ANSI/AHRI Standard 230

2013 Standard for

Sound Intensity Testing Procedures for Determining Sound Power of HVAC Equipment

Approved American National Standard

ANSI

AHRI

AIR-CONDITIONING, HEATING, & REFRIGERATION INSTITUTE

we make life better™

2111 Wilson Boulevard, Suite 500
Arlington, VA 22201, USA
www.ahrinet.org
PH 703.524.8800
FX 703.562.1942

Approved by ANSI on April 15, 2014

IMPORTANT

SAFETY DISCLAIMER

AHRI does not set safety standards and does not certify or guarantee the safety of any products, components or systems designed, tested, rated, installed or operated in accordance with this standard/guideline. It is strongly recommended that products be designed, constructed, assembled, installed and operated in accordance with nationally recognized safety standards and code requirements appropriate for products covered by this standard/guideline.

AHRI uses its best efforts to develop standards/guidelines employing state-of-the-art and accepted industry practices. AHRI does not certify or guarantee that any tests conducted under its standards/guidelines will be non-hazardous or free from risk.

Note:

This is a new Standard.

This standard describes the methodology for determination of Sound Power Levels of broad-band, and/or discrete-frequency noise sources using the intensity method. It is based on sound tests utilizing the sound intensity method as described in ISO 9614-1 (measurement at discrete points, grade 2) or ISO 9614-2 (measurement by scanning, grade 2).

Price $10.00 (M) $20.00 (NM)
Printed in U.S.A.

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

SOUND INTENSITY TESTING PROCEDURES FOR DETERMINING SOUND POWER OF HVAC EQUIPMENT

Section 1. Purpose

1.1 *Purpose.* The purpose of this standard is to provide the methodology for the determination of Sound Power Levels of noise sources using the sound intensity method. The standard contains information on instrumentation, installation and operation of the source and procedures for the calculation of Sound Power Level.

This standard covers the frequency range from the 50 Hz to the 10,000 Hz One-third Octave Band (63 Hz to 8000 Hz Octave Bands). The product specific AHRI sound performance rating standard will specify the frequency range of interest for qualification, calculation, and reporting. This standard is based on ISO 9614-1 (grade 2) or ISO 9614-2 (grade 2) but provides additional exceptions and extensions. Section 7.2 refers to measurement at discrete points and Section 7.3 refers to measurement by scanning.

1.1.1 *Intent.* This standard is intended for the guidance of the industry, including manufacturers, engineers, installers, contractors and users.

1.1.2 *Review and Amendment.* This standard is subject to review and amendment as technology advances.

1.2 *Measurement Uncertainty.* Sound Power Levels obtained from intensity measurements made in conformance with this standard shall result in measurement standard deviations which are equal to or less than those in Table 1. The uncertainties in this table include uncertainty in the sound intensity measurement method due to the test environment, background noise levels and selection of measurement points as defined in ISO 9614-1 (grade 2) or measurement surfaces in ISO 9614-2 (grade 2). The standard deviations in Table 1 do not account for variations of sound power caused by changes in operating conditions.

Table 1. Maximum Standard Deviations of Sound Power Level Reproducibility Determined in Accordance With This Standard

One-third Octave Band Center Frequency, Hz	One-third Octave Band Maximum Standard Deviation of Reproducibility, dB
50 - 80	4.0
100 - 160	3.0
200 - 315	2.0
400 - 5000	1.5
6000 - 10000	3.0

Section 2. Scope

2.1 *Scope.* This standard applies to HVAC products where sound power is determined by measurement using the sound intensity method. This standard provides a standalone method of test that is referenced by other AHRI sound performance rating standards and provides an alternative to the reverberation room method of test outlined in AHRI Standard 220.

Section 3. Definitions

All terms in this document will follow the standard industry definitions in the *ASHRAE Wikipedia* website (http://wiki.ashrae.org/index.php/ASHRAEwiki) unless otherwise defined in this section.

3.1 *Broadband Sound.* Sound that is random in nature with frequency components distributed over a broad frequency band. Typically pure tones or periodic disturbances will not be distinguishable in this type of sound spectrum.

3.2 *Discrete Frequency Sounds/Tones*. These consist of one or more sounds, each of which is essentially sinusoidal.

3.3 *Discrete Frequency Source*. A noise source that produces Discrete Frequency Sounds/Tones.

3.4 *Octave Band*. A band of sound covering a range of frequencies such that the highest is twice the lowest. The Octave Bands used in this standard are those defined in ANSI Standard S1.6.

3.5 *One-third Octave Band, n*. A band of sound covering a range of frequencies such that the highest frequency is the cube root of two times the lowest frequency. The One-third Octave Bands used in this standard are those defined in ANSI Standard S1.6.

3.6 *Pressure-Residual Intensity Index (PRI).* The difference between the indicated Sound Pressure Level, L_p, and the indicated Sound Intensity Level, L_i, when the intensity probe is placed in a sound field such that L_i is zero for each frequency band. Details of determining the PRI are provided in Clause 6.1 of ISO 9614-1 and ISO 9614-2.

3.7 *Reference Sound Source (RSS).* A portable, aerodynamic sound source that produces a known stable broadband sound power output.

3.8 *"Shall" or "Should."* "Shall" or "should" shall be interpreted as follows:

3.8.1 *Shall*. Where "shall" or "shall not" is used for a provision specified, that provision is mandatory if compliance with the standard is claimed.

3.8.2 *Should*. "Should" is used to indicate provisions which are not mandatory but which are desirable as good practice.

3.9 *Reproducibility*. Deviations in test results obtained with the same method on identical test items in different laboratories with different operators using different test instrumentation.

3.10 *Sound Intensity Level, L_i*. Ten times the logarithm to the base ten of the ratio of the sound intensity component radiated by the source to a reference sound intensity, expressed in decibels (dB). The reference sound intensity used in this standard is 1 picowatt per meter squared (pW/m^2). The sound intensity component is the value of the intensity vector, normal to a measurement surface, directed out of a volume enclosing the sound source.

3.11 *Sound Power Level, L_w*. Ten times the logarithm to the base ten of the ratio of the sound power radiated by the source to a reference sound power, expressed in decibels, dB. The reference sound power used in this standard is 1 picowatt, pW.

3.11.1 *A-weighted Sound Power Level (L_{wA}).* The logarithmic summation of A-weighted, one-third octave band Sound Power Levels.

3.12 *Sound Pressure Level, L_p*. Twenty times the logarithm to the base ten of the ratio of a given sound pressure to a reference sound pressure of 20 μ Pa, expressed in decibels, dB.

3.13 *Unit Under Test (UUT).* HVAC equipment or duct termination for which the sound power is to be determined.

Section 4. General Requirements

4.1 *Size of Noise Source.* The size and shape of the noise source is unrestricted and serves to define the measurement surface. The measurement surface, consisting of multiple sub-surfaces, shall totally enclose the noise source under test. The basic concept is measurement of the sound intensity distribution around the equipment.

4.2 *Character of Noise Radiated by the Source.* The signal shall be stationary in time, as defined in Clause 3.13 of ISO 9614-1 (grade 2) and Clause 3.13 of ISO 9614-2 (grade 2). Care should be taken to avoid measurement during times of operation of non-stationary extraneous noise sources of which the occurrences are predictable.

4.3 *Time Averaging.* To minimize the random error in the measurement, it is required that the averaging time be long enough to give repeatable results. The minimum averaging time shall be 30 seconds per each square meter of measurement surface.

Section 5. Acoustic Environment

5.1 *Criteria for Adequacy of the Test Environment.* The temperature, humidity and barometric pressure of the test environment shall be within the instrument manufacturer's stated limits. In addition, the test environment shall satisfy the requirements stated in clauses 5.2 to 5.4 of ISO 9614-1 (grade 2) and 5.2 to 5.4 of ISO 9614-2 (grade 2) covering extraneous intensity, vibration, temperature, configuration of the surroundings and atmospheric conditions. Even though sound intensity measurements are relatively insensitive to background sound compared to other methods, an excessive amount of background sound will increase the uncertainty of the measurements. The background Sound Pressure Level shall be no greater than the direct sound from the equipment under test.

Care shall be taken to ensure that flow–induced noise over the intensity probe does not influence the measurements. Measurements shall be performed with a windscreen at all times. The windscreen shall meet the requirements of AHRI Standard 250 Section 5.10. Averaging times may be extended to improve the measurement results. Intensity measurements in airflow shall meet the requirements in Section 6.3.

For some measurements consisting of discrete points according to ISO 9614-1 or scanned sub-surfaces according to ISO 9614-2, it may not be possible to eliminate flow-induced noise over the intensity probe. Provided all measurements that are invalid due to flow-induced noise do not exceed 10% of the total measurement surface area, such discrete points or scanned sub-surfaces may be excluded when determining the sound power of the noise source.

Section 6. Instrumentation

6.1 *General.* The sound intensity instruments and probes used for measurement shall meet the class 1 requirements of IEC 61043. Measurements and analysis shall be conducted in One-third Octave Bands using equipment in compliance with ANSI Standard S1.11. Synthesized One-third Octave Band levels from narrow band analysis are not allowed.

For the calibration and field check of the instruments, see the requirements of Clause 6.2 of ISO 9614-1 (grade 2) and 9614-2 (grade 2). The two values of the normal sound intensity, $I_{(n)}$, at each One-third Octave Band for the field check should have opposite signs and the allowable difference in Sound Intensity Levels, L_i, shall be less than 1.5 dB in all bands.

6.2 *Instrumentation.* The sound intensity instrumentation shall be capable of measurements from the 50 Hz to the 10,000 Hz One-third Octave Band. A common sound intensity probe consists of two 12mm diameter pressure microphones in a face-to-face configuration with a solid spacer between the microphone grids. The use of two different intensity microphone spacers may be required to cover the entire frequency range in conformance with Table 1. A 50mm microphone spacer is typically used for the one-third octave band frequency range from 50 Hertz to 315 Hertz; a 12mm microphone spacer is typically used for the one-third octave band frequency range from 400 Hz to 10,000 Hz. The use of a single microphone spacer for the entire range of frequency bands is, however, permitted if the requirements of Sections 6.3 and 6.4 are met.

Some intensity analyzers have a built in feature to correct for the high frequency roll off of the intensity probe with a specific microphone spacer. If the analyzer does not provide a high frequency correction, the procedure in Section 6.4 may also be used to quantify the high frequency correction at the 1,600 Hz through 10,000 Hz One-third Octave Bands.

The Pressure-Residual Intensity Index (PRI) of the measurement instrumentation (microphone pair, spacer and analyzer) shall be recorded according to the procedure in Clause 6.1 of ISO 9614-1 and ISO 9614-2 for each frequency band. This procedure is referred to as phase calibration. The procedure in Section 6.3 of this standard is then used to check the quality of each sound intensity measurement.

6.3 *Qualification of Sound Intensity Measurements.* To conform with this standard, the quality of each measurement shall meet the following requirements for each One-third Octave Band:

$$PI_{(n)} < PRI_{(n)} - 10 \qquad (1)$$

Where:

$PI_{(n)}$ = Pressure-intensity index (mean-pressure level minus the intensity level) of the measurement for the n^{th} One-third Octave Band, dB

$PRI_{(n)}$ = Pressure-Residual Intensity Index, determined by the phase calibration of the particular microphone pair, spacer and analyzer used for the measurement for the n[th] One-third Octave Band, dB

Measurements in each frequency band that do not meet this requirement are invalid. Measurements in each frequency band where the mean-pressure level is less than the intensity level (PI index is negative) are also invalid. This condition often occurs when the measurement is influenced by flow-induced noise over the probe.

6.4 *High Frequency Correction*. For measurements systems using 10 to 15 mm microphone spacers, the results of the performance verification in Section 6.5 may be used to determine a high frequency correction for each individual sound intensity probe and analyzer combination. The probe correction, $L_{wi(n)}$, is the one-third octave band level in decibels that is added to the sound power, determined by the intensity measurements, to equal the sound power of the Reference Sound Source (RSS). The high-frequency probe correction shall only be applied to the 1600 Hz through 10,000 Hz One-third Octave Bands.

6.5 *Performance Verification by Comparison with a Reference Sound Source.* In order to ensure consistent and accurate sound intensity results, it is required to periodically verify the performance of the instrumentation system and the skill of the test operator. The performance of the sound intensity instrumentation system shall be verified at an interval no longer than 90 days by determining the sound power of a Reference Sound Source (RSS) according to ANSI S12.12, Section 5.8. The performance of the test operator shall be verified every 30 days by: 1) determining the sound power of a Reference Sound Source (RSS) according to ANSI S12.12, Section 5.8 or 2) by having demonstrated the successful execution of additional sound intensity tests. The Reference Sound Source used for this verification shall have the characteristics required in AHRI Standard 250 and be calibrated in accordance with AHRI Standard 250 for the frequency range of 50 Hz to 10kHz. The measurement grid shall be as shown in Figure 1. The same sound intensity probe, windscreen and analyzer combination shall be used during the performance verification and all subsequent intensity measurements. The sound power, determined by intensity measurements with the high frequency correction as determined in Section 6.4, shall differ from the RSS value as determined by AHRI Standard 250 by no more than the levels shown in Table 2.

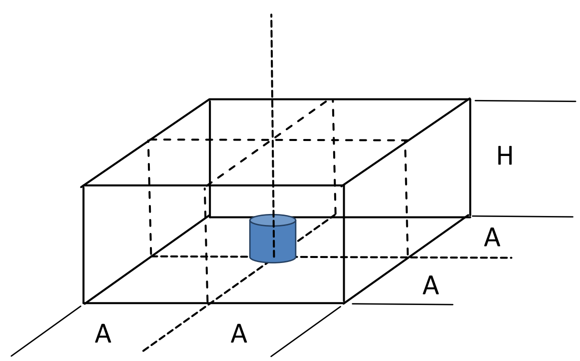

Figure 1. Performance Verification Measurement Grid

The RSS shall be mounted on the floor with the vertical axis at the center of the measurement grid passing through the center of the RSS fan wheel. Dimensions "A" and “H” shall be no less than 1 meter.

Table 2 – Performance Verification Limits	
One-third Octave Band, Hz	Tolerance, dB
50 to 80	3.0
100 to 160	2.0
200 to 5000	1.5
6300 to 10000	2.5

Section 7. Measurement of Component Sound Intensity Levels

7.1 *Measurement Surface*. The measurement surface shall be defined to enclose the source or sources of interest and to exclude other noise sources or absorptive materials that are not an integral part of the source under test. The measurement surface shall be divided into sub-surfaces with known areas, preferably equal in size. When scanning, the sub-surfaces should be small enough to facilitate the reach of the operator and to maintain even coverage with time. A suggested maximum size of each sub-surface is 1 m^2. The number of sub-surfaces shall be at least the larger of: 1) the surface area in square meters or 2) eight. After a set of measurements is made, the average of the original set of measurement points or sub-surfaces shall be compared to a set with half the number of measurements to ensure the adequacy of the number of measurement points or sub-surfaces. This is especially true for tonal noise sources. This concept is called convergence index. The choice of measurement points or sub-surfaces shall be shown to result in a convergence index less than or equal to the following in Table 3.

Table 3 – Convergence Index

One-third Octave Band, Hz	Tolerance, dB
50 to 160	0.75
200 to 5000	0.4
6300 to 10000	0.65

The convergence index shall be calculated from the difference between two calculations of the surface Sound Intensity Level using N and N/2 sub-surface evenly distributed areas using Equation 2.

$$\delta_{(n)} = L_{Ia(n)} - L_{Ib(n)} \qquad 2$$

Where:

$\delta_{(n)}$ = Convergence index for the n^{th} One-third Octave Band
$L_{Ia(n)}$ = Intensity level determined from N sub-surface areas for the n^{th} One-third Octave Band
$L_{Ib(n)}$ = Intensity level determined from N/2 sub-surface areas for the n^{th} One-third Octave Band
N = Total number of measurement positions and sub-surfaces

7.2 *Measurements Employing Discrete Points – ISO 9614-1 (grade 2).*

7.2.1 *Initial Test.* Make measurements of normal sound intensity on an initial measurement surface. If this initial surface proves to be unsatisfactory, modify it according to the actions specified in Annex B of ISO 9614-1 (grade 2). The initial measurement surface shall be defined around the source under test.

Note: This surface should preferably take one of the geometrically simple and quantifiable forms indicated in Figure 1 of ISO 9614-1 (grade 2). Follow the procedures outlined in Clause 8 of ISO 9614-1 (grade 2) for conducting the initial tests and any additional tests which may be required.

7.2.2 *Calculation of Sound Power Level.*

7.2.2.1 *Calculation of Partial Sound Power for Each Sub-surface of the Measurement Surface(s).* Calculate a partial sound power in each frequency band for each sub-surface of the measurement surface from Equation 3.

$$P_{(n)k} = I_{(n)k} \cdot S_k \qquad 3$$

Where:
$I_{(n)k}$ = Signed magnitude of the normal sound intensity component measured at position k on the measurement surface for the n^{th} One-third Octave Band, W/ m^2
$P_{(n)k}$ = Partial sound power for sub-surface k for the n^{th} One-third Octave Band, W
S_k = Area of sub-surface k, m^2

Where the normal sound intensity level, $L_{i(n)k}$, for sub-surface k and the n^{th} One-third Octave Band is expressed in decibels, the value of $I_{(n)k}$ shall be calculated from Equation 4.

$$I_{(n)k} = I_0 \cdot 10^{L_{i(n)k}/10} \qquad 4$$

Where:
$I_0 = 10^{-12}$ W/m^2

Where the normal Sound Intensity Level $L_{i(n)k}$ for sub-surface k and the nth One-third Octave Band is a negative vector indicating that it points towards the source, the value of $I_{(n)k}$ shall be calculated from Equation 5.

$$I_{(n)k} = -I_0 \cdot 10^{L_{i(n)k}/10} \text{W/m}^2 \qquad 5$$

7.2.2.2 *Calculation of the Sound Power Level of the Noise Source.* Calculate the Sound Power Level of the noise source in each frequency band from Equation 6.

$$L_{w(n)} = 10 \lg \sum_{k=1}^{N} \left(\frac{P_{n(k)}}{P_0} \right) + L_{k(n)} \qquad 6$$

Where:

$L_{wk(n)}$ = High frequency compensation determined in Section 6.4 for the nth One-third Octave Band, dB
$L_{w(n)}$ = Test unit component Sound Power Level for the nth One-third Octave Band, dB
N = Total number of measurement positions and sub-surfaces
$P_{n(k)}$ = Partial sound power for sub-surface k, calculated from Equation 3 for the nth One-third Octave Band, W
P_0 = Reference sound power = 10^{-12} W

7.3 *Measurements Employing Scanning ISO 9614-2 (grade 2).* The scanning procedure and the definition of the initial measurement surface shall be as described in Clauses 8.l and 8.2 of ISO 9614-2.

7.3.1 *Calculation of Partial Sound Power.* Calculate a partial sound power in each frequency band for each sub-surface of the measurement surface from Equation 7.

$$\overline{P_{(n)k}} = \overline{I_{(n)k}} \cdot S_k \qquad 7$$

Where:

$\overline{I_{(n)k}}$ = Signed magnitude of the sub-surface average normal sound intensity measured on partial surface k on the measurement surface for the nth One-third Octave Band, W/m^2
$\overline{P_{(n)k}}$ = Partial sound power determined by scanning for sub-surface k for the nth One-third Octave Band, W
S_k = Area of sub-surface k, m^2

7.3.2 *Calculation of Sound Power Level.* Calculate the sound power, P, of the source under test in each frequency band of interest using Equation 8.

$$\overline{P_{(n)}} = \sum_{k=1}^{N} \overline{P_{(n)k}} \qquad 8$$

Where:
N = Number of sub-surfaces of the measurement surface
$\overline{P_{(n)}}$ = Sound power for each octave band, n

Calculate the Sound Power Level, L_w, of the source under test in each frequency band of interest using Equation 9.

$$L_{w(n)} = 10 \lg \left(\frac{\overline{P_{(n)}}}{P_0} \right) + L_{wk(n)} \qquad 9$$

Where:

$L_{w(n)}$ = Test unit component Sound Power Level for the n^{th} One-third Octave Band, dB
$L_{wk(n)}$ = High frequency compensation determined in Section 6.4 for the n^{th} One-third Octave Band, dB
$\overline{P_{(n)}}$ = Source sound power for the n^{th} One-third Octave Band, W
P_0 = Reference sound power = 10^{-12} W

Note: When the intensity vector is negative, P is negative. In this case, the Sound Power Level, L_{wk}, is expressed as a negative value.

7.4 *Octave Band Sound Power Level Calculations.* Unless directed otherwise in the product specific AHRI standards, octave band sound power level calculations shall be made per Equation 10.

$$L_{wk} = 10 \cdot \log \sum_{n=3m-2}^{3m} 10^{0.1(L_{wn})} \qquad 10$$

Where:

n = An integer number lying within the range (3m – 2) and 3m, and which identifies the three One-third Octave Bands which make up the m^{th} Octave Band.
L_{wm} = Sound Power Level in the m^{th} Octave Band
L_{wn} = Sound Power Level in the n^{th} One-third Octave Band

7.4.1 *Rounding.* Data rounding shall be per directions in individual AHRI standards.

7.5 *A-weighted Sound Power Level.* Unless directed otherwise in the product specific AHRI standards, the A-weighted Sound Power Level shall be calculated per Equation 11.

$$L_{wA} = 10 \cdot \log \sum_{n=n_{min}}^{n_{max}} 10^{0.1(L_{wn} + C_n)} \qquad 11$$

Where:

C_n and n = Band index and A-weighting factor as given in Table 4
n_{min} and n_{max} = Values given in Table 4 of n corresponding, respectively, to the lowest (n_{min}) and highest (n_{max}) One-third Octave Bands of measurement
L_{wA} = A-weighted Sound Power Level
L_{wn} = Sound Power Level in the n^{th} One-third Octave Band

Table 4. One-third Octave Band Numbers and A-weighting Factors					
Band Index, n	One-third Octave Band Frequency, Hz	A-weighting factor, C_n	Band Index, n	One-third Octave Band Frequency, Hz	A-weighting factor, C_n
1	50	-30.2	13	800	-0.8
2	63	-26.2	14	1000	0.0
3	80	-22.5	15	1250	0.6
4	100	-19.1	16	1600	1.0
5	125	-16.1	17	2000	1.2
6	160	-13.4	18	2500	1.3
7	200	-10.9	19	3150	1.2
8	250	-8.6	20	4000	1.0
9	315	-6.6	21	5000	0.5
10	400	-4.8	22	6300	-0.1
11	500	-3.2	23	8000	-1.1
12	630	-1.9	24	10000	-2.5

7.4.1 *Rounding*. Data rounding shall be per directions in individual AHRI product rating standards.

7.5 *Linear Sound Power Level.* Unless directed otherwise in the product specific AHRI standards, the linear Sound Power Level shall be calculated per Equation 12.

$$L_{wL} = 10 \cdot \log \sum_{n=n_{min}}^{n_{max}} 10^{0.1(L_{wn})} \qquad 12$$

Where:

n = Band index from Table 4

n_{min} and n_{max} = Values given in Table 4 of j corresponding, respectively, to the lowest (n_{min}) and highest (n_{max}) One-third Octave Bands of measurement

L_{wn} = Sound Power Level in the n^{th} One-third Octave Band

L_{wL} = Linear Sound Power Level

Section 8. Information to be Recorded

8.1 *General*. The information listed in Section 7, when applicable, shall be compiled and recorded for all measurements made in accordance with this International Standard. In addition to the information required in Section 7.2 through 7.5 the information to be reported shall be in accordance to Clause 10 of ISO 9614-1 (grade 2) and 9614-2 (grade 2) as applicable. Record the product specific standard (if any) applied to the test source.

8.2 *Noise Source Under Test*. Unless superseded by the product specific standard, the following information shall be recorded:

8.2.1 A description of the noise source under test (including the manufacturer, type, technical data, dimensions, serial number and year of manufacture)

8.2.2 The mode(s) of operation used for the test(s)

8.2.3 The relevant measurement time interval(s)

8.2.4 The installation and mounting conditions

8.3 *Test Environment*. The following information shall be recorded:

8.3.1 The air temperature in degrees Celsius,˚C, the relative humidity, %, and the static pressure, kPA, in the room at the time of test

8.4 *Instrumentation*. The following information shall be recorded:

8.4.1 The equipment used for the measurements, including the name, type, serial number and manufacturer

8.4.2 The date and place of calibration; the methods used to calibrate the sound calibrator, and calibration verification of the instrumentation system

8.5 *Acoustical Data*. The following information shall be recorded:

8.5.1 The sound power levels, dB, in One-third Octave Bands

8.5.2 The date and time when the measurements were performed

Section 9. Test Report

9.1 *Test Report*. Unless otherwise specified by an AHRI product rating standard, the test report shall contain a statement that the results were obtained in accordance with ANSI/AHRI Standard 230-2013, the date and time of the test, the name and model number of the UUT, operating conditions during the test, and the Sound Power Levels.

Section 10. Conformance Conditions

10.1 *Conformance.* While conformance with this standard is voluntary, conformance shall not be claimed or implied for products or equipment within the standard's *Purpose* (Section 1) and *Scope* (Section 2) unless such product claims meet all of the requirements of the standard and all of the testing and rating requirements are measured and reported in complete compliance with the standard. Any product that has not met all the requirements of the standard cannot reference, state, or acknowledge the standard in any written, oral, or electronic communication.

APPENDIX A. REFERENCES – NORMATIVE

A1 Listed here are all the standards, handbooks, and other publications essential to the formation and implementation of the standard. All references in this appendix are considered part of this standard.

A1.1 ANSI Standard S1.6-1984 (R2011) *American National Standard Preferred Frequencies, Frequency Levels, and Band Numbers for Acoustical Measurements*, 2011, American National Standards Institute, 25 West 43rd Street, 4th Fl., New York, NY 10036, U.S.A.

A1.2 ANSI Standard S1.11-2004 (R2009), *Specification for Octave-Band and Fractional Octave-Band Analog and Digital Filters*, 2009, American National Standards Institute, 25 West 43rd Street, 4th Fl., New York, NY 10036, U.S.A.

A1.3 ANSI Standard S12.12-1992 (R2012), *Engineering Method for the Determination of Sound Power Levels of Noise Sources Using Sound Intensity*, 2012, American National Standards Institute, 25 West 43rd Street, 4th Fl., New York, NY 10036, U.S.A.

A1.4 ANSI/AHRI Standard 220-2012, *Reverberation Room Qualification and Testing Procedures for Determining Sound Power of HVAC Equipment*, 2012, Air-Conditioning, Heating and Refrigeration Institute, 2111 Wilson Boulevard, Suite 500, Arlington, VA 22201, U.S.A.

A1.5 ANSI/AHRI Standard 250-2013, *Performance and Calibration of Reference Sound Sources*, 2013, Air-Conditioning, Heating and Refrigeration Institute, 2111 Wilson Boulevard, Suite 500, Arlington, VA 22201, U.S.A.

A1.6 *ASHRAEwiki*, *Terminology*, http://wiki.ashrae.org/index.php/ASHRAEwiki, 2012, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Circle, N.E., Atlanta, GA 30329, U.S.A.

A1.7 IEC 61043:1993, Electroacoustics - *Instruments for the measurement of sound intensity - Measurements with pairs of pressure sensing microphones*, 1993, International Electrotechnical Commission, 3, rue de Varembe, P.O. Box 131, 1211 Geneva 20, Switzerland.

A1.8 ISO 9614-1:1993, Acoustics – *Determination of sound power levels of noise sources using sound intensity - Part 1: Measurement at discrete points*, 1993, International Organization for Standardization, Case Postale 56, CH-1211, Geneva 21 Switzerland.

A1.9 ISO 9614-2:1996, Acoustics -- *Determination of sound power levels of noise sources using sound intensity - Part 2: Measurement by scanning*, 1996, International Organization for Standardization, Case Postale 56, CH-1211, Geneva 21 Switzerland.

APPENDIX B. REFERENCES – INFORMATIVE

None.