ANSI/AHRI Standard 261 (SI)

2012 Standard for

Sound Rating of Ducted Air Moving and Conditioning Equipment

Approved American National Standard ANSI

Approved by ANSI on June 26, 2013

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Note:

This standard supersedes AHRI Standard 260-2001 and differs in the following ways.

- Data in the 63 Hertz Octave Band is required;
- Sound power shall be determined following AHRI Standard 220 procedures if a reverberation room is used;
- Sound power shall be determined following ISO 9614 procedures if Sound Intensity is used;
- The Duct End Correction shall be determined following ASHRAE Technical Report 1314;
- Acoustic Test Elbow corrections shall follow the method described by Beranek (1960).

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SOUND RATING OF DUCTED AIR MOVING AND CONDITIONING EQUIPMENT

Section 1. Purpose

1.1 *Purpose.* The purpose of this standard is to establish a method of sound rating the indoor portions of ducted air moving and conditioning equipment. The standard provides definitions; requirements for acquiring mapped sound data; sound power level calculations and ratings; minimum data requirements for published sound ratings; 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.

1.2 *Rationale.* Ducted Equipment presents unique challenges when providing sound ratings since their ratings are used to both compare products and to provide the information necessary to predict application sound levels. For these reasons, the sound ratings shall define the sound coming from various portions of the equipment (Sound Components). The Sound Components are the Sound Sources that impact the application sound paths.

Ducted air-conditioning equipment can have ducted discharge, ducted inlet, and casing radiated Sound Components. Depending on its applied configuration, free discharge (or free inlet) combined with the casing radiated sound component may also be needed. All Sound Components are acoustically described/rated by utilizing a mapped sound rating approach that is typically referenced to the product's supply fan operating map. The supply fan is contained in the Base Unit of the product. In addition, this standard defines an approach to account for the acoustical effects of product Appurtenances (such as modulation devices or discharge/inlet plena) and other Sound Sources (such as the refrigeration circuit, return and exhaust fans, etc.) to the Base Unit Mapped Sound Rating. Thus, a Mapped Sound Rating can be developed for a given product configuration and each of its various Sound Components defining the sound for any product operating condition. Figure 1 presents an example of a typical product application showing the relationship between the product Sound Components and the various application sound paths. Figure 2 presents an example of a typical vertically ducted product depicting the contribution of the various product Sound Sources on the Sound Components.

All Sound Components are tested utilizing either a reverberation room (qualified by test) or using Sound Intensity. Reverberation room tests are conducted using the Comparison Method and a calibrated Reference Sound Source, while the Sound Intensity tests are conducted using measurements made at discrete points or by the scanning method. Sound ratings are in the form of Octave Band Sound Power Levels (dB) from 63 to 8000 Hz derived from One-third Octave Band measurements. In addition to the stated Octave Band ratings, this standard can be used to provide One-third Octave Band sound ratings from 50 to 10,000 Hz.

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In the example presented in Figure 1, there are two Sound Components present, ducted discharge and free inlet combined with casing radiated. The ducted discharge sound component affects or defines the source strength for two application sound paths 1) the supply duct airborne sound and 2) the supply duct breakout sound. The free inlet combined with casing radiated sound component affects or defines the source strength for the 3) return airborne and 4) wall transmission application sound paths.

