ANSI/AHRI Standard 370-2025 (SI/I-P)

Sound Performance Rating of Large Air-cooled Outdoor Refrigerating and Air-conditioning Equipment

Approved American National Standard
ANSI

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IMPORTANT

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ICS Code: 17.140.01

Note:

This standard supersedes ANSI/AHRI Standard 370-2015 and AHRI Standard 370-2015 (with Addendum 1).

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Intent

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

Review and Amendment

This standard is subject to review and amendment as technology advances.

2025 Edition

This edition of AHRI Standard 370*, Sound Performance Rating of Large Air-cooled Outdoor Refrigerating and Air-conditioning Equipment*, was prepared by Waterside and Refrigeration Standards Technical Committee. The standard was approved by the Standards Committee on 16 December 2024. This standard was approved as an American National Standard (ANS) on 20 March 2025.

Origin and Development of AHRI Standard 370

The initial publication was ARI Standard 370-1986, *Sound Rating of Large Air-cooled Outdoor Refrigerating & Air-conditioning Equipment*. Subsequent revisions were:

- ARI Standard 370–2001, *Sound Performance Rating of Large Air-cooled Outdoor Refrigerating & Air-conditioning Equipment*
- AHRI Standard 370-2011, *Sound Performance Rating of Large Air-cooled Outdoor Refrigerating & Air-conditioning Equipment*
- ANSI/AHRI Standard 370-2015, *Sound Performance Rating of Large Air-cooled Outdoor Refrigerating & Air-conditioning Equipment*
- AHRI Standard 370-2015 (with Addendum 1), *Sound Performance Rating of Large Air-cooled Outdoor Refrigerating and Air-Conditioning Equipment*

Summary of Changes

ANSI/AHRI Standard 370-2025 contains the following updates to the previous edition:

- Incorporated the addendum
- Removed the SQI reference
- Expand allowable capacity range
- Include both SI and IP units

Committee Personnel

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Sound Standards Technical Committee (STC) Scope:

The Sound STC is responsible for development and maintenance of standards and guidelines related to sound and vibration of Heating, Ventilation, Air Conditioning, and Refrigeration (HVAC/R) equipment.

Out of scope for this Standards Technical Committee are standards that are not related to sound or vibration performance, including seismic and shipping.

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These lists represent the membership at the time the Standards Technical Committee and Standards Committee were balloted on the final text of this edition. Since that time, changes in the membership may have occurred. Membership on these committees shall not in and of itself constitute an endorsement by the committee members or their employers of any document developed by the committee on which the member serves.

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Curtis Eichelberger	Eichelberger Acoustics LLC	Testing Laboratory
Lanny Huffman	Hickory Sheet Metal	Consumer/User
Derrick Knight	Trane Technologies	Product Manufacturer
Satheesh Kulankara	Johnson Controls, Inc.	Product Manufacturer
Jerry Lilly	JGL Acoustics	General Interest
Karl Peterman	Swegon North America Inc.	Product Manufacturer

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SOUND PERFORMANCE RATING OF LARGE AIR-COOLED OUTDOOR REFRIGERATING AND AIR-CONDITIONING EQUIPMENT

Section 1. Purpose

This standard establishes methods for determining the sound ratings of the outdoor portions of factory-made commercial and industrial *Large Air-cooled Outdoor Refrigerating and Air-conditioning Equipment*. This standard establishes definitions; test requirements; rating requirements; minimum data requirements for *Published Ratings*; and conformance conditions.

Section 2. Scope

2.1 *In scope*

This standard applies to the air-cooled outdoor portions of factory-made commercial and industrial *Air-cooled Outdoor Refrigerating and Air-conditioning Equipmen*t. This equipment is covered by:

AHRI 210/240, *Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment*,

AHRI 340/360, *Performance Rating of Commercial and Industrial Unitary Air-conditioning and Heat Pump Equipment*,

AHRI 365 (I-P) and AHRI 366 (SI), *Commercial and Industrial Unitary Air-conditioning Condensing Units,*

AHRI 520, *Performance Rating of Positive Displacement Condensing Units*,

AHRI 460, *Performance Rating of Remote Mechanical-draft Air-cooled Refrigerant Condensers,*

AHRI 490 (I-P) and AHRI 491 (SI), *Remote Mechanical-draft Evaporatively-cooled Refrigerant Condensers,*

AHRI 550/590 (I-P) and AHRI 551/591 (SI), *Performance Rating of Water Chilling Packages Using the Vapor Compression Cycle*.

2.2 *Exclusions*

This standard does not apply to the outdoor portions of unitary air-conditioning or heat pump equipment that fall within the scope of AHRI 270, *Sound Rating of Outdoor Unitary Equipment* (cooling capacity ratings of less than 10.5 kW (36,000 BTU/Hr)).

Section 3. Definitions

All terms in this document shall follow the standard industry definitions in the *ASHRAE Terminology* website unless otherwise defined in Section 3.2.

3.1 *Expressions of Provision*

Terms that provide clear distinctions between requirements, recommendations, permissions, options, and capabilities.

3.1.1 *"Can" or "cannot"*

Express an option or capability.

