



## Standard Test Method for Determining A-Weighted Sound Power Level of Vacuum Cleaners<sup>1</sup>

This standard is issued under the fixed designation F 1334; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This test method covers the overall A-weighted sound pressure level emitted by small portable upright, canister, and combination vacuum cleaners intended for operation in domestic and commercial applications.

1.2 The measurement is performed on a stationary vacuum cleaner in a semi-reverberant room. This test method determines sound power by a comparison method for small noise sources, that is, comparison to a broad band reference sound source.

1.3 This test method describes a procedure for determining the approximate sound power level of small noise sources. This test method uses a non-special semi-reverberant room.

1.4 Results are expressed as sound power level in decibels.

1.5 The values stated in inch-pound units are to be regarded as the standard. The SI units given in parentheses are for information only.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

### 2. Referenced Documents

#### 2.1 ASTM Standards:

C 634 Definitions of Terms Relating to Environmental Acoustics<sup>2</sup>

E 177 Practice for Use of the Terms of Precision and Bias in ASTM Test Methods<sup>3</sup>

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method<sup>3</sup>

F 608 Method for Evaluation of Carpet-Embedded Dirt Removal Effectiveness of Household Vacuum Cleaners (Laboratory Method)<sup>4</sup>

F 655 Specifications for Test Carpets and Pads for Vacuum Cleaner Testing<sup>4</sup>

#### 2.2 ANSI Standards:

S1.4-1983 Specifications for Sound Level Meters<sup>5</sup>

S12.31-1990 Precision Methods for the Determination of Sound Power Levels of Broad Band Noise Sources in Reverberant Rooms<sup>5</sup>

S12.32-1990 Precision Methods for Determination of Sound Power Levels for Discrete Frequency and Narrow Band Noise Sources in Reverberant Rooms<sup>5</sup>

S12.33-1990 Engineering Methods for Determination of Sound Power Levels of Noise Sources in a Special Reverberant Test Room<sup>5</sup>

#### 2.3 ISO Standard:

3741, 3742, and 3743 are similar to and may be used in place of ANSI S12.31, S12.32 and S12.33 respectively<sup>5</sup>

#### 2.4 IEC Standard:

704.1 Test Code for the Determination of Airborne Acoustical Noise Emitted by Household and Similar Electrical Appliances<sup>5</sup>

### 3. Terminology

#### 3.1 Definitions:

3.1.1 *population*—the total of all of the units of the particular model and/or type of vacuum cleaner being tested.

3.1.2 *population sample or sample*—three or more units, randomly taken from the population.

3.1.3 *test unit or unit*—a single vacuum cleaner of the model and/or type being tested.

3.1.4 Unless otherwise indicated, definitions are in accordance with Terminology C 634.

### 4. Significance and Use

4.1 The test results enable the comparison of A-weighted sound emission from vacuum cleaners when tested under the condition of this test method.

### 5. Test Room Requirements

5.1 The test room shall be semi-reverberant. It shall contain sufficiently little sound absorption material so the requirements

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee F-11 on Vacuum Cleaners and is the direct responsibility of Subcommittee F11.25 on Sound Measurement.

Current edition approved Nov. 10, 1997. Published August 1998. Originally published as F 1334 – 91. Last previous edition F 1334 – 91.

<sup>2</sup> *Annual Book of ASTM Standards*, Vol 04.06.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 14.02.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 15.07.

<sup>5</sup> Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

of 5.2 can be met. It should be large enough to meet the dimension requirements of 5.2. Check the calibration of each microphone according to the instrument manufacturer's directions.<sup>6</sup>

5.2 Identify a location on the test room floor which can accommodate six equally spaced microphone positions 60° apart located at a height of 60 in. (1.5 m) above the floor on a 12 ft (3.6 m) diameter circle the center of which is the center of the sound source. These positions shall result in a standard deviation of the six sound pressure measurements of not more than 2.3 dB when measuring the reference sound source. This location is suitable for the vacuum cleaner and reference sound source for this test method.

5.3 *Environmental*—Ambient test conditions within the test room shall be controlled to within  $20 \pm 4^\circ\text{C}$  and 30 to 70 % relative humidity.

5.4 Also, any room which has qualified in accordance with ANSI S1.26, S12.31, S12.32, S12.33, ISO 3741, 3742 and 3743 may be used to measure the sound power levels of vacuum cleaners.<sup>7</sup>

5.5 The measured A-weighted sound pressure levels shall be corrected for the influence of background noise according to Table 2.