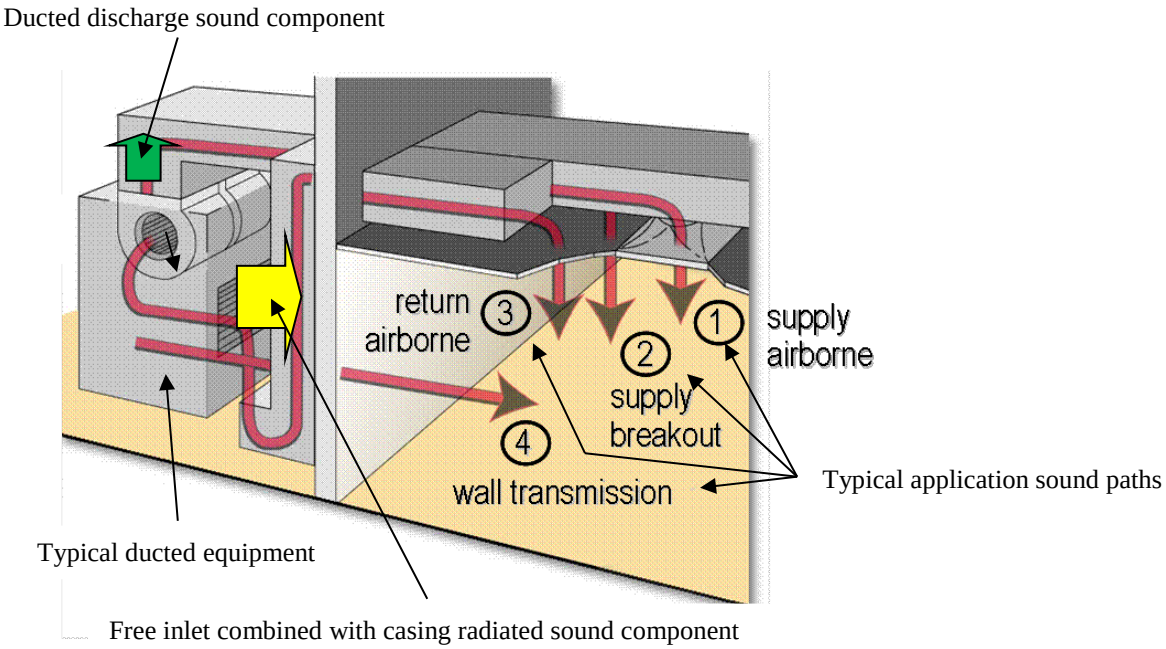


Figure 1 – Typical Ducted Product Application

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In Figure 2, a typical vertical ducted unit is presented with its Sound Components and their contributing product Sound Sources. In this example, there are two Sound Components, the ducted discharge and the ducted inlet. The ducted discharge sound component is first defined by the supply fan discharge sound in the Base Unit coupled with the discharge plenum. The contribution of appurtenance sound from supply fan discharge airflow impinging the heat exchanger in the discharge plenum must also be added to the supply fan discharge sound. Finally, the effects of the other sources on the ducted discharge sound from the condenser fans and the refrigerant circuit must be considered. For the ducted inlet sound component, the sound from the return side of the return fan is first considered. In this case, the return side sound from the supply fan contributes as another sound source.

