

ANSI/AMCA Standard 300-14

Reverberant Room Method for Sound Testing of Fans

An American National Standard
Approved by ANSI on August 14, 2014



**AIR MOVEMENT AND CONTROL
ASSOCIATION INTERNATIONAL INC.**

The International Authority on Air System Components



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ANSI/AMCA Standard 300-14

Reverberant Room Methods for Sound Testing of Fans



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Related AMCA Documents

Related Publications	AMCA Publication 302	<i>Application of Sone Loudness Ratings for Non-Ducted Air Moving Devices</i>
	AMCA Publication 303	<i>Application of Sound Power Level Ratings for Fans</i>
	AMCA Publication 311	<i>Certified Ratings Program — Product Rating Manual for Fan Sound Performance</i>
Related Standards	ANSI/AMCA Standard 301	<i>Methods for Calculating Fan Sound Ratings from Laboratory Test Data</i>
	ANSI/AMCA Standard 320	<i>Laboratory Methods of Sound Testing of Fans Using Sound Intensity</i>

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Reverberant Room Method For Sound Testing of Fans

1. Purpose

This standard establishes a method of determining the sound power levels of a fan. It was originally developed in response to the need for a reliable and accurate method of determining the sound power levels of fan equipment.

2. Scope

This standard applies to fans of all types and sizes. It is limited to the determination of airborne sound emission for the specified setups. Vibration is not measured, nor is the sensitivity of airborne sound emission to vibration effects determined.

The size of a fan that can be tested in accordance with this standard is limited only by the practical aspects of the test setups. Dimensional limitations, test subject dimensions, and air performance will control the test room size, power and mounting requirements for the test subject.

The test setup requirements in this standard establish the laboratory conditions necessary for a successful test. Rarely will it be possible to meet these requirements in a field situation. This standard is not intended for field measurements.

3. Definitions/Units of Measure/Symbols

3.1 Definitions

3.1.1 Blade passage frequency (BPF)

The frequency of fan impeller blades passing a single fixed object, per the following formula:

$$BPF = (\text{number of blades})(\text{fan rotational speed, rev/min})/60, \text{ in Hz.}$$

3.1.2 Chamber

An enclosure used to regulate airflow and absorb sound; it may also conform to air test chamber conditions given in ANSI/AMCA Standard 210 [1].

3.1.3 Decibel (dB)

A dimensionless unit of level in logarithmic terms for expressing the ratio of a power or power-like quantity to a similar reference quantity (see Sections 3.1.13 and 3.1.14).

3.1.4 Ducted fan

A fan having a duct connected to either its inlet, its outlet or to both.

3.1.5 End reflection

A phenomenon that occurs whenever sound is transmitted across an abrupt change in area, such as at the end of a duct in a room. When end reflection occurs, some of the sound entering the room is reflected back into the duct and does not escape into the room.

3.1.6 Frequency

The number of times in one second that a periodic function repeats itself.

3.1.7 Informative

A term that indicates that the referenced material is provided as advice to the reader but does not constitute a mandatory requirement.

3.1.8 Non-ducted fan

A fan without ducts connected to its inlet and outlet.

3.1.9 Normative

A term that indicates that the referenced material, if applied, constitutes a mandatory requirement.

3.1.10 Octave band

The interval between any two frequencies having a ratio of two. Fan sound power levels are reported in eight standardized octave bands, shown in Table 2. Fan sound power levels may also be reported in one-third octave bands, also shown in Table 2.

3.1.11 Reverberant room

An enclosure meeting the requirements of Annex A or Annex A and B.

3.1.12 Shall and should

The word "shall" is to be understood as mandatory; the word "should" is to be understood as advisory.

3.1.13 Sound power level

Expressed in decibels (dB), the value of 10 times the logarithm (base 10) of the ratio of the sound power W to the reference sound power W_{ref} according to:

$$L_W, \text{ in dB} = 10 \log_{10} (W/W_{\text{ref}}) \quad \text{Eq. 3.2-1}$$

3.1.14 Sound pressure level

Expressed in decibels (dB), the value of 20 times the logarithm (base 10) of the ratio of the sound pressure p to the reference sound pressure p_{ref} according to:

$$L_p, \text{ in dB} = 20 \log_{10} (p/p_{\text{ref}}) \quad \text{Eq. 3.2-2}$$



Reverberant Room Method for Sound Testing of Fans

1. Scope

This standard applies to fans of all types and sizes. This standard is limited to the determination of airborne sound emission for the specified setups. Vibration is not measured, nor is the sensitivity of airborne sound emission to vibration effects determined.

