

**AHRI Standard 350
(formerly ARI Standard 350)**

**2008 Standard for
Sound Performance Rating
of Non-Ducted Indoor Air-
Conditioning Equipment**



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Note:

This standard supersedes ARI Standard 350-2000 and differs in the following ways.

- a. Published Ratings include the following:
 - Octave band Sound Power Levels, dB (125 Hz to 8,000 Hz are required, 63 Hz is optional)
 - Overall A-Weighted Sound Power Level, dB (100 Hz to 10,000 Hz are required, 50 Hz to 10,000 Hz are optional)
 - Sound Quality Indicator (SQI) per ARI Standard 1140 (optional)
 - One-third octave band Sound Power Levels, dB (optional)
- b. The frequency range of interest has been expanded to include the 63 Hz Octave Band (comprised of the 50, 63 and 80 Hz One-Third Octave Bands) as optional data.
- c. All Sound Power Levels are determined from one-third octave band sound pressure level measurements.
- d. This standard references ARI Standard 220 for reverberation room qualification and testing, replacing ANSI Standard S12.31 and ANSI Standard S12.32, which were withdrawn.

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Sound Performance Rating of Non-Ducted Indoor Air-Conditioning Equipment

Section 1. Purpose

1.1 *Purpose.* The purpose of this standard is to establish for Non-Ducted Indoor Air-Conditioning Equipment: definitions; test requirements; rating requirements; minimum data requirements for Published Ratings; marking and nameplate data; and conformance conditions.

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.

Section 2. Scope

2.1 *Scope.* This standard applies to the indoor portions of factory-made non-ducted air-conditioning equipment as defined in ARI Standards 210/240, 340/360, 310/380 and 440.

Section 3. Definitions

All terms in this document shall follow the standard industry definitions established in the current edition of *ASHRAE Terminology of Heating, Ventilation, Air-Conditioning and Refrigeration*, unless otherwise defined in this section.

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

3.2 *Non-Ducted Indoor Air-Conditioning Equipment.* Air-conditioning units without ducts.

3.3 *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 S1.11.

3.4 *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 ANSI Standard S1.11.

3.5 *Published Rating.* A statement of the assigned values of those performance characteristics, under stated rating conditions, by which a unit may be chosen to fit its application. These values apply to all units of like nominal size and type (identification) produced by the same manufacturer. As used herein, the term Published Rating 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.

3.5.1 *Application Rating.* A rating based on tests performed at application Rating Conditions (other than Standard Rating Conditions).

3.5.2 *Standard Rating.* A rating based on tests performed at Standard Rating Conditions.

3.6 Rating Conditions. Any set of operating conditions under which a single level of performance results, and which cause only that level of performance to occur.

3.6.1 Standard Rating Conditions. Rating Conditions used as the basis of comparison for performance characteristics.

3.8 Reference Sound Source (RSS). A portable, aerodynamic sound source that produces a known stable broadband sound.

3.7 “Shall” or “Should”. “Shall” or “should” shall be interpreted as follows:

3.7.1 Shall. Where “shall” or “shall not” is used for a provision specified, that provision is mandatory if compliance with the standard is claimed.

3.7.2 Should. “Should” is used to indicate provisions which are not mandatory but which are desirable as good practice.

3.9 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).

3.9.1 A-Weighted Sound Power Level, L_{wA} . The logarithmic summation of A-weighted, one-third octave band Sound Power Levels.

3.10 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).

3.11 Sound Quality Indicator (SQI). The calculated metric determined when following the procedure contained in ARI Standard 1140 for quantifying sound quality whereby measured sound levels are weighted to adjust for psychoacoustic sensitivity to frequency distribution and any discreet tones which may be present and then converted to a single number Sound Quality Indicator.

Section 4. Test Requirements

4.1 Test Requirements. All standard sound power level ratings shall be determined by tests conducted in a reverberation room meeting the requirements of and qualified in accordance with ARI Standard 220 except as noted within the body of this standard. Sound Power Levels for the unit under test shall be determined per ARI Standard 220.

A Reference Sound Source (RSS) shall be used that meets the performance requirements and is calibrated per ARI Standard 250.

Sound data taken shall be per ARI Standard 220 in One-Third Octave Bands (100 Hz to 10,000 Hz are required, 50 Hz to 80 Hz are optional) in accordance with the procedure specified above for the type of test being conducted. A record shall be made of the actual equipment thermal rating conditions under which the equipment was tested. In addition, the equipment volumetric flow rate (cfm) [m^3/s] and external static pressure, (inches of water gage) [kPa gage] shall be noted.