3.1.2 *"May"*

Signifies a permission expressed by the document.

3.1.3 *"Must"*

Indication of unavoidable situations and does not mean that an external constraint referred to is a requirement of the document.

3.1.4 *"Shall" or "shall not"*

Indication of mandatory requirements to strictly conform to the standard and where deviation is not permitted.

3.1.5 *"Should" or "should not"*

Indication of recommendations rather than requirements. In the negative form, a recommendation is the expression of potential choices or courses of action that is not preferred but not prohibited.

3.2 *Standard-specific Definitions*

3.2.1 *A-weighted Sound Power Level, LwA*

The logarithmic summation of A-weighted, *One-third Octave Band* levels.

3.2.2 *Hertz (Hz)*

A unit of frequency equal to one cycle per second.

3.2.3 *Large Air-cooled Outdoor Refrigerating and Air-conditioning Equipment*

Equipment that consists of one or more assemblies, including an outdoor coil and outdoor fan, and can include a compressor.

3.2.4 *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 ASA/ANSI S1.11.

3.2.5 *One-third Octave Band*

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 ASA/ANSI S1.11.

3.2.6 *Published Rating*

A statement of the assigned values of those performance characteristics, under stated rating conditions, where a unit can be chosen to fit the application. These values apply to all units of the same nominal size and type (identification) produced by the same manufacturer. This includes the rating of all performance characteristics shown on the unit or published in specifications, advertising or other literature controlled by the manufacturer, at stated *rating conditions*.

3.2.6.1 *Application Rating*

A rating based on tests performed at rating conditions other than standard *rating conditions*.

3.2.6.2 *Standard Rating*

A rating based on tests performed at standard *rating conditions*.

3.2.7 *Rating Conditions*

Any set of operating conditions where a single level of performance results and causes only that level of performance to occur.

3.2.8 *Reference Sound Source (RSS)*

A portable, aerodynamic sound source that produces a known stable broad band sound power output

3.2.9 *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 square meter, pW/m^2 (internationally recognized units). 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.

3.2.10 *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).

3.2.11 *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 µPa, expressed in decibels, dB.

3.2.12 *Unit Under Test (UUT)*

HVAC equipment that has the sound power determined.

Section 4. Test Requirements

4.1 *Test Requirements*

All standard *Sound Power Level* ratings shall be determined by tests conducted in a qualified reverberation room, anechoic room, or an indoor or outdoor space that is an essentially free field over a reflecting plane. The defined limits for an essentially free field feasibility are explained in Section 4.1.3 and Appendix D.

4.1.1 *Sound tests in a Reverberation Room*

Sound tests in a reverberation room shall be conducted in a reverberation room meeting the requirements of and is qualified per AHRI 220. Sound tests shall be conducted in accordance with AHRI 220 using an *RSS* that meets the performance requirements of and is calibrated per AHRI 250.

4.1.2 *Sound Tests in a Hemi-Anechoic Room*

Sound tests in a hemi-anechoic room that affords a free-field condition above the measurement space or above a reflecting plane shall be conducted in accordance with ISO 3745, as adapted for *Large Air-cooled Outdoor Refrigerating and Air-conditioning Equipment* in Appendix D of this standard.

4.1.3 *Sound Tests in Indoor or Outdoor Spaces*

Sound tests in indoor or outdoor spaces that qualify as an essentially free field over a reflecting plane shall be conducted in accordance with ISO 3744, as adapted for *Large Air-cooled Outdoor Refrigerating and Air-conditioning Equipment* in Appendix D of this standard.

4.1.4 *Sound Tests Using Sound Intensity*

Sound tests using sound intensity shall be conducted in accordance with ANSI/AHRI 230-2013, as adapted for *Large Air-cooled Outdoor Refrigerating and Air-conditioning Equipment*. For this equipment, the sound component of interest as discussed in Section 7 of AHRI 230 is the entire unit. The measurement grid shall enclose the entire unit.

4.2 *Test Conditions*

Standard sound ratings shall be based on sound tests conducted with the unit operating at rated voltage (V), phase, and frequency (*Hz*) as specified on the unit nameplate and measured at the service connection. Sound tests shall be conducted as prescribed below:

4.2.1 *Standard Sound Ratings*

Standard sound ratings shall be based on sound tests conducted with the unit operating at rated voltage, V, phase and frequency, *Hz*, as specified on the unit nameplate and measured at the service connection. The sound measurements shall be made with the equipment operating at the AHRI standard thermal rating condition.

4.2.2 *Application Sound Rating (Optional)*

Application Sound Ratings for conditions other than the AHRI standard thermal rating condition shall be based on sound tests conducted with the equipment operating at those conditions.

Note: Where applicable, manufacturers should account for contributions from exhaust fan(s), return fan(s), and indoor fan(s) that can be measured per AHRI 260 (I-P) and AHRI 261 (SI) and be added to AHRI 370 Sound Rating.

4.2.3 *Fan(s) Only Sound Rating (Optional)*

The compression equipment shall be turned off and sound readings taken with only the outdoor fans operating. The speed of the fan shall be controlled to match within ± 3% of the speed during the rating condition.