The size of a fan that can be tested in accordance with this standard is limited only by the practical aspects of the test setups. Dimensional limitations, test subject dimensions, and air performance will control the test room size and power and mounting requirements for the test subject.

The test setup requirements in this standard establish the laboratory conditions necessary for a successful test. Rarely will it be possible to meet these requirements in a field situation. This standard is not intended for field measurements.

2. Normative References

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

ANSI/AMCA 210-99 / ANSI/ASHRAE 51-1999 *Laboratory Methods of Testing Fans for Aerodynamic Performance Rating*, Air Movement and Control Association International, Inc., 30 W. University Drive, Arlington Heights, IL 60004-1893 U.S.A., 1999

ANSI S1.4-1983; S1.4A-1985 *Specification for Sound Level Meters*, Acoustical Society of America, 120 Wall St., 32nd Floor, New York, NY 10005-3993 U.S.A., 1985 (AMCA #2315-83-AO)

ANSI S1.11-2004 *Specification for Octave Band and Fractional Octave Band Analog and Digital Filters*, Acoustical Society of America, 120 Wall St., 32nd Floor, New York, NY 10005-3993 U.S.A., 1986 (AMCA #1727-86-AO)

ANSI S1.40-1984 *Standard Specification for Acoustical Calibrators*, Acoustical Society of America, 120 Wall St., 32nd Floor, New York, NY 10005-3993 U.S.A., 1984 (AMCA #1895-84-AO)

ANSI S12.5-1990 *Requirements for the Performance and Calibration of Reference Sound Sources*, Acoustical Society of America, 120 Wall St., 32nd Floor, New York, NY 10005-3993 U.S.A., 1990 (AMCA #1863-90-AO)

ANSI S12.12-1992 *Engineering Method for the Determination of Sound Power Levels of Noise Sources Using Sound Intensity*, Acoustical Society of America, 120 Wall St., 32nd Floor, New York, NY 10005-3993 U.S.A., 1992 (AMCA #1850-92-AO)

ANSI/IEEE/ASTM SI 10-1997 *Standard for Use of the International System of Units (SI): The Modern Metric System*, Institute of Electrical and Electronic Engineers, 345 east 47th Street, New York, NY 10017 U.S.A., 1997 (AMCA #2924-97-AO)

3. Definitions / Units of Measure / Symbols

3.1 Definitions

3.1.1 Blade passage frequency (BPF). The frequency of fan impeller blades passing a single fixed object, per the following formula:

$$BPF = (\text{number of blades})(\text{fan rotational speed, rev/min}) / 60, \text{ in Hz.}$$

3.1.2 Chamber. An enclosure used to regulate airflow and absorb sound; it may also conform to air test chamber conditions given in ANSI/AMCA 210.

3.1.3 Decibel (dB). A dimensionless unit of level in logarithmic terms for expressing the ratio of a power, or power-like, quantity to a similar reference quantity (see Sections 3.1.13 and 3.1.14).

3.1.4 Ducted fan. A fan having a duct connected to either its inlet, its outlet, or to both.

3.1.5 End reflection. A phenomenon that occurs whenever sound is transmitted across an abrupt change in area, such as at the end of a duct in a room. When end reflection occurs some of the sound entering the room is reflected back into the duct and does not escape into the room.

3.1.6 Frequency. The number of times in one second that a periodic function repeats itself.

3.1.7 Informative. A term that indicates that the referenced material is provided as advice to the reader but does not constitute a mandatory requirement.

3.1.8 Non-ducted fan. A fan without ducts connected to its inlet and outlet.

3.1.9 Normative. A term that indicates that the referenced material, if applied, constitutes a mandatory requirement.

3.1.10 Octave band. The interval between any two frequencies having a ratio of two. Fan sound power levels are reported in eight standardized octave bands shown in Table 1. Fan sound power levels may also be reported in one-third octave bands, also shown in Table 1.