4.2 Mounting of Equipment for Testing. Equipment shall be mounted in a way that is representative of a design application of the product.

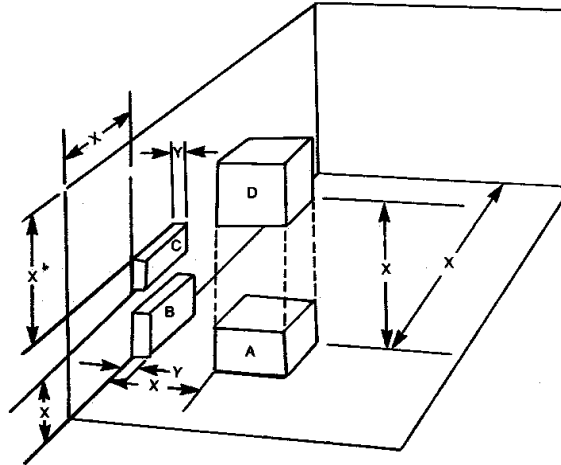
4.2.1 Position A (Figure 1) – Mounted away from wall.

4.2.2 Position B (Figure 1) – Mounted against or through the wall with the bottom of equipment on the floor. The equipment shall be mounted at the minimum manufacturer’s recommended projection into the room.

4.2.3 Position C (Figure 1) – Mounted against or through the wall but the bottom of equipment is not on the floor. The equipment shall be mounted at the minimum manufacturer’s recommended projection into the room.

4.2.4 Position D (Figure 1) – Ceiling mounted equipment may be suspended from the sound room ceiling or from a frame device or mounted on rails supported by concrete blocks.

4.2.5 All equipment shall be mounted according to the manufacturer’s installation instructions. If any deviations from these instructions are necessary, they shall be done in a manner that will not affect the acoustic performance of the equipment.



- A = Location for equipment used away from a wall
- B = Location for equipment used against or through the wall on the floor
- C = Location for equipment mounted against or through a wall
- D = Location for equipment suspended or fastened to ceiling
- X = 5.0 ft [1.5 m] minimum to adjoining room surfaces(s) other than mounting plane
- Y = Manufacturers recommended minimum

Figure 1. Location of Equipment in the Test Room

4.2.6 In the case of wall-mounted equipment, the mounting wall shall be a heavy masonry or equivalent construction, or auxiliary mounting platform shall be provided, to minimize wall vibration effects.

4.2.7 Room fan coil air-conditioners designed for furred-in application or for application with minimal duct work shall be installed in accordance with Position A, B or D (see Figure 1) and operated at free-delivery conditions without enclosures or ductwork.

4.2.8 *Electrical Characteristics.* Tests shall be performed at the rated voltage(s), phase and frequency specified on the unit nameplate, and measured at the unit service connection.

4.2.9 *Air Quantity.* The volumetric flow rate of both indoor and outdoor fans (if any) shall be the same as required to produce the rated capacity under the appropriate ARI standard.

4.2.10 *Operation.* All components required to produce the standard rating cooling capacity under the appropriate ARI standard shall be operated while data is being taken. Standard Rating Conditions (cooling) for the appropriate standard shall be maintained.

4.2.10.1 For free-delivery air-source heat pumps rated under ARI Standards 210/240 and 310/380, the heating mode shall also be used to sound rate this equipment using the following conditions:

- 70 °F [21 °C] indoor dry bulb
- 65 °F [18 °C] outdoor dry bulb
- 55 °F [13 °C] outdoor wet bulb

4.2.10.2 Room fan-coil air-conditioners rated per ARI Standard 440 shall be tested without water circulating through the coil.

4.2.11 *Test Condition Tolerances.* The allowable tolerances for sound ratings are as follows:

- Air temperature..... ± 2.0 °F [±1.1 °C]
- Water temperature ± 2.0 °F [±1.1 °C]

When the indoor-side loading is simulated by a method not requiring air, the following tolerances apply:

- Suction gas temperature at compressor*.....± 5.0 °F [± 2.8 °C]
- Evaporator pressure.....± 2.0 psi [±14 kPa]

* Applicable only when the suction gas superheat is at least 10 °F [5.6 °C] in the equivalent Standard Rating test specified in the ARI standard for the equipment being tested.