4.2.4 *Test Condition Tolerances*

During sound rating tests, the equipment operating conditions shall not deviate from the specified operating conditions by more than the following tolerances:

4.2.4.1 *Testing with Air Temperature Control*

When not simulating indoor or outdoor load, the air temperature shall be controlled to ± 1°C (1.8°F).

4.2.4.2 *Testing with Simulated Indoor-side Load*

When the indoor-side loading is simulated by a method not requiring air temperature control, the evaporator pressure tolerance of ± 15 kPa (2.2 psi) applies during sound rating tests.

4.2.4.3 *Testing with Simulated Outdoor-side Load*

When the outdoor-side loading is simulated by a method not requiring air temperature control, the compressor discharge pressure of ± 70 kPa (10.2 psi) tolerance applies during sound rating tests.

4.3 *Data to be Taken*

Sound level data taken shall be in *One-third Octave Bands* (50 *Hz* to 10,000 *Hz* are required) in accordance with the procedure specified for the type of test being conducted.

4.4 *Air Velocity at Measurement Positions*

Sound Pressure Level measurements shall not be made when the air velocity over the microphone exceeds 2.0 m/s (6.6 ft/s). A foam windscreen shall be installed on the microphone that shall not affect the microphone response by more than ± 1 dB for frequencies of 20 *Hz* to 4000 *Hz* or ± 1.5 dB for frequencies above 4000 *Hz*. *Sound Intensity Level* measurements in airflow shall meet the requirements of Section 6.3 of AHRI 230.

4.5 *Unit Installation*

The *UUT* shall be located within the reverberation room as specified in AHRI 220 when testing per Section 4.1.2 or Section 4.1.3 of this standard, or per AHRI 230 when testing per Section 4.1.4. Where applicable, unit supply and return ducting shall be lagged to prevent sound radiation [refer to AHRI 260 (I-P) and AHRI 261 (SI) for guidance in duct construction]. The noise radiating from the connecting refrigerant piping on split systems or water piping on air-cooled chilled water systems shall be minimized.

Section 5. Rating Requirements

5.1 *Product Ratings*

The outdoor sound rating shall be for the complete unit operating at AHRI thermal rating condition.

5.1.1 *Required Ratings:*

1) Un-weighted *Octave Band Sound Power Levels*, dB (63 *Hz* to 8000 *Hz*)
2) Overall *A-weighted Sound Power Level*, dB (A-weighted 50 *Hz* to 10,000 *Hz*)
3) Thermal conditions and capacity

5.1.2 *Optional Information:*

Un-weighted *One-third Octave Band* Sound Power Levels, dB (50 Hz to 10,000 Hz)

5.2 *Application Ratings*

If these are to be published, application ratings shall include the following information:

5.2.1 *Required Ratings:*

1) Un-weighted *Octave Band Sound Power Levels*, dB (63 *Hz* to 8000 *Hz*)
2) Overall *A-weighted Sound Power Level*, dB (A-weighted 50 *Hz* to 10,000 *Hz*)
3) Thermal conditions and capacity where applicable

5.2.2 *Optional Information:*

Un-weighted *One-third Octave Band Sound Power Levels*, dB (50 *Hz* to 10,000 *Hz*)

5.3 *Determination of Outdoor One-third Octave Band Sound Power Levels*

The unit's *One-third Octave Band Sound Power Levels* shall be determined per ANSI/AHRI 220-2014. The *UUT* shall be installed as specified by Section 4.5 of this standard.

5.3.1 *Octave Band Sound Power Level Calculations*

Octave Band Sound Power Level calculations shall be made per ANSI/AHRI 220-2014.

Each *Octave Band Sound Power Level* shall be rounded to the nearest decibel.

5.3.2 *A-weighted Sound Power Level*

The *A-weighted Sound Power Level* shall be calculated per ANSI/AHRI 220-2014.

The *A-weighted Sound Power Level* shall be rounded to the nearest decibel.

5.4 *Rating Tolerances*

Any equipment tested in accordance with this standard shall have un-weighted *Octave Band Sound Power Levels* (L_w) and an overall *A-weighted Sound Power Level* (L_{wA}), not higher than their *Published Ratings*. Optional *One-third Octave Band Sound Power Levels* can be determined and shall not be higher than the equipment's *Published Rating*. (Refer to Appendix C, Table 1).

5.5 *Application Sound Ratings*

Application sound ratings for conditions other than the AHRI standard thermal rating condition shall be based on sound tests conducted with the equipment operating at those conditions.

Section 6. Minimum Data Requirements for Published Ratings

6.1 *Published Ratings*

Published sound power ratings shall be for the unit with all components running that are necessary to produce the AHRI standard thermal rating. Additionally, sound power data can be published for the unit operating with only the fan(s) running or at application rating points. Variable speed equipment shall be operated at constant speed for the duration of the test. For equipment with variable capacity compressors, the compressors shall be operated at rated and constant capacity for the duration of the test.