## 6. Instrumentation and Equipment

6.1 *Acoustical Instrumentation*—The sound measurement system shall be as specified in ANSI S1.4-1983.

6.2 *Voltage Regulator System*—The regulator shall be capable of maintaining  $\pm 1$  V, the rated voltage ( $\pm 1$  %) and frequency ( $\pm 1$  Hz) with sinusoidal wave form.

6.3 *Test Carpet and Pad*—The test carpet and pad shall be 54 in. wide (137 cm) and 72 in. (183 cm) long. The carpet shall be multilevel. Carpet and pad shall be as specified in Specification F 655.

NOTE 1—For this test method two standard size 27 by 72-in. (69 by 183-cm) long test carpets could be placed side by side to make it 54 by 72-in. (138 by 183-cm) long. It is recommended that the two pieces of test carpet be taped to the floor, side by side with the pile running in the same direction.

<sup>6</sup> Further information provided in ANSI S1.10-1966 (R1986) Method for the Calibration of Microphones, available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

<sup>7</sup> Further information provided in ANSI S1.26-1978 (R1989) Method for the Calibration of the Absorption of Sound by the Atmosphere, available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

**TABLE 2 Corrections for Background Noise Levels**

Difference Between Sound Pressure Level Measured with Sound Source Operating and Background Noise Level Alone, dB		Correction to be Subtracted from Sound Pressure Level Measured with Sound Source Operating to Obtain Sound Pressure Level Due to Sound Source Alone, dB
Less than	6	No correction allowed
	6	1
	7	1
	8	1
	9	0.5
	10	0.5
Greater than	10	0

6.4 *Reference Sound Source*—The reference sound source shall meet the requirements of Section 9 of ANSI S12.31.

6.5 *Instrumentation*:

6.5.1 *Thermometer*, accurate to within  $\pm 2^\circ\text{C}$ .

6.5.2 A means of measuring relative humidity, accurate to within  $\pm 2$  % over the range used.

6.5.3 *Barometer*, accurate to within  $\pm 2$  %.

## 7. Operation of Vacuum Cleaner

7.1 *Run-In*—Operate new test cleaners continuously for at least 1 h prior to testing. Canister cleaners shall be run open with no hose attached. Upright and power nozzles shall be run so that the rotating brush does not engage the carpet or the floor.

7.2 *Warm-Up*—Operate the cleaners for 10 min just prior to making sound pressure level measurements in the same configuration as described in 7.1.

7.3 *Test Configuration*:

7.3.1 The vacuum cleaner shall be configured for the carpet cleaning mode.

7.3.2 The dust bag or primary filter shall be new.

7.3.3 All belts shall be new at the start of the run-in.

7.3.4 Rotating agitator type cleaner including power nozzle shall use the same setting as specified in Test Method F 608 for cleaning multilevel carpet that is as follows:

7.3.4.1 If various settings are provided, set the motor speed setting, suction regulator, or nozzle height, or combination thereof, using the manufacturer's specified setting for cleaning multilevel carpet. Momentary or instantaneous speeds are not to be used.

7.3.5 For straight air canister cleaners use the same setting specified in Test Method F 608 for cleaning multilevel carpet, that is as follows:

7.3.5.1 If various settings are provided, the motor setting, suction regulator, or nozzle height, or combination thereof, using the manufacturer's specific setting for cleaning multilevel carpet. If no specific instructions are given, or if judged to be inadequate or unclear, position the nozzle on the carpet so the maximum suction is provided, taking care to maintain the tilt angle throughout the test. Momentary or instantaneous speeds are not to be used.

7.3.6 *Voltage*—Tests are to be conducted at the nameplate voltage ( $\pm 1$  %) and frequency ( $\pm 1$  Hz), when measured at the appliance plug. For cleaners with dual nameplate voltage ratings, conduct sound tests at the highest voltage.

## 8. Location of Sound Sources and Equipment

8.1 *Carpet and Pad*—Lay the carpet and pad directly on the floor over the location defined in 5.2 with the geometric center of the carpet coinciding with the test location.

8.2 Locate the vacuum cleaner or the reference sound source at the position determined in 5.2. All modules (generally the motor/blower and its housing in the base of an upright unit, or in the canister of a canister unit) shall be adequately secured in a manner which will not affect the sound pressure readings.

8.2.1 *Reference Sound Source Location*—Position the center of the radiating portion (fan blades, for an aerodynamic source) over the location defined above. The reference sound source is placed directly on the carpet.

## 8.2.2 Vacuum Cleaner Location:

8.2.2.1 Center the principal module over the source location as determined in 5.2.

8.2.2.2 Take care to ensure the rotating brush model does not damage the carpet seam (that is, center upright on carpet on center of carpet with the rotating brush perpendicular to seam).