Section 5. Rating Requirements

5.1 *Introduction.* The sound ratings shall be comprised of:

- Octave band Sound Power Levels, (L_w), dB (125 Hz to 8,000 Hz are required, 63 Hz is optional)
- Overall A-Weighted Sound Power Level, (L_{wA}), dB (100 Hz to 10,000 Hz are required, 50 Hz to 10,000 Hz are optional)
- Sound Quality Indicator (SQI) per ARI Standard 1140 (optional)
- One-third octave band Sound Power Levels, dB (optional)

5.2 *Determination of Sound Power Levels.* One-Third Octave Band Sound Power Levels for the unit under test shall be determined per ARI Standard 220.

5.2.1 *Octave Band Sound Power Level Calculations.* Octave band sound power level calculations shall be made per Equation 1.

$$L_{wi} = 10 \cdot \log \sum_{j=3i-2}^{3i} 10^{0.1(L_{wj})} \tag{1}$$

Where:

- L_{wi} = Sound Power Level in the i^{th} Octave Band
- L_{wj} = Sound Power Level in the j^{th} One-third octave band
- j = An integer number lying within the range $(3i - 2)$ and $3i$, and which identifies the three One-Third Octave Bands (see Table 1) which make up the i^{th} Octave Band.

Each octave band Sound Power Level shall be rounded to the nearest decibel. An example of the calculation procedure is provided in Appendix D.

5.2.2 *A-Weighted Sound Power Level.* The A-Weighted Sound Power Level shall be calculated per Equation 2.

$$L_{wA} = 10 \cdot \log \sum_{j=j_{min}}^{j_{max}} 10^{0.1(L_{wj} + C_j)} \tag{2}$$

Where:

- L_{wA} = A-Weighted Sound Power Level
- L_{wj} = Sound Power Level in the j^{th} One-Third Octave Band

C_j and j = Values given in Table 1

j_{min} and j_{max} = Values given in Table 1 of j corresponding, respectively, to the lowest (j_{min}) and highest (j_{max}) One-Third Octave Bands of measurement

Table 1. One-Third Octave Band Numbers and A-Weighting Factors

Band Number (j)	One-Third Octave Band Center Frequency	A-Weighting Factor (C_j)	Band Number (j)	One-Third Octave Band Center Frequency	A-Weighting Factor (C_j)	Band Number (j)	One-Third Octave Band Center Frequency	A-Weighting Factor (C_j)	Band Number (j)	One-Third Octave Band Center Frequency	A-Weighting Factor (C_j)
1	50	-30.2	7	200	-10.9	13	800	-0.8	19	3150	1.2
2	63	-26.2	8	250	-8.6	14	1000	0.0	20	4000	1.0
3	80	-22.5	9	315	-6.6	15	1250	0.6	21	5000	0.5
4	100	-19.1	10	400	-4.8	16	1600	1.0	22	6300	-0.1
5	125	-16.1	11	500	-3.2	17	2000	1.2	23	8000	-1.1
6	160	-13.4	12	630	-1.9	18	2500	1.3	24	10000	-2.5

The A-Weighted Sound Power Level shall be rounded to the nearest decibel. An example of the calculation procedure is provided in Appendix E.

5.3 Sound Quality Indicator Calculation (Optional). If the Sound Quality Indicator of the outdoor unit is to be determined the procedures in ARI Standard 1140 shall be used. The SQI can be used for both full unit operation and fan(s) only operation.

5.4 Rating Tolerances. Any indoor unitary equipment tested in accordance with this standard shall have Octave Band Sound Power Levels (L_w) and an Overall A-Weighted Sound Power Level (L_{wA}), shall be higher than their Published Ratings. An optional Sound Quality Indicator (SQI) or optional one-third octave band Sound Power Levels can be determined, none of which are higher than its Published Rating. (Refer to Appendix E)

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 ARI standard thermal rating. The sound power ratings shall include items 1 and 2 as listed below; Items 3 and 4 are optional. Additionally, sound power data may be published for the unit operating with only the fan(s) running.

1. The octave band Sound Power Levels to the nearest decibel from 125 Hz to 8,000 Hz (63 Hz is optional).
2. The overall A-Weighted Sound Power Level to the nearest decibel covering the range of 100 Hz to 10,000 Hz (or optionally from 50 Hz to 10,000 Hz).
3. Optionally, the Sound Quality Indicator (SQI) may be published. The SQI shall be rounded to the nearest 0.1.
4. Optionally, the one-third octave band Sound Power Levels to the nearest 0.1 decibel may be published.

6.2 Standard Sound Rating. When ARI standard thermal rating conditions have been established for the equipment, a standard sound rating shall be published for the unit operating at those conditions.