6.1.1 *Required:*

1) The *Octave Band* un-weighted *Sound Power Levels* to the nearest decibel from 63 *Hz* to 8,000 *Hz*.
2) The overall *A-weighted Sound Power Level* to the nearest decibel covering the range of 50 *Hz* to 10,000 *Hz*.
3) Sound measurement type; reverberant room, hemi-anechoic room, free field over a reflecting plane or sound intensity.
4) Thermal conditions, capacity, fan(s) and compressor(s) speed.
5) Statement of options tested with the equipment. These options can include economizers, exhaust fans, high static drives, and return fans.

6.1.2 *Optional:*

The One-third Octave Band un-weighted Sound Power Levels

6.2 *Minimum Data Requirements for Published Ratings*

As a minimum, *Published Ratings* shall include all *Standard Ratings*. All claims to ratings within the scope of this standard shall include the statement "Rated in accordance with AHRI Standard 370". All claims to ratings outside the scope of this standard shall include the statement "Outside the scope of AHRI Standard 370". *Application Ratings* within the scope of the standard shall include a statement of the conditions under which the ratings apply.

Section 7. Conformance Conditions

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 in complete compliance with the standard. Any product that has not met all the requirements of the standard shall not reference, state, or acknowledge the standard in any written, oral, or electronic communication.

APPENDIX A. REFERENCES – NORMATIVE

This appendix lists all standards, handbooks, and other publications essential to the development and implementation of the standard. All references in this appendix are part of the standard.

A.1. ANSI/AHRI Standard 220-2014, *Reverberation Room Qualification and Testing Procedures for Determining Sound Power of HVAC Equipment,* 2014, Air-Conditioning, Heating, and Refrigeration Institute, 2311 Wilson Blvd, Suite 400, Arlington, VA 22201, U.S.A.

A.2. ANSI/AHRI Standard 230-2013, *Sound Intensity Testing Procedures for Determining Sound Power of HVAC Equipment*, 2013, Air-Conditioning, Heating, and Refrigeration Institute, 2311 Wilson Blvd, Suite 400, Arlington, VA 22201, U.S.A.

A.3. ANSI/AHRI Standard 250-2013, *Performance and Calibration of Reference Sound Sources*, 2013, Air-Conditioning, Heating, and Refrigeration Institute, 2311 Wilson Blvd, Suite 400, Arlington, VA 22201, U.S.A.

A.4. AHRI Standard 260 (I-P)-2012, *Sound Rating of Ducted Air Moving and Conditioning Equipment*, 2012, Air-Conditioning, Heating, and Refrigeration Institute, 2311 Wilson Blvd, Suite 400, Arlington, VA 22201, U.S.A.

A.5. AHRI Standard 261 (SI)-2012, *Sound Rating of Ducted Air Moving and Conditioning Equipment*, 2012, Air-Conditioning, Heating, and Refrigeration Institute, 2311 Wilson Blvd, Suite 400, Arlington, VA 22201, U.S.A.

A.6. AHRI Standard 270-2015, Sound Rating of Outdoor Unitary Equipment, 2015, Air-Conditioning, Heating, and Refrigeration Institute, 2311 Wilson Blvd, Suite 400, Arlington, VA 22201, U.S.A.

A.7. ANSI/AHRI Standard 340/360-2007 with Addendum 2, *Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment*, 2007, Air-Conditioning, Heating, and Refrigeration Institute, 2311 Wilson Blvd, Suite 400, Arlington, VA 22201, U.S.A.

A.8. ANSI/AHRI Standard 365 (I-P)-2009, *Commercial and Industrial Unitary Air-Conditioning Condensing Units*, 2009, Air-Conditioning, Heating, and Refrigeration Institute, Air-Conditioning, Heating, and Refrigeration Institute, 2311 Wilson Blvd, Suite 400, Arlington, VA 22201, U.S.A.

A.9. ANSI/AHRI Standard 366 (SI)-2009, *Commercial and Industrial Unitary Air-Conditioning Condensing Units*, 2009, Air-Conditioning, Heating, and Refrigeration Institute, 2311 Wilson Blvd, Suite 400, Arlington, VA 22201, U.S.A.

A.10. AHRI Standard 460-2005, *Performance Rating of Remote Mechanical-Draft Air-Cooled Refrigerant Condensers*, 2005, Air-Conditioning, Heating, and Refrigeration Institute, 2311 Wilson Blvd, Suite 400, Arlington, VA 22201, U.S.A.

A.11. AHRI Standard 490 (I-P)-2011, *Remote Mechanical-Draft Evaporatively-Cooled Refrigerant Condensers*, 2003, Air-Conditioning, Heating, and Refrigeration Institute, 2311 Wilson Blvd, Suite 400, Arlington, VA 22201, U.S.A.

A.12. AHRI Standard 491 (SI)-2011, *Remote Mechanical-Draft Evaporatively-Cooled Refrigerant Condensers*, 2003, Air-Conditioning, Heating, and Refrigeration Institute, 2311 Wilson Blvd, Suite 400, Arlington, VA 22201, U.S.A.

A.13. AHRI Standard 520-2004, *Performance Rating of Positive Displacement Condensing Units*, 2004, Air-Conditioning, Heating, and Refrigeration Institute, 2311 Wilson Blvd, Suite 400, Arlington, VA 22201, U.S.A.

