserted to distinguish from acoustical noise emission characteristics against volume flow rate.

NOTE 2 The presentation is derived in accordance with ISO 5801 or Annex A, which complement each other. The method for small air-moving devices of volume flow rate up to 0.015 m³/s is specified in Annex A.

NOTE 3 For convenience, in this part of this American National Standard, the term “*p-q* curve” is used.

3.3.3

point of operation

point on the air-moving device aerodynamic performance curve corresponding to a particular volume flow rate

NOTE The point of operation is controlled during a test by adjusting the “slider” on the test plenum exit port assembly.

3.3.4

overall static efficiency of air-moving device

$\eta_{o,s}$

volume flow rate multiplied by the fan static pressure and divided by the input electrical power

NOTE 1 The overall static efficiency, $\eta_{o,s}$, expressed as a percentage, is given by

$$\eta_{o,s} = \frac{P_{s,f} q_V}{P_{\text{input}}} \times 100 \quad (3)$$

where

$p_{s,f}$ is the fan static pressure, in pascals;

q_V is the volume flow rate, in cubic meters per second;

P_{input} is the motor input power, in watts (true power, not including reactive component), supplied at the terminals of the electric drive motor.

NOTE 2 The air-moving device is defined to include the motor, impeller and frame; therefore, the overall static efficiency includes both the electromechanical efficiency of the motor and the aerodynamic efficiency of the impeller and frame.

3.3.5

standard air density

density under standard air conditions

NOTE The value is 1.20 kg/m³.

3.3.6

standard air conditions (for aerodynamic performance measurement)

specified meteorological conditions

NOTE For the purposes of this part of this American National Standard, the conditions are: 20 °C temperature; 50 % relative humidity; and 1.013×10^5 Pa ambient pressure.

4 Limitations of measurement

Experimental data show that this method is useful up to the maximum volume flow rate, $q_{V,\max}$, as a function of nominal air volume, V , of the plenum used and up to a fan static pressure of 750 Pa.

$$q_{V,\max} = \frac{q_{V,0}}{V_0} V \quad (4)$$

where

$q_{V,\max}$ is the maximum volume flow rate of the scaled plenum, in cubic meters per second;

$q_{V,0}$ is the maximum volume flow rate of the full-size plenum, in cubic meters per second,
 $q_{V,0} = 1 \text{ m}^3/\text{s}$;

V_0 is the nominal air volume of the full-size plenum defined in Clause 6, in cubic meters,
 $V_0 = 1.3 \text{ m}^3$;

V is the nominal air volume of the scaled plenum, in cubic meters.

NOTE 1 The value of the interior air volume of a full-size plenum of 1.3 m^3 is rounded up from $1.296 \text{ m}^3 = 1.2 \text{ m (width)} \times 1.2 \text{ m (depth)} \times 0.9 \text{ m (height)}$.

NOTE 2 It is noted that the “nominal air volume” means approximate air volume calculated from the outer dimensions of the plenum. For instance, in case of 1/4 sized plenum, the nominal air volume of the plenum, excluding the leg height, becomes $V = blh = 0.3 \text{ m} \times 0.3 \text{ m} \times 0.225 \text{ m} = 0.02025 \text{ m}^3$, where b is width, l is depth, and h is height.

For the purposes of this part of this American National Standard, it is recommended that the smallest plenum possible be applied, provided that the maximum volume flow rate of the fan is within the limit of Equation (4).

The method defined in this part of this American National Standard, by reference to ISO 7779, provides for determination of sound power levels in a qualified environment, using either a comparison method in a reverberation test room based on ISO 3741, or a direct method in essentially free-field conditions over a reflecting plane based on ISO 3744 or ISO 3745. The method specified in this part of this American National Standard may be applied to air-moving devices (AMDs) which radiate: a) broad-band noise; b) narrow-band noise; or c) noise that contains discrete frequency components.

The method specified in this part of this American National Standard permits the determination of acoustical noise emission levels for an individual unit under test. If these levels are determined for several units of the same production series, the results may be used to determine a statistical value for the production series.