All claims to sound ratings within the scope of this standard shall include the statement “Rated in accordance with ARI Standard 350”. All claims to ratings outside the scope of this standard shall include the statement “Outside the scope of ARI Standard 350”. Wherever application sound ratings are published or printed, they shall include a statement of the standard thermal rating conditions at which the ratings apply and be accompanied by the standard sound rating.

Section 7. Marking and Nameplate Data

7.1 Marking and Nameplate Data. As a minimum, the nameplate shall display the manufacturer's name, model designation, and electrical characteristics.

Nameplate voltages for 60 Hz systems shall include one or more of the equipment nameplate voltage ratings shown in Table 1 of ARI Standard 110. Nameplate voltages for 50 Hz systems shall include one or more of the utilization voltages shown in Table 1 of IEC Standard 60038.

Section 8. Conformance Conditions

8.1 *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 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 standards, handbooks and other publications essential to the formation and implementation of the standard. All references in this appendix are considered as part of this standard.

A1.1 ANSI Standard S1.11-2004, *Specification for Octave-Band and Fractional Octave-Band Analog and Digital Filters*, 2004, American National Standards Institute, 25 West 43rd Street, 4th Fl., New York, NY 10036, U.S.A.

A1.2 AHRI Standard 110-2002, *Air-Conditioning and Refrigerating Equipment Nameplate Voltage*, 2002, Air-Conditioning, Heating, and Refrigeration Institute, 2311 Wilson Blvd., Suite 400, Arlington, VA 22203-1678, U.S.A.

A1.3 AHRI Standard 210/240-2008 (formerly ARI Standard 210/240-2008), *Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment*, 2008, Air-Conditioning, Heating, and Refrigeration Institute, 2311 Wilson Blvd., Suite 400, Arlington, VA 22203-1678, U.S.A.

A1.4 AHRI Standard 220-2007 (formerly ARI Standard 220-2007), *Reverberation Room Qualification and Testing Procedures for Determining Sound Power of HVAC Equipment*, 2007, Air-Conditioning, Heating, and Refrigeration Institute, 2311 Wilson Blvd., Suite 400, Arlington, VA 22203-1678, U.S.A.

A1.5 AHRI Standard 250-2008 (formerly ARI Standard 250-2008), *Performance and Calibration of Reference Sound Sources Equipment*, Air-Conditioning, Heating, and Refrigeration Institute, 2008, 2311 Wilson Boulevard, Suite 400, Arlington, VA 22203-1678, U.S.A.

A1.6 AHRI Standard 310/380-2004 (formerly ARI Standard 310/380-2004), *Packaged Terminal Air-Conditioners and Heat Pumps*, (CSA C744-04), 2004, Air-Conditioning, Heating, and Refrigeration Institute, 2311 Wilson Blvd., Suite 400, Arlington, VA 22203-1678, U.S.A.

A1.7 AHRI Standard 340/360-2007 (formerly ARI Standard 340/360-2007), *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 22203-1678, U.S.A.

A1.8 AHRI Standard 440-2005 (formerly ARI Standard 440-2005), *Performance Rating of Room Fan-Coils*, 2005, Air-Conditioning, Heating, and Refrigeration Institute, 2311 Wilson Blvd., Suite 400, Arlington, VA 22203-1678, U.S.A.

A1.9 AHRI Standard 1140-2006 (formerly ARI Standard 1140-2006), *Sound Quality Evaluation Procedures for Air-Conditioning and Refrigeration Equipment*, 2006, Air-Conditioning, Heating, and Refrigeration Institute, 2311 Wilson Blvd., Suite 400, Arlington, VA 22203-1678, U.S.A.

A1.10 *ASHRAE Terminology of Heating, Ventilating, Air-Conditioning and Refrigeration*, Second Edition, 1991, ASHRAE, 180 Technology Parkway, Peachtree Corners, GA 30092, U.S.A.

A1.11 IEC Standard 60038, *IEC Standard Voltages*, 2002, International Electrotechnical Commission, 3, rue de Varembe, P.O. Box 131, 1211 Geneva 20, Switzerland

APPENDIX B. REFERENCES – INFORMATIVE

B1 Listed are standards, handbooks, and other publications which may provide useful information and background but are not considered essential. References in this appendix are not considered part of the standard.

B1.1 AHRI Standard 260-2001 (formerly ARI Standard 260-2001), *Sound Rating of Ducted Air Moving and Conditioning Equipment*, 2001, Air-Conditioning, Heating, and Refrigeration Institute, 2311 Wilson Blvd., Suite 400, Arlington, VA 22203-1678, U.S.A.