A.14. AHRI Standard 550/590 (I-P)-2011 with Addendum 3, *Performance Rating of Water Chilling Packages Using the Vapor Compression Cycle*, 2011, Air-Conditioning, Heating, and Refrigeration Institute, 2311 Wilson Blvd, Suite 400, Arlington, VA 22201, U.S.A.

A.15. AHRI Standard 551/591 (SI)-2011 with Addendum 3, *Performance Rating of Water Chilling Packages Using the Vapor Compression Cycle*, 2011, Air-Conditioning, Heating, and Refrigeration Institute, 2311 Wilson Blvd, Suite 400, Arlington, VA 22201, U.S.A.

A.16. ANSI/ASA S1.11-2004, *Specification for Octave-Band and Fractional Octave-Band Analog and Digital Filters*, 2004, Acoustical Society of America, 1305 Walt Whitman Road, Suite 300, Melville, NY 11747, U.S.A.

A.17. ASHRAE Terminology. ASHRAE. Accessed July 4, 2022. https://www.ashrae.org/technical-resources/authoring-tools/terminology.

A.18. ISO 3744, Acoustics. *Determination of sound power levels of noise sources using sound pressure. Engineering method in an essentially free field over a reflecting plane*, 2009, International Organization for Standardization, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland.

A.19. ISO 3745, Acoustics -- *Determination of sound power levels of noise sources using sound pressure -- Precision methods for anechoic and hemi-anechoic rooms*, 2003, International Organization for Standardization, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland.

APPENDIX B. REFERENCES – INFORMATIVE

This appendix lists standards, handbooks, and other publications that can provide useful information and background but are not essential for the use of this standard. All references in this appendix are not part of the standard.

None.

APPENDIX C. TEST METHOD MEASUREMENT REPRODUCIBILITY – INFORMATIVE

Sound power levels obtained in conformance with this standard are expected to result in measurement standard deviations that are equal to or less than those in Table 1. The standard deviations due to changes in operating conditions are not reflected in the values in Table 1.

Table 1 Expected 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* Expected Maximum Standard Deviation of Reproducibility, σ_{R0}, dB
50 - 80	4.0
100 - 160	3.0
200 - 315	2.0
400 - 5,000	1.5
6300 - 10,000	3.0
Octave Band Center Frequency, *Hz*	Octave Band Expected Maximum Standard Deviation of Reproducibility, σ_{R0}, dB
63	3.5
125	2.5
250	1.5
500 - 4000	1.0
8000	2.0
A-weighted 50-10,000 *Hz*	A-weighted Expected Maximum Standard Deviation of Reproducibility, σ_{R0}, dB
A-weighted	0.5[1]

Note:
1. Applicable to a source that emits noise with a relatively “flat” spectrum in the frequency range 50 *Hz* to 10,000 *Hz*.

APPENDIX D. DETERMINING SOUND POWER LEVELS USING SOUND PRESSURE MEASUREMENTS MADE IN A QUASI-FREE FIELD OVER A REFLECTING PLANE – NORMATIVE

D.1. *Purpose*

This appendix provides a procedure for determining the *Sound Power Levels* (L_W) by measuring sound pressure in an essentially -free field over a reflecting plane, as adapted from ISO 3744 or in a free field condition above a reflecting plane in a hemi-anechoic room as adapted from ISO 3745.

D.2. *Test Method*

D.2.1. *Instrumentation*

The instrumentation and instrumentation systems employed shall meet the requirements of AHRI 220 except that the measurement microphone(s) shall be free field type.

D.2.2. *Test Environment*

The test site shall be a flat, indoor, or outdoor area free of reflecting objects other than the reflecting plane, such that the source radiates into a free field over a reflecting plane.

1) The reflecting plane shall extend at least 3.5 m (11.5 ft) beyond the measurement surface.

   Note: 3.5 m (11.5 ft) is nominally equal to half a wavelength (λ/2) at 50 *Hz* (the lowest frequency of interest).

2) The site shall meet the qualification requirements of ISO 3744 or ISO 3745 as applicable.

3) The need for and the value of the environmental correction (K_2) to account for departures of the test environment from the ideal condition shall be determined using the procedure described in Appendix E. For the purposes of this document, the value of K_2 shall be limited to: -2.0 dB ≤ K_2 ≤ + 2.0 dB. The environmental correction (K_2) shall be determined by test only using a vertical shafted *RSS* that meets the requirements of and is calibrated per AHRI 250.

D.2.3. *Microphone Measurement Points*

The points of sound pressure measurement shall be determined relative to a reference parallelepiped, the smallest imaginary rectangular parallelepiped, terminating on the reflecting plane, that shall just enclose the machine. In determining the size of the reference parallelepiped, minor projections from the machine that are not major radiators of sound energy can be disregarded.

1) The measurement parallelepiped where the microphones are positioned is a surface of area, S, m^2, enveloping the machine whose sides and top are parallel to the sides and top of the reference parallelepiped and are spaced 1.0 m (3.3 ft) outward from the reference parallelepiped.