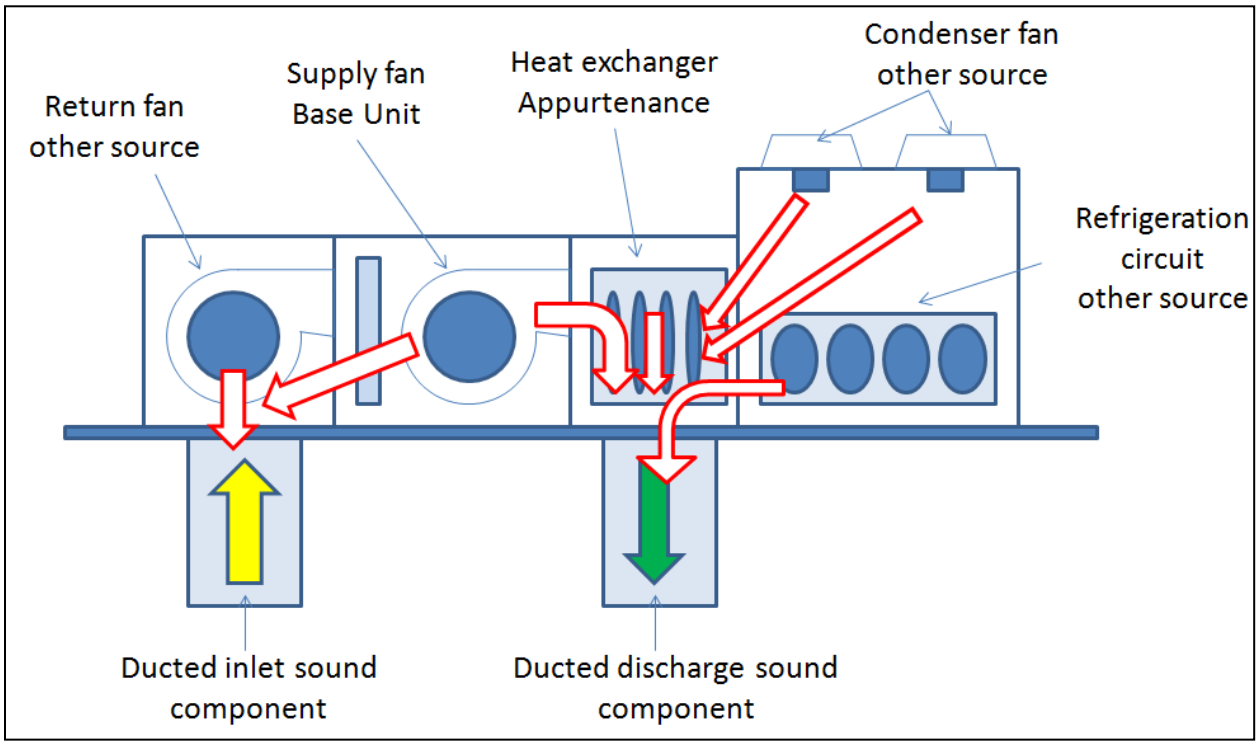


Figure 2 – Relationship Between Sound Components and Sound Sources

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Section 2. Scope

2.1 *Scope.* This standard applies to Ducted Equipment and specifies the methods for the determination of the sound power rating of the indoor sections of factory-made residential, commercial and industrial air-conditioning and Heat Pump equipment, which are electrically driven, with mechanical compression and containing fans, using mapped sound data for rating the various product Sound Components. Sound power ratings reported are octave-band Sound Power Levels from 63 Hz to 8000 Hz. The terms Air-Conditioner and equipment are used to mean Air-Conditioners and Heat Pumps in this part of the standard. In addition to the stated Octave Band ratings, this standard can additionally be used to provide One-third Octave Band sound ratings from 50 to 10,000 Hz.

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 *Acoustic Baffle*. A barrier that creates a well defined duct termination and test surface for a ducted sound intensity measurement. The barrier is rigid and non-absorbing.

3.2 *Acoustic Test Duct*. A duct used to convey the sound of the unit configuration under test to the reverberation room or intensity surface during a ducted discharge or ducted inlet sound component test. A Duct End Correction shall be added to the sound data measured in the reverberation room or from the intensity method to account for the presence of the duct termination.

3.3 *Acoustic Test Duct Elbow.* An elbow that may be added to the Acoustic Test Duct to facilitate testing. An Acoustic Test Duct Elbow Correction, shall be made (in addition to the Duct End Correction) to the sound data to account for the presence of the Acoustic Test Duct Elbow.

3.4 *Acoustic Test Duct Elbow Correction (E_2)***.** A correction in a frequency band to account for insertion loss effects of the elbow on the sound propagating through the Acoustic Test Duct. The table in Appendix C of this standard defines the Acoustic Test Duct Elbow Correction.

3.5 *Appurtenance***.** An addition to a Base Unit for purposes of air modulation, heat transfer, control, isolation, safety, static pressure regain, etc.

Examples of Appurtenances include:

1. Coil(s)
2. Electric heater(s)
3. Air filter(s)
4. Damper(s)
5. Moisture eliminator(s)
6. Fan-motor drive(s)
7. Gas heat exchanger(s)
8. Inlet or discharge plena
9. Modulating device(s) in the fan inlet/discharge
10. Application duct geometry(s) (such as duct elbow configurations)
11. Alternate unit casing construction(s) (such as double walled, lined, perforated face)

3.6 *Air-Conditioner***.** One or more factory-made assemblies which normally include an evaporator or cooling coil, a compressor and condenser combination, and may include a heating function; where such equipment is provided in more than one assembly, the separated assemblies shall be designed to be used together.

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3.7 *Base Unit.* A factory-made encased assembly consisting of one or more fans meant to be connected to a duct and other necessary equipment to perform one or more of the functions of circulating, cleaning, heating, cooling, humidifying, and mixing of air, but which may or may not include a source of heating or cooling.

3.8 *Comparison Method*. A method of determining Sound Power Level by comparing the average Sound Pressure Level produced in the room to a Reference Sound Source of known Sound Power Level output. The difference in Sound Power Level is equal to the difference in Sound Pressure Level when conditions in the room are the same for both sets of measurements.

3.9 *Ducted Equipment.* Heating, ventilating and air conditioning equipment having one or more supply fans which employ ductwork to convey the conditioned air to and/or from the desired space. Ducted Equipment may have various combinations of discharges and inlets as follows:

3.9.1 Ducted discharge(s) and ducted inlet(s).
3.9.2 Ducted discharge(s) with free inlet(s).
3.9.3 Ducted inlet(s) with free discharge(s).