APPENDIX C. EXAMPLE CALCULATION OF OCTAVE BAND SOUND POWER LEVELS – INFORMATIVE

Table C1. Example Calculation of Octave Band Sound Power Levels, L_{wi}					
One-Third Octave Band Center Frequencies, Hz	One-Third Octave Band Sound Power Levels, (L_{wj})	$10^{0.1(L_{wj})}$	Octave Band Center Frequencies, Hz	$\sum_{j=3i-2}^{3i} 10^{0.1(L_{wj})}$	Octave Band Sound Power Levels, (L_{wi})
50 63 80	61.24 71.91 75.10	1,330,454.42 15,526,270.00 32,359,365.69	63	49,216,090.11	77
100 125 160	68.82 60.34 62.80	7,627,054.58 1,081,433.95 1,906,841.66	125	10,615,330.19	70
200 250 315	58.99 60.73 57.80	792,000.55 1,183,067.65 602,559.59	250	2,577,627.79	64
400 500 630	57.71 53.17 50.56	589,679.65 207,707.14 113,694.33	500	911,081.13	60
800 1,000 1,250	48.90 48.25 48.10	77,680.97 66,784.26 64,565.42	1,000	209,030.66	53
1,600 2,000 2,500	49.30 49.50 50.80	85,113.80 89,125.09 120,226.44	2,000	294,465.34	55
3,150 4,000 5,000	51.40 48.40 46.30	138,038.43 69,183.10 42,657.95	4,000	249,879.48	54
6,300 8,000 10,000	43.32 40.28 38.64	21,453.96 10,668.71 7,317.66	8,000	39,440.33	46
<i>NOTE: 50, 63 and 80 Hz one-third octave band data is optional as is 63 Hz octave band data.</i>					

APPENDIX D. EXAMPLE CALCULATION OF A-WEIGHTED SOUND POWER LEVELS – INFORMATIVE

Table D1. Example Calculation of A-Weighted Sound Power Levels L_{WA}				
One-Third Octave Band Center Frequencies, Hz	One-Third Octave Band Sound Power Levels, (L_{Wj})	A-weighting Adjustments	A-Weighted One-Third Octave Band Sound Power Levels, (L_{WAj})	$10^{0.1(L_{Wj})}$
50	61.24	-30.2	31.04	1,270.57
63	71.91	-26.2	45.71	37,244.93
80	75.10	-22.5	52.60	181,970.09
100	68.82	-19.1	49.72	93,833.27
125	60.34	-16.1	44.24	26,546.06
160	62.80	-13.4	49.40	87,159.48
200	58.99	-10.9	48.09	64,376.22
250	60.73	-8.6	52.13	163,308.80
315	57.80	-6.6	51.20	131,825.67
400	57.71	-4.8	52.91	195,261.29
500	53.17	-3.2	49.97	99,414.89
630	50.56	-1.9	48.66	73,407.23
800	48.90	-0.1	48.82	76,263.13
1,000	48.25	0.0	48.25	66,784.26
1,250	48.10	0.6	48.70	74,131.02
1,600	49.30	1.0	50.30	107,151.93
2,000	49.50	1.2	50.70	117,489.76
2,500	50.80	1.3	52.10	162,181.01
3,150	51.40	1.2	52.60	181,970.09
4,000	48.40	1.0	49.40	87,096.36
5,000	46.30	0.5	46.80	47,863.01
6,300	43.32	-0.1	43.22	20,965.61
8,000	40.28	-1.1	39.18	8,281.55
10,000	38.64	-2.5	36.14	4,115.02
$\sum_{j=1}^{24} 10^{0.1(L_{WAj})} = 2,109,911.24$				
$L_{WA} = 10[\log_{10}(2,109,911.24)] = 63 \text{ dBA}$				
<p><i>NOTE: 50, 63 and 80 Hz one-third octave band data is optional.</i></p>				

APPENDIX E. EXPECTED SIZE OF MEASUREMENT ERRORS – INFORMATIVE

Table E1. 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, σ_{R0}, dB
50 - 80	4.0
100 - 160	3.0
200 - 315	2.0
400 - 5,000	1.5
6,300 - 10,000	3.0
Octave Band Center Frequency, Hz	Octave Band Maximum Standard Deviation of Reproducibility, σ_{R0}, dB
63	3.5
125	2.5
250	1.5
500 - 4,000	1.0
8,000	2.0
A-Weighted 50-10,000 Hz	A-weighted Maximum Standard Deviation of Reproducibility, σ_{R0}, dB
A-Weighted	0.5*
*Applicable to a source which emits noise with a relatively "flat" spectrum in the frequency range 50 Hz to 10,000 Hz.	