2) The area of the measurement surface (S_a) is given by Equation 1 below, where meters are required to align with the acoustic reference quantities:

Note: Equation **1** calculates an adjusted measurement surface area that is based on empirical data to give equivalency between the survey method and reverberation room method.

$$S_a = \pi \cdot (L/2) \cdot (W/2+H) \quad \textbf{1}$$

Where:

H = Height of the measurement parallelepiped, m

L = Length of the measurement parallelepiped, m

S_a = Adjusted measurement surface area, m^2

W = Width of the measurement parallelepiped, m

Such that $L \geq W$ (Figure 1 and Figure 2)

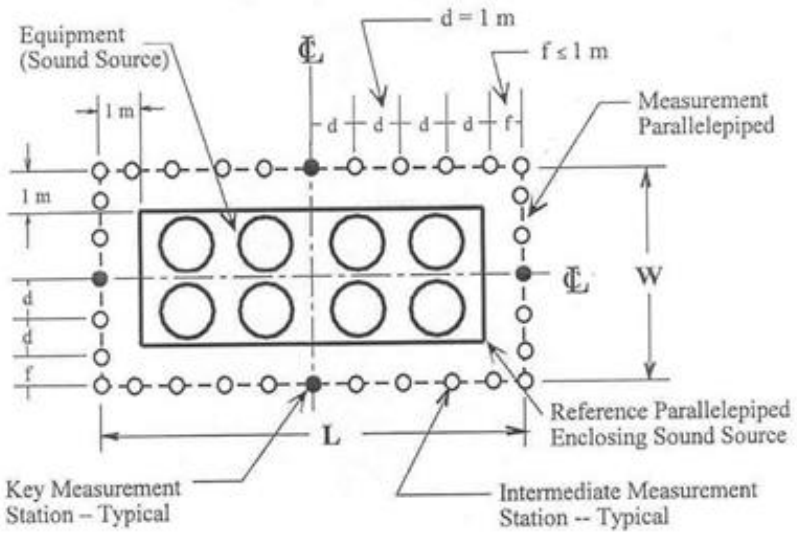

Figure 1 Plan View of Measurement Parallelepiped

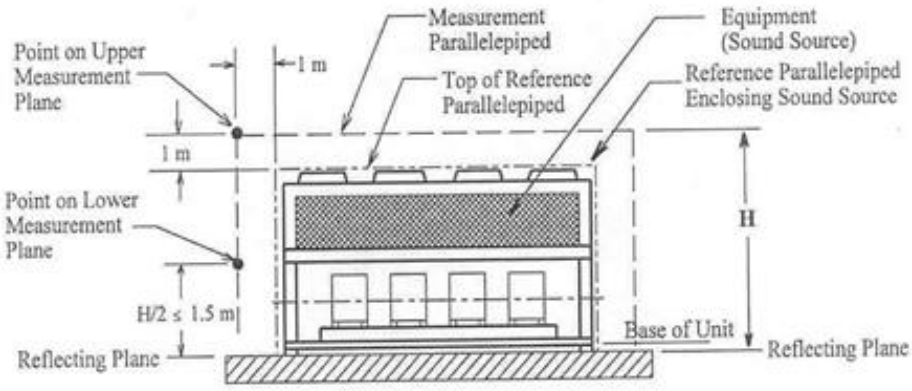

Figure 2 Elevation of Measurement Parallelepiped

3) The key measurement stations shall be located at the mid-point of each of the four sides of the measurement parallelepiped (Figure 1).

   a) Additional intermediate measurement stations shall be added extending outward at 1.0 m (3.3 ft) intervals from the key stations towards the corners of the measured parallelepiped. The distance between the last immediate and the corner stations can be less than but shall not be greater than 1.0 m (3.3 ft) (Figure 1).

   b) Measurements shall be taken at two elevations at each station. The uppermost shall be in a horizontal plane 1.0 m (3.3 ft) above the top of the reference parallelepiped. The second shall be at a level midway between the upper plane and the reflecting plane or 1.5 m (4.9 ft) above the reflecting plane, whichever is less, as shown in Figure 2.

   c) The surface *Sound Pressure Level*, L_{Pf} shall be adjusted by adding the value of the environmental correction, K_2 to account for departures of the test environment from the ideal condition.

D.2.4. *Data to be Taken*

The *Sound Pressure Level* shall be measured and recorded in each of the *One-third Octave Bands* from 50 *Hz* to 10,000 *Hz* at each measurement position

APPENDIX E. DETERMINATIONOF K_2 – NORMATIVE

E.1. *Purpose*

This appendix provides a procedure for determining a correction factor, K_2, that quantifies the behavior of a test environment that deviates from a free field over a reflecting plane or a hemi-anechoic test room. This factor is used to mitigate the effects that the reverberant build-up of acoustic energy in the space has on the calculation of sound power. The method detailed in this appendix compares a series of *RSS Sound Pressure Level* measurements made in a known environment (controlled measurement space) with a series of identical *Sound Pressure Level* measurements made in the test space (where actual chiller sound measurements are made) to calculate the correction factor.

E.2. *Test Method*

E.2.1. *Instrumentation*

The instrumentation and instrumentation systems employed shall meet the requirements of AHRI Standard 220 except that the measurement microphone(s) shall be a nominal 12 mm (0.5 in) diameter free field microphone with a windscreen. For all measurements, the microphone shall be oriented to point directly at the *RSS*.