This equipment may be ducted in various configurations horizontally and vertically, and may incorporate multiple inlets and outlets.

3.10 *Duct End Correction (E_1).* A correction in a frequency band that accounts for the acoustic energy in an Acoustic Test Duct that is prevented from entering the test space by the impedance mismatch created by the termination of the Acoustic Test Duct. A method for computing the Duct End Correction is described in Section 5.2.1 of this standard.

3.11 *Effective Diameter*. The diameter of an Acoustic Test Duct which is equal to either the diameter of a circular duct or the Effective Diameter of a rectangular duct calculated according to Equation 1, m:

$$D_e = \left(\frac{4A}{\pi} \right)^{1/2} \quad (1)$$

Where:

A = Cross-sectional area of the duct, m^2
D_e = Effective Diameter, m

3.12 *Heat Pump.* One or more factory-made assemblies which normally include an indoor conditioning coil, a compressor and outdoor heat exchanger (including means to provide a heating function), and may optionally include a cooling function. When such equipment is provided in more than one assembly, the separated assemblies shall be designed to be used together.

3.13 *Hertz (Hz).* Unit of frequency in cycles per second.

3.14 *Mapped Sound Rating.* Equipment sound ratings that are based upon a series of tests performed across the range of operating conditions determined typically from a flow pressure map for the product supply fan and as defined by the equipment manufacturer. Contributions due to Appurtenances and other sources such as return fans, exhaust fans, and the refrigeration circuit are superimposed on the supply fan sound rating map. One-third Octave Band Sound Power Levels are obtained for each test point of the series to provide Octave Band sound power ratings. The mapped rating process is defined in Section 6.2. A special case exists when a supply fan is used in conjunction with a return or exhaust fan in the Base Unit (See Appendix D).

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3.15 *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.

3.16 *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 frequency. The One-third Octave Bands used in this standard are those defined in ANSI/ASA Standard S1.11.

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

3.18 *Reference Sound Source (RSS).* A portable, aerodynamic sound source that produces a known stable broad band sound power output as defined in AHRI Standard 250.

3.19 *Reproducibility*. The degree of agreement in test results obtained with the same method on identical test items in different laboratories with different operators using different equipment.

3.20 *Sound Components*. The product sound that can be independently defined to describe a product's contribution to the various sound paths in a typical application. The Sound Components that may need to be defined for a given product consist of one or more of the following:

3.20.1 Ducted discharge

3.20.2 Ducted inlet

3.20.3 Casing radiated

3.20.4 Free discharge (or free inlet) combined with casing radiated

3.20.5 Free discharge (or free inlet)

3.21 *Sound Intensity*. The sound power transmitted through a unit area.

3.22 *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.

3.23 *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).

3.24 *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 (internationally recognized units), expressed in decibels (dB).

3.25 *Sound Sources*. Any phenomenon occurring within the unit that contributes to the product sound. For the purposes of this standard there are three types of Sound Sources. Their combined effects are added together to obtain the total sound for a given product sound component. The three types of Sound Sources are:

3.25.1 Base Unit: sound generated by the primary fan(s) in the Base Unit.

3.25.2 Appurtenance: sound generated or attenuated due to the Appurtenance having airflow through or impacting it.

3.25.3 Other: sound generated by an element that is not caused by primary fan airflow through or impacting the element in the product. The refrigerant circuit, airborne noise from a variable

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frequency drive (VFD) ventilation fan, motor noise, gas burner combustion noise, outdoor air condenser fans, and secondary fans, such as return fans and exhaust fans (See Appendix D).

Section 4. Requirements for Acquiring Sound Data

4.1 *General Test Considerations.* This standard incorporates a reverberation room Comparison Method and/or a Sound Intensity method to obtain the Sound Power Levels of the various Sound Components for ducted air-moving and air-conditioning equipment. These methods yield the Sound Power Levels for a complete ducted unit by adding the effects of Appurtenances and other Sound Sources to the sound of the Base Unit as required.

When using the reverberation room method, Sound Power Levels shall be determined using AHRI Standard 220. The reverberation room method of qualification, method of test, facilities, and requirements are per AHRI Standard 220 or as defined in the body of this standard in Sections 4.2 through 4.6.

