

getting to the source ...

Sound Ratings and ARI Standard 260P

from the editor:

The source–path–receiver model provides a systematic approach to acoustical analysis, tracing sound from its origin (HVAC equipment, for example) to the site at which it is heard. As explained in the 1996 EN issue, “Specifying Quality Sound,” an acoustical analysis based on this model can help you write an equipment specification that is more likely to satisfy the acoustical target.

Defining the endpoints of this model was described as “straightforward,” at least when compared to quantifying the sound paths: manufacturers provide sound-power data for “source” equipment and owners set sound-pressure targets for “receiver” rooms.

This article reveals the understatement inherent in “manufacturers provide sound-power data.” It explains why meaningful equipment sound ratings aren’t consistently available, and how a proposed industry standard, ARI 260P, will help designers predict actual sound levels with greater confidence.

Obtaining accurate, representative acoustical data for HVAC equipment is an important step in any acoustical analysis. It also poses a problem for system designers, particularly when the equipment includes a fan. Here’s why:

- Methods for predicting sound data vary from manufacturer to manufacturer, hampering comparisons of equipment.
- Experience-based “safety factors” applied by designers to offset potentially inaccurate data often result in over-attenuation and unnecessarily inflate the first cost of the system.
- The disparity between rating conditions and the actual installation makes it difficult to design for proper attenuation.

“The objective of ARI 260P is to deliver application-specific sound data.”

Help is on the way in the form of a proposed standard written by the Air-Conditioning and Refrigeration Institute. When adopted, ARI 260P will establish a method for sound rating a broad range of ducted HVAC equipment with fans. The benefit: consistent sound ratings that more accurately represent real-world installations.

The Challenge of Providing Accurate Sound Ratings

Done properly, collecting accurate sound data for an entire line of products is an expensive endeavor. A product line consists of many models; each model typically comes in a range of sizes and with various options that generate, dampen, or otherwise alter sound.

Consider, too, that each fan in an air-moving product may run at multiple speeds and under a range of flow and static-pressure conditions. The fact that each fan type has a characteristic operating profile further complicates data collection.

Of course, it is not enough to collect data ... the data must accurately predict the sound levels that will be produced once the equipment is installed. Sufficient testing must be done to ensure that each prediction approaches a data-collection point. Measurement accuracy requires specialized, single-purpose test facilities built to stringent design specifications. Finally, these facilities must be equipped with laboratory-grade equipment and staffed with knowledgeable personnel.

Assuring accuracy increases the cost and complexity of obtaining equipment sound data. Test standards for air-moving equipment must therefore balance accuracy with practicality.

Previous “Solutions”

A brief review of the conventional methods for establishing sound data—AMCA 300, fan data plus appurtenance-effect equations, and the ASHRAE fan algorithm—provides a useful context for the changes proposed in ARI 260P.

ASHRAE fan algorithm. Though increasingly less common, there are still cases where fan sound levels are based on prediction equations such as the general fan algorithm published by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE). This method provides a considerable cost benefit by eliminating the need for a test facility ... but at the expense of accurate data. In 1995, after tests proved that predicted data could vary from measured readings by as much as 10 dB in a given octave band, ASHRAE replaced the fan prediction algorithm in its handbook series with this statement:

“The sound power generated by a fan performing at a given duty is best obtained from manufacturers’ test data taken under approved test conditions.”
[from the 1999 ASHRAE Handbook—Applications, Chapter 46.4]

Fan data plus predicted appurtenance effects. Another sometimes-used rating method records test data for the fan by itself; then uses classic acoustical formulas to predict the effect of the cabinet, coils, filters, and other appurtenances that comprise the unit. Prediction programs vary from manufacturer to manufacturer, and since these programs are usually proprietary, it is also difficult to judge their accuracy. This can prevent designers from effectively comparing data between manufacturers or applying that data in an analysis.

AMCA 300. Written by the Air Movement and Control Association International, Inc., this standard defines the test methodology for collecting fan-only sound data; however, it has also been used to test entire units. The label, “taken in accordance with AMCA 300,” does not distinguish between these uses, so it is up to the designer to determine whether the data reflects the entire unit or, as intended, the fan by itself. Once published, ARI 260P will eliminate this ambiguity since it will become the test standard for rating the acoustical performance of packaged, ducted HVAC equipment with fans.