E.2.2. *Test Environments*

The test site for the controlled measurement shall be a flat, indoor. or outdoor area free of reflecting objects other than the reflecting plane where the test unit sits, such that the source radiates into a free field over a reflecting plane.

Note: As examples, an outdoor space on a hard reflective surface without walls (or obstructions) within fifteen meters of the parallelepiped surface should qualify as a free field or a hemi-anechoic room in accordance with ISO 3745, and does meet the requirements for the test environment for the control series of measurements.

E.2.3. *Microphone Measurement Points*

The points of sound pressure measurement shall be determined relative to a reference parallelepiped, the smallest imaginary rectangular parallelepiped, terminating on the reflecting plane, that shall just enclose the machine to be tested. In determining the size of the reference parallelepiped, minor projections from the machine that are not major radiators of sound energy can be disregarded.

1) The measurement parallelepiped where the microphones are positioned is a hypothetical surface enveloping the machine whose sides and top are parallel to the sides and top of the reference parallelepiped and are spaced 1.0 m (3.3 ft) outward from the reference parallelepiped.
2) The key measurement stations shall be located at the mid-point of each of the four sides of the measurement parallelepiped (Figure 1).
3) Additional intermediate measurement stations shall be added extending outward at 1 m (3.3 ft) intervals (d) from the key stations towards the corners of the measured parallelepiped. The distance (f) between the last intermediate stations can be less than but shall not be greater than 1 m (3.3 ft) (Figure 1).
4) The exact measurement parallelepiped shall be used for both the measurements conducted in the control space and in the test area.
5) Measurements shall be taken at two elevations at each station. The uppermost shall be in a horizontal plane 1.0 m (3.3 ft) above the top of the reference parallelepiped. The second shall be at a level midway between the upper plane and the reflecting plane or 1.5 m (4.9 ft) above the reflecting plane, whichever is less (Figure 1).

E.2.4. *RSS Positions*

The required number of *RSS* positions is a function of the length of the measurement parallelepiped and shall be determined using Figure 3 and Table 2.