3.1.11 Reverberant room. An enclosure meeting the requirements of Annex A, or Annex A and Annex B.

3.1.12 Shall and should. The word *shall* is to be understood as mandatory; the word *should* as advisory.

3.1.13 Sound power level. The value, expressed in decibels (dB), of ten times the logarithm (base 10) of the ratio of the sound power W to the reference sound power W_{ref} , according to:

$$L_W, \text{ in dB} = 10 \log_{10} (W / W_{\text{ref}}) \quad (3.2-1)$$

3.1.14 Sound pressure level. The value, expressed in decibels (dB), of twenty times the logarithm (base 10) of the ratio of the sound pressure p to the reference sound pressure p_{ref} , according to:

$$L_p, \text{ in dB} = 20 \log_{10} (p / p_{\text{ref}}) \quad (3.2-2)$$

3.1.15 Wavelength. The distance between two points having the same phase in two consecutive cycles of a periodic wave, along a line in the direction of propagation [5]. Wavelength (λ) is determined by frequency and the speed of sound in the air through which the wave propagates:

$$\lambda = c / f \quad (3.2-3)$$

Where:

f = frequency, Hz

c = 343 m/s @ 20°C (1125 ft/s @ 68°F)

The value for c is acceptable for use in this standard within the limits of $\pm 5^\circ\text{C}$ (9°F) for standard air.

3.1.16 Standard air. Air having a density of 1.2 kg/m³ (0.075 lbf/ft³). Standard air has a ratio of specific heats of 1.4 and a viscosity of 1.8185×10^{-3} Pa·s (1.222×10^{-5} lbf/ft·s). Air at 20°C (68°F), 50% relative humidity, and 101.325 kPa (14.696 lbf/in.², 29.92 in. Hg) barometric pressure has these properties, approximately).

Table 1 - Standardized Octave and One-Third Octave Bands [5]

Octave Bands								
Band no.	1	2	3	4	5	6	7	8
ANSI Band no.	18	21	24	27	30	33	36	39
Center frequency f , Hz	63	125	250	500	1000	2000	4000	8000

One-Third Octave Bands

	Band 1				Band 2				Band 3				Band 4			
ANSI Band no.	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Center freq. f , Hz	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600

	Band 5				Band 6				Band 7				Band 8			
ANSI Band no.	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
Center freq. f , Hz	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000	12500	16000	20000	25000

3.2 Symbols

SYMBOL	DESCRIPTION	UNIT OF MEASURE	
		SI	I-P
$A_{\min}$	Minimum distance to reverberant field	m	ft
c	Speed of sound	m/s	ft/s
D	Duct diameter	m	ft
E_o	End reflection factor, at duct outlet	dB	dB
E_i	End reflection factor, at duct inlet	dB	dB
E_W	End reflection factor, adjustment to sound power level	dB	dB
f	Frequency	Hz	Hz
J_1	Bessel function of the first kind, first order	---	---
k	Wave number	---	---
L_p	Sound pressure level, re 20 μ Pa (0.0002 μ bar)	dB	dB
L_{pc}	Corrected fan sound pressure level	dB	dB
L_{pb}	Sound pressure level of room background, measured over the normal microphone path	dB	dB
L_{pm}	Sound pressure level of fan + room background, measured over the normal microphone path	dB	dB
L_{pq}	Sound pressure level of the RSS, corrected	dB	dB
L_{pqm}	Sound pressure level of RSS + room background, measured over the normal microphone path	dB	dB
L_W	Sound power level re 1 picowatt (1.0×10^{-12} W)	dB	dB
L_{Wi}	Sound power level; transmitted to inlet duct from fan	dB	dB
L_{Wmi}	Sound power level measured at the open inlet of the fan	dB	dB
L_{Wmo}	Sound power level measured at the open outlet of the fan	dB	dB
L_{Wmt}	Sound power level measured at the open inlet and outlet of the fan		
L_{Wo}	Sound power level transmitted to the outlet duct from fan	dB	dB
L_{Wr}	Sound power level of RSS	dB	dB
p	Sound pressure	Pa	bar
p_{ref}	Sound pressure reference level, 20 μ Pa (0.0002 μ bar)	Pa	bar
P_s	Fan static pressure	Pa	in. wg
P_t	Fan total pressure	Pa	in. wg
r	Ratio (of Duct area / Orifice area) dimensionless	---	---
R	Reflection coefficient dimensionless	---	---
s	Standard deviation	dB	dB
W	Sound power (in watts)	W	W
W_{ref}	Reference sound power (1 picowatt)	W	W
Z_M	Mechanical impedance	N-s/m	---
α	Ratio of transmitted to reflected sound	dimensionless	
γ	Ratio of specific heats	dimensionless	
λ	Wavelength	m	ft
ω	Angular frequency	rad/s	rad/s