Method for Sound Testing of Portable Household Electric Room Air Cleaners

ANSI/AHAM AC-2-2006 (R2008)

Approved American National Standard

ANSI

AHAM

ASSOCIATION OF HOME APPLIANCE MANUFACTURERS

Leadership ➤ Knowledge ➤ Innovation

1111 19th Street NW ➤ Suite 402 ➤ Washington, DC 20036
t 202.872.5955 f 202.872.9354 www.aham.org

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PREFACE

The Association of Home Appliance Manufacturers (AHAM) develops standards in accordance with AHAM's "Policy and Procedures Governing Technical Standards" which states:

> "AHAM Standards shall be in the best interest, mutually, of consumers who use appliances, the industries which provide and service appliances, and other interested parties. They shall relate to actual use conditions, and be technically and scientifically sound."

Use or observance of AHAM standards is voluntary.

AHAM standards are presented to the American National Standards Institute (ANSI) for recognition as American National Standards. ANSI/AHAM AC-2-2006 (R2008) was approved as an American National Standard on December 15, 2008.

This standard contains test procedures which may be applied to any brand or model of portable household electric room air cleaner within the stated confines of the standard's limits of measurability for measuring performance. Results of tests in accordance with this standard may be publicly stated.

With regard to safety, AHAM recommends that all appliance products –both major and portable- manufactured or marketed in the Untied States be submitted to an appropriate independent laboratory for inspection and listing in conformance with the safety standards and procedures followed by such laboratories. The relevant standards for portable household electric room air cleaners are UL 867, "Standard for Electrostatic Air Cleaners" and UL 507, "Standard for Fans."

The annexes to this standard are noted as "normative" if the material included in the annex is considered part of the standard and as "informative" if the material included in the annex is provided for informational purposes only.

AHAM welcomes comments and suggestions regarding this standard. Any standard may be reviewed and improved as needed. All standards must be updated or confirmed at least every five years. Any interested party, at any time, may request a change in an AHAM standard. Such request should be addressed to AHAM's President, and should be accompanied by a statement of reason for the request and a suggested alternate proposal.

This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of any regulatory limitations prior to use.

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1. PURPOSE

The purpose of this standard is to establish a method to determine the sound rating of portable household electric room air cleaners. The sound rating is comprised of a set of sound levels that includes:

1. A-Weighted Sound Power Level, L_{WA} (unit: dB re 1 pW)

2. Loudness, s_t (unit: $sone_o$ - Stevens)

Both of the ratings (sound power level and loudness) shall be included in the test report.

Established in the standard are definitions, tests, calculations, ratings, and minimum data requirements for published ratings and conformance conditions.

The standard method provides a means to compare and evaluate different models of portable household electric room air cleaners regarding their generated sound levels.

The standard methods of measurement are not intended to inhibit improvement and innovation in product testing, design, or performance. This standard is subject to review and amendment as technology advances.

2. SCOPE

This standard includes sections on definitions, test room requirements, and the installation mounting and operating conditions under which the portable household electric - room air cleaners are tested.

3. DEFINITIONS

3.1 Portable Household Electric Room Air Cleaner. An electric appliance with the function of removing particulate matter from the air and which can be moved from room to room.

3.2 Design Characteristics of Portable Household Electric Room Air Cleaners

3.2.1 Fan with Filter. Air cleaners that operate with an electrical source of power and that contain a motor and fan for drawing air through a filter media.

3.2.2 Fan and Electrostatic Plates. Air cleaners that operate with a fan and that incorporate electrically charged plates or wires to electrostatically collect particulate matter. Such devices may include a filter(s).

3.2.3 Fan, Filter and Ion Generator. Air cleaners that incorporate an ion generator in addition to a fan and filter.

3.2.4 Ion Generator. Air cleaners that incorporate an ion generator only.

3.2.5 Other Types. A device that has the stated capacity to reduce the concentration of particulate matter in a room. Such devices do not have to contain a fan and can incorporate any of the particle removal methods noted above.

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3.3 A-Weighting. A frequency weighting applied to one-third octave band data in accordance with the provisions of ANSI Standard S12.51, Annex F, Section F.2. See Table 2.

3.4 One-Third Octave Band. This is a band of sound covering a range of frequencies such that the highest frequency is the cube root of two times the lowest. The one-third octave bands used in this standard are those defined in ANSI Standard S1.11. See Table 1.

3.5 Comparison Method. A method of determining sound power level of a source under test in a reverberation room by comparing the average sound pressure level of that source to the average sound pressure level of a reference sound source of known sound power level output. The difference in sound power level is equal to the difference in sound pressure level when conditions in the room are the same for both sets of measurements. Refer to ANSI S12.51.

3.6 Hertz (Hz). A unit of frequency equal to one cycle per second.

3.7 Reference Sound Source (RSS). A portable aerodynamic sound source that produces a known stable broad band sound power output. For the purposes of this standard, the RSS is in conformance with ANSI S12.5.

3.8 Sound Power Level. Sound Power is a measurement of the rate of acoustic energy emitted from the appliance. The sound power level (L_W) of a sound source, in decibels (dB), is ten times the logarithm to the base ten of the ratio of the sound power radiated by the source to a reference sound power. The reference sound power used in this standard is one picowatt (pW).

3.9 Sound Pressure Level. The sound pressure level (L_p) in decibels (dB re 20 μPa) is twenty times the logarithm to the base ten of the ratio of a given sound pressure to a reference sound pressure of 20 μPa expressed in decibels (dB). For an average listener a 10dB change in sound pressure level is roughly equivalent to a doubling of loudness.

3.10 Sone. The sone is a unit of loudness; one sone is defined as the loudness of a 1000 Hz tone having a sound pressure level of 40 dB. The loudness scale is a subjective scale, and has been established such that a sound of loudness of two sones is twice as loud as the 40 dB reference sound of one sone; three sones is three times as loud as one sone, etc. The definition of loudness is based on the Stevens method as outlined in ANSI S3.4.

3.11 Sound Rating. A set of values that characterize the sound behavior of a portable household electric room air cleaner. For this standard, the sound ratings are comprised of: (1) the A-weighted sound power level (unit: dB re 1 pW) which is derived from measured one-third octave band sound pressure levels and (2) the loudness (unit: sone) which is derived from calculated one-third octave band pressure levels for the rating distance of 1 meter and spherical divergence.

3.12 Rating Distance. Sound pressure level must be expressed at a stated distance from the air cleaner. In this procedure, the sound pressure level is computed as if the person hearing the sound is one meter (1 meter = 3.3 feet) from the air cleaner. The rating distance is one meter away in a spherical free field.

4. GENERAL CONDITIONS FOR MEASUREMENT

The following conditions shall be met prior to and during the sound testing.

1. Units received for testing shall be inspected upon receipt for shipping damage or other visual defects.

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2. The number and type of filters in the air cleaner shall be documented.

3. The run-in and the sound test shall be conducted with the air cleaner operating at rated voltage and frequency within ±1%.

4. The run-in period in the reverberation room immediately prior to test shall not be less than 30 minutes.

5. The air cleaner run-in and sound test shall be conducted at the highest speed setting with all additional features turned "on"

6. The air cleaner shall be located near a corner in the room, between 1.5 and 2.0 meters from the two closest boundary surfaces/walls. Refer to ANSI S12.51, Section 7.2.

7. The use of a foam windscreen on the microphone is required for these tests.

   The same windscreen shall be used in measuring to one-third octave band sound pressure levels from both the reference sound source and the air cleaner being tested.

NOTE: Pressure fluctuations due to high air speed and air streams causing turbulence at the microphone may affect the measurement and result in an overestimation of the sound power level of the air cleaner. This effect may be minimized by reorienting the air cleaner so that air streams minimally impinge on the microphone.

8. A record shall be made of the actual equipment rating and thermal operating conditions under which the air cleaner was tested, including:

   Voltage, unit: V (volts)

   Frequency, unit: Hz (hertz)

   Dry Bulb Temperature, unit: °F (degrees Fahrenheit)

   Wet Bulb Temperature, unit: °F (degrees Fahrenheit)

   Barometric Pressure, unit: in. Hg (inches of Mercury)

   Power, unit: W (watts)

9. Test Chamber Ambient Temperature and Humidity

   Chamber ambient temperature is to be (70 ± 5) °F [(21 ± 3) °C] with a relative humidity (RH) of (40 ± 10)%.

5. TEST REQUIREMENTS

5.1 Test Requirements. All sound tests used to determine sound ratings or to verify published sound ratings shall be conducted in accordance with ANSI Standard S12.51, using the comparison method with a reference sound source calibrated in accordance with ANSI S12.5. Throughout the frequency range, the laboratory facility shall have been qualified for broad band response in accordance with ANSI S12.51 using frequency rather than noise source position as the independent variable.

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5.1.1 Data to be Recorded. One-Third Octave Band Sound Pressure Levels shall be determined and recorded for the frequency bands from 100 to 10,000 Hz in accordance with ANSI S12.51.

6. SOUND POWER LEVEL AND LOUDNESS CALCULATIONS AND RATINGS

6.1 Rating System

This system utilizes a dual rating system.

1. A-Weighted Sound Power Level, L_{WA}, unit: dB re 1 pW

2. Loudness, s_t, unit: $sone_o$ (Stevens)

Both of the ratings are based on the same One-Third Octave Band Sound Pressure Level test data.

6.2 A-Weighted Sound Power Level

6.2.1 Conversion of One-Third Octave Band Sound Pressure to One-Third Octave Band Sound Power Levels. All of the measured One-Third Octave Band Sound Pressure Level data acquired in Section 5 shall be converted to One-Third Octave Band Sound Power Levels using Equation 1.

Equation 1 $$L_{w(n)} = L_{p(n)} + [L_{wr(n)} - L_{pr(n)}]$$

Where:

$L_{w(n)}$ = Test unit Sound Power Level, dB, in the nth One-Third Octave Band

$L_{p(n)}$ = Test unit measured Sound Pressure Level, dB, in the nth One-Third Octave Band

$L_{wr(n)}$ = RSS Sound Power Level, dB, in the nth One Third Octave Band

$L_{pr(n)}$ = RSS measured Sound Pressure Level, dB, in the nth One-Third Octave Band

6.3 Determination of the A-weighted sound power level rating, L_{WA}

6.3.1 The A-weighted sound power level rating for the specified air cleaner shall be determined from the one-third octave band sound power levels obtained in 6.2.1 by using Equation 2 and rounding off to the nearest 0.1 decibel.

Equation 2 $$L_{WA} = 10 \log_{10}\left[\sum_{1}^{N} 10^{(L_{W(n)} + L_{A(n)})/(10\ \mathrm{dB})}\right]$$

Where:

L_{WA} = A-weighted sound power level, dB re 1 pW

$L_{W(n)}$ = one-third octave band sound power level in nth band, dB re 1 pW

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$L_{A(n)}$ = A-weighting adjustments for the nth band from Table 2.

N = total number of bands. For the standard one-third octave bands of Table 1, with nominal mid-band frequencies from 100 – 10,000 Hz, N = 21

6.4 Loudness

6.4.1 This procedure describes the method for the computation of a single number rating for the loudness of Portable Household Electric Room Air Cleaners. The rating is in sones based on the measured sound power levels extrapolated to sound pressure at a distance of one meter (3.3 feet) , using spherical divergence.

The loudness in sones is calculated from the One-Third Octave Band Sound Power Level, calculated in 6.2. From the One-Third Octave Band Sound Power Level, the calculated One-Third Octave Band Sound Pressure Level is obtained using Equation 3:

Equation 3 $$L_{pn} = L_{Wn} - 11.0 \text{ dB}$$

L_{pn} = calculated one-third octave band sound pressure level in the nth band, dB re 20 uPa

L_{Wn} = one-third octave band sound power level in the nth band, dB re 1 pW

This computation gives the predicted one-third octave band sound pressure level for the test air cleaner at the rating distance of 1 meter.

6.4.2 Computation of the One-Third Octave Band Test Air Cleaner Loudness Each of the twenty-one (21) one-third octave band sound power levels are converted to sone values by interpolation in Table of Loudness Index Values (Annex A).

6.4.3 Computation of the Loudness Rating of Air Cleaners. In accordance with ANSI Standard S3.4, the computation of the single number sone rating of the test air cleaner is achieved by using Equation 4 (using the Tables in Annex C).

Equation 4 $$S_t = I_m + 0.15\left(\sum_{n=1}^{21} I_n - I_m\right)$$

Where:

Σ I is the sum of the twenty-one individual one-third octave band sone values

I_n is the sone loudness value for the nth one-third octave band

I_m is the greatest one-third octave band sone value

S_t is the loudness rating of the air cleaner in sones.

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