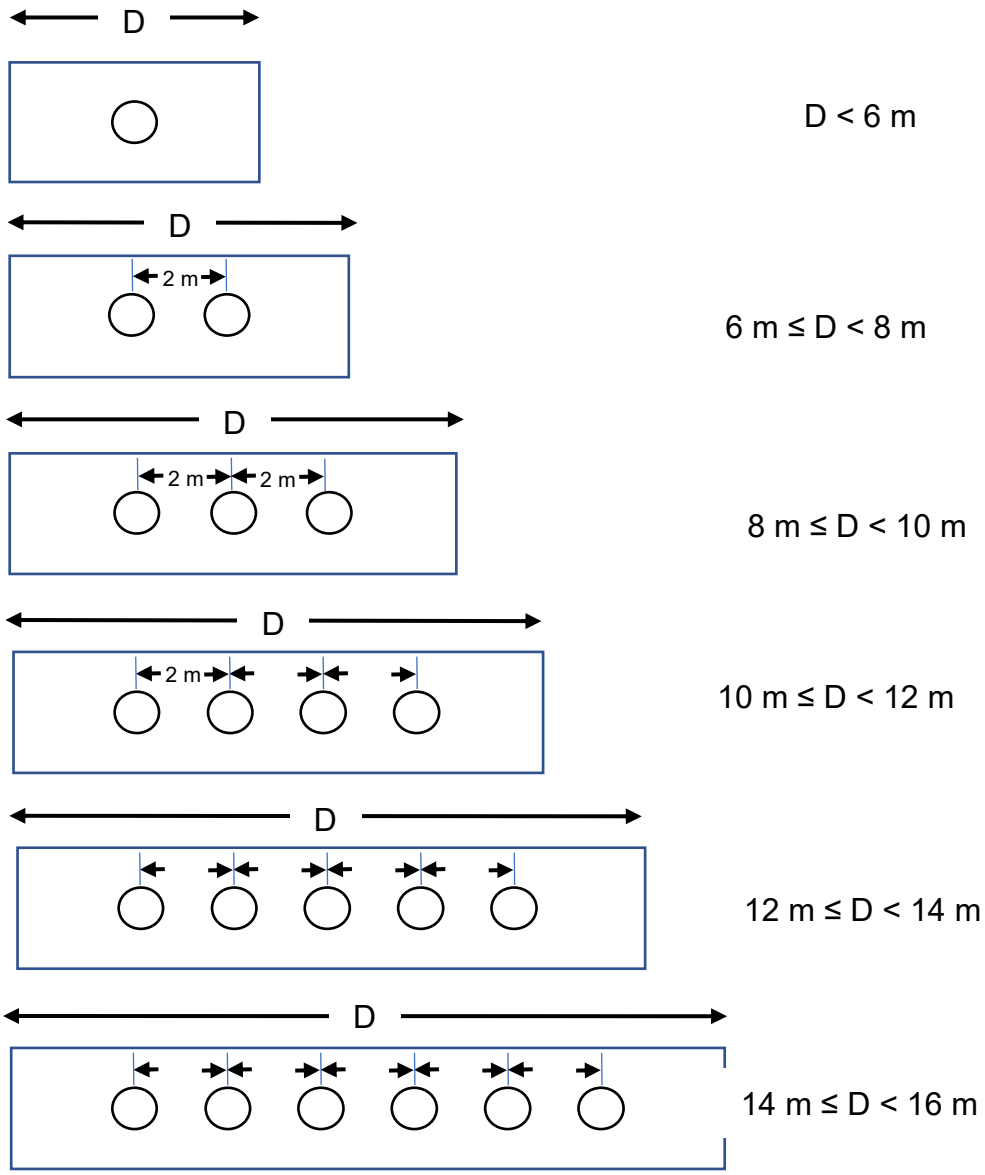

Figure 3 Schematic of RSS Locations Required for Determination of K_2

Table 2 Required Number of RSS Positions Based on Parallelepiped Length

Measurement Parallelepiped Length, D(m)	Number of *RSS* positions
D < 6	1
6 ≤ D < 8	2
8 ≤ D < 10	3
10 ≤ D < 12	4
12 ≤ D < 14	5
14 ≤ D < 16	6

E.2.5. *Test Procedure – Qualified Room or Free-field Area (Control)*

In the qualified test area, the *Sound Pressure Level* shall be measured and recorded in each of the *One-third Octave Bands* from 50 *Hz* to 10,000 *Hz* at each measurement position using the following steps:

1) Place the *RSS* at one of the source locations as indicated in Figure 3.
2) Position a microphone in a consistent location and orientation relative to each position of the *RSS* at least two meters but not greater than three meters from the *RSS*. This measurement is used to monitor the stability of the *RSS*. Data at this fixed microphone shall be taken simultaneously with the measurements of the parallelepiped position data. The *Sound Pressure Level* measured at this fixed location shall not vary by more than 0.5 dB over the duration of the test in any of *the One-third Octave Bands* from 50 *Hz* to 10,000 *Hz* for the measurement to be valid.
3) Acquire *One-third Octave Band Sound Pressure Level* data at each of the measurement positions on the parallelepiped with the *RSS* not in operation.
4) Acquire *One-third Octave Band Sound Pressure Level* data at each of the measurement positions on the parallelepiped with the *RSS* operating.

If multiple *RSS* positions are required per Section E.2.4, relocate the *RSS* to the additional position(s) and repeat step 4).

E.2.6. *Test Procedure – Sound Test Area*

The *Sound Pressure Level* shall be measured and recorded in each of the *One-third Octave Bands* from 50 *Hz* to 10,000 *Hz* at each measurement position in the test area using the method outlined in Section E.2.5.

E.3. *Calculation of Results*

E.3.1. *Correction for Background Noise*

Each of the measured *Sound Pressure Levels* ($L_{p(m)}$) shall be compared to the measured background noise ($L_{p(b)}$) at the same position and frequency and the correction for each microphone position and frequency shall be determined per AHRI Standard 220 for both sets of data acquired in Section E.2.5 and Section E.2.6.

E.3.2. *Calculation of Surface Sound Pressure Level – Control Area*

For each *One-third Octave Band*, once the measured values from Section E.2.5 have been corrected for background noise, calculate the average *Sound Pressure Level* over the control area measurement surface ($\bar{L}_{P_{CONTROL}}$) using Equation 2.

$$\bar{L}_{P_{CONTROL}} = 10 \cdot log_{10}\left(\frac{1}{M}\sum_{m=1}^{M} 10^{0.10 \cdot L_{P(m)}}\right) \quad \textbf{2}$$

Where:

$\bar{L}_{P_{CONTROL}}$ = *Sound Pressure Level* for each *One-third Octave Band*, averaged over the control measurement surface, in dB, re: 20 µPa.

$L_{P(m)}$ = *Sound Pressure Level* of the m^{th} measurement, in dB, re: 20 µPa

M = The total number of measurements made including all *RSS* locations

E.3.3. *Calculation of Surface Sound Pressure Level – Test Area*

For each *One-third Octave Band*, once the measured values from Section E.2.6 have been corrected for background noise, calculate the average *Sound Pressure Level* over the test area measurement surface using Equation 3.

$$\bar{L}_{P_{TEST}} = 10 \cdot log_{10}\left(\frac{1}{M}\sum_{m=1}^{M} 10^{0.10 \cdot L_{P(m)}}\right) \quad \textbf{3}$$

Where:

$\bar{L}_{P\,TEST}$ = *Sound Pressure Level* for each *One-third Octave Band*, averaged over the test measurement surface, in dB, re: 20 µPa

$L_{P(m)}$ = *Sound Pressure Level* of the m^{th} measurement, in dB, re: 20 µPa

M = The total number of measurements made including all *RSS* locations

E.3.4. *Calculation of K_2*

For each *One-third Octave Band*, the environmental correction, K_2 can be calculated by subtracting the average *Sound Pressure Level* for the control area from the test area using Equation 4.

$$K_2 = \overline{L}_{P_{TEST}} - \overline{L}_{P_{CONTROL}} \quad \textbf{4}$$