8.2.2.3 *Second Module*—If there is a second module not integral with the basic unit (for example, the power nozzle), it shall be positioned on the side of the principle module away from the center of the room. Position the second module in such a way that, to the maximum extent possible, its sound emissions are not shielded by the principal module, and vice versa. For example, a position shall be such that air exhaust noise will radiate into the room in a direction other than toward the second module.

8.2.3 *Handle*—Any operating handle shall be separately supported in a position such that the handle grip is 31 in. (79 cm) above the carpet surface. Take care that the support structure does not introduce additional rattles, etc. There shall be a rigid clamping of the handle to the support structure.

## 9. Sampling

9.1 Test a sufficient number of samples of each vacuum cleaner model until a 90 % confidence level is established within  $\pm 2.0$  dBA of the mean value. Test a minimum of three samples.

## 10. Procedure

10.1 With the vacuum cleaner operating according to Section 7 of this test method, take six sound pressure level (A-weighted) readings from the positions in accordance with 5.2 (six is defined as the minimum number of microphone positions) with the microphone directed towards the sound source. The use of more microphone positions is permissible. Calculate the average sound pressure level:

$$L_m = 10 \log \left\{ \frac{1}{N_m} \sum_{i=1}^{N_m} 10^{L_i/10} \right\} \quad (1)$$

where:

$L_M$  = octave-band or A-weighted sound pressure level averaged over all microphone positions, for a single source location, dB,

$L_i$  = octave-band or A-weighted sound pressure level for the  $i$ th microphone position, dB, and

$N_m$  = number of microphone positions.

10.2 Replace the vacuum cleaner with the reference sound source. Operate the sound source according to the manufacturer's recommendations. Using the same microphone positions as in 10.1, take sound pressure level readings from each of the microphone positions. Calculate the average sound pressure level by using the Eq 1 in 10.1.

10.3 Using the same test vacuum cleaner repeat 10.1 and 10.2 two additional times for a total of three test runs.

10.4 Calculate the value of A-weighted sound power level for each sound pressure level recorded according to the "comparison method" in Section 11.

10.5 The sound power value for each individual test unit is the average of three test runs meeting the repeatability statements in Section 14.

10.6 A minimum of two additional test units of the same model must be selected in accordance with the sampling statement of Section 9. Repeat 10.1-10.4 for each additional test unit. See Annex A1 for a procedural example and whether additional units need to be tested.

10.7 The best estimate of sound power level for the population of the vacuum cleaner model being tested is the arithmetic mean of the sound power level of the sample population meeting the requirements of the sampling statement in Section 9.

## 11. Calculation of Sound Power Levels for the Comparison Method

11.1 Calculate the sound power level produced by the source in each octave band within the frequency range of interest as follows. Subtract the band source pressure level produced by the reference sound source (corrected for background noise according to 5.5) from the band sound pressure level of the source under test (corrected for the background noise according to 5.5). Add the difference to the known sound power level produced by the reference sound source:

$$L_w = L_{wr} + L_p - L_{pr} \quad (2)$$

where:

$L_w$  = the octave-band or A-weighted sound power level, in decibels, produced by the source under test,

$L_p$  = the average octave-band or A-weighted sound pressure level, in decibels, produced by the source under test, as determined in accordance with 10.1,

$L_{wr}$  = the known octave-band or A-weighted sound power levels, in decibels, produced by the reference sound source, and

$L_{pr}$  = the average octave-band or A-weighted sound pressure level, in decibels, produced by the reference sound source, as determined in accordance with 10.1.

## 12. Information

12.1 *General*—Record the name and location of the test laboratory, including the date and time of the measurements.

12.2 *Test Room*—Record the description of the room construction, dimensions, configurations, and deployment of absorptive materials, etc.

12.3 *Equipment*—Maintain recorded diagram of the acoustical data acquisition system. This shall include the model number and serial number of all microphones, preamplifiers, filters, meters, etc. Describe microphone cables specifically. Record the calibrator model number and serial number, output frequency and calibrated level. Record any other pertinent equipment information.

12.4 *Geometry*—Record the source location point and the microphone positions.

12.5 *Vacuum Cleaner*—Record the manufacturer, model name and number, and unit serial number.

12.6 *Environment*—Record the temperature, relative humidity, and barometric pressure.

12.7 *Calibration Check*—Record the actual readout level with the calibrator on the microphone, both at the beginning and end of the measurement period, to the nearest 0.1 dB, or as