When using the intensity method, Sound Power Level shall be determined in accordance with ISO 9614-1 (grade 2) and ISO 9614-2 (grade 2), using the method outlined in Appendix F and the requirements in Section 4.2 through 4.5 and 4.7.

4.2 *Equipment Configurations and Sound Components.*

Only those Sound Components that apply to how the product is installed and used shall be included in the product sound rating. The appropriate sound component(s) shall be selected based on the product application.

4.2.1 *Equipment with Ducted Discharge(s) and Ducted Inlet(s).* The following sound component Sound Power Levels can be determined for this configuration:

4.2.1.1 Ducted discharge
4.2.1.2 Ducted inlet
4.2.1.3 Casing radiated

4.2.2 *Equipment with Ducted Discharge(s) and Free Inlet(s).* The following sound component Sound Power Levels can be determined for this configuration:
4.2.2.1 Ducted discharge
4.2.2.2 Optional free inlet
4.2.2.3 Optional free inlet combined with casing radiated

The free inlet combined with casing radiated sound power component shall not be derived from separate free inlet and casing radiated sound tests.

4.2.3 *Equipment with Ducted Inlet(s) and Free Discharge(s).* The following sound component Sound Power Levels can be determined for this configuration:
4.2.3.1 Ducted inlet
4.2.3.2 Optional free discharge
4.2.3.3 Free discharge combined with casing radiated

The free discharge combined with casing radiated sound power component shall not be derived from separate free discharge and casing radiated sound tests.

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4.3 *Method of Test.*

4.3.1 *General.* All sound tests shall be conducted using either the AHRI Standard 220 reverberation room Comparison Method or the ISO 9614 Sound Intensity method. The specific test set-up will depend on the product Sound Components being tested. The tests can be divided into two basic types: ducted sound component tests and non-ducted sound component tests. For ducted sound component tests, the sound component of interest is ducted into the test space with an Acoustic Test Duct. For non-ducted sound component tests, the unit may either be located in the test space with the untested Sound Components being ducted out, or the unit is located adjacent to the test space without an Acoustic Test Duct.

4.3.2 *Ducted Sound Components* For ducted discharge and ducted inlet Sound Components tested in accordance with this standard, a Duct End Correction (E_1) (as computed in Section 5.2.1 of this standard) shall be added to each One-third Octave Band. The addition of the Duct End Correction (E_1) provides the user with the sound power that would be transmitted into an acoustically, non-reflective duct system.

Products having multiple ducted discharges or multiple ducted inlets on a common face that are meant by the manufacturer to join into a common duct shall be tested at the same time. A Duct End Correction (E_1) of only one of the ducts shall be made. However, if products have multiple ducted inlets or discharges on a common face or different faces, and are not joined into a common duct, each shall be tested separately. Duct End Corrections shall be made for each of the ducts.
An airflow control device, such as an orifice end plate, shall not be placed in the Acoustic Test Duct. However, airflow control devices can be part of other test ducts or plenum not related to the sound component under test.

Although a straight Acoustic Test Duct is preferred for ducted sound component tests, an Acoustic Test Duct Elbow may be used to accommodate test facility and unit set-up limitations. If an Acoustic Test Duct Elbow is employed, Acoustic Test Duct Elbow Corrections (E_2) shall be added to the sound data to account for attenuation of the Acoustic Test Duct Elbow using Appendix C.

4.3.3 *Test Unit Airflow Measurements.* All test airflow measurements shall be made in accordance with either ANSI/AMCA Standard 210/ASHRAE 51 or ASHRAE 37.

4.4 *Test Set-up Configurations.*

4.4.1 *Ducted Discharge Tests.* For this test the unit discharge is ducted into a test space using an Acoustic Test Duct. When using a reverberation room, sound measurements of the ducted discharge component shall be conducted using AHRI Standard 220. When using Sound Intensity, sound of the ducted discharge component shall be determined using Appendix F. Test configurations are conceptually shown (and not to scale) in Figure 3 or 4. For either reverberation room or Sound Intensity tests, a Duct End Correction (and Acoustic Test Duct Elbow Correction if needed) shall be added to the Sound Power Level to account for the acoustic energy that is prevented from entering the test space by the impedance mismatch created by the termination of the Acoustic Test Duct. For ducted discharge tests, it is recommended that the Acoustic Test Duct be three effective duct diameters in length, but shall not be less than 1m. However, duct lengths up to five effective duct diameters are permissible if needed for set-up or airflow performance measurement considerations.

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