How ARI 260P Will Help

ARI 260 (identified as “ARI 260P” in its proposed form) is one of a series of sound standards that prescribe test methods, set minimum requirements for cataloged ratings, and define conditions for conformance. Properly implemented, these standards produce accurate, verifiable sound ratings for a broad range of air-moving and air-conditioning equipment. The jurisdiction for ARI 260P is **ducted air-conditioning equipment containing one or more fans**; examples include:

- central-station air handlers
- unitary air conditioners (including air-source heat pumps)
- water-source heat pumps
- ground-source heat pumps (including closed-loop)
- fan-coil air conditioners

The underlying objective of ARI 260P is to deliver **application-specific** sound data; that is, sound data that accurately represents the acoustical impact of the equipment once it is installed. Several sound components (not just one, as in many standards) must be measured to obtain such a representation. To

accomplish this objective in a manner that is both accurate and practical, ARI 260P employs the acoustics-lab workhorse, the **reverberation room**, to collect data for the **entire unit**. It also defines a strict methodology to assure the correctness of interpolations.

The proposed standard addresses four aspects of rating equipment sound:

- unit configuration
- test-setup parameters
- interpolation for untested operating points
- secondary sources of sound

Unit configuration. A fan performs differently inside a unit than it does in a stand-alone application. The unit casing generally changes the airflow patterns at the fan inlet and discharge openings, which can increase the sound power for a given flow and static-pressure condition. This effect is the major reason for the difference between cataloged ratings and the actual sound produced by the unit. Even if the manufacturer’s prediction program correctly accounted for appurtenance effects, the change in fan conditions would still produce a discrepancy.

To eliminate such inaccuracies, ARI 260P requires that the entire unit be tested as it will be configured in the field. Figures 1 through 4 show the test

Figure 1—Ducted-Discharge Test Setup

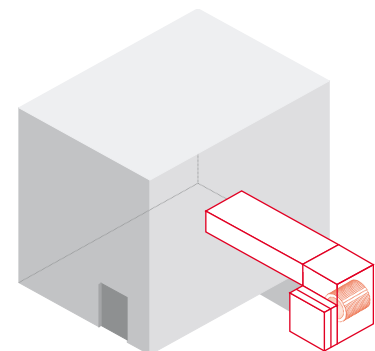
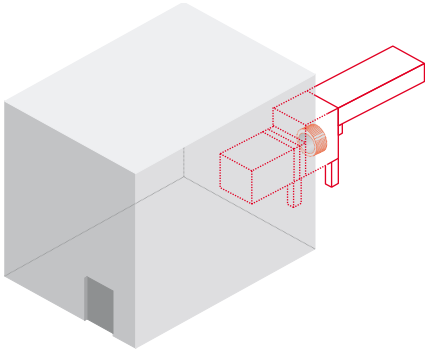


Figure 2—Ducted-Inlet Test Setup



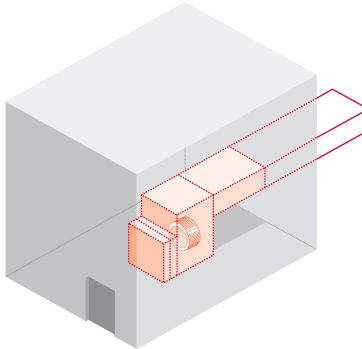
setups used to determine ducted-discharge, casing-only, inlet-plus-casing, and ducted-inlet sound. Together, they provide all of the component sound data needed to perform a complete acoustical analysis.

Figure 5 demonstrates how the component sound data collected under ARI 260P will enhance the accuracy of a designer’s acoustical analysis. In this instance, the source of the sound is an air handler installed in an equipment room adjacent to an occupied space; sound reaches the occupied space via four paths:

- Sound leaving the unit with the discharge air enters the space through duct breakout (supply-breakout path);
- Or it follows the air through the diffuser into the room (supply-airborne path).
- Sound radiated from the return opening and casing passes through the wall (radiated path);
- Or it travels in the direction opposite that of the return air (return-airborne path).

To predict the acoustical impact of the air handler in the occupied space, the designer needs sound data from the

Figure 3—Free-Inlet-Plus-Casing-Radiated Test Setup

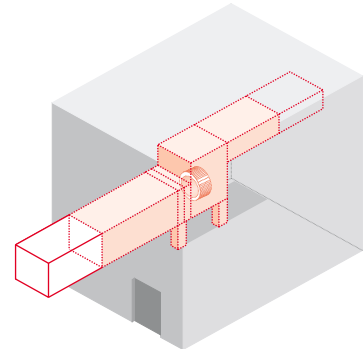


ducted-discharge (Figure 1) and the free-inlet-plus-casing-radiated (Figure 3) test setups.

ARI 260P requires sound testing for all of the configurations in which the equipment is commonly applied. For example, another typical application of the air handler in Figure 5 connects the return duct directly to the unit. Therefore, under ARI 260P, data must also be collected for ducted-inlet (Figure 2) and casing-radiated (Figure 4) sound.

Note: One or more of these tests may be omitted, based on how the equipment is commonly applied. For example, if an air handler is installed with an unducted return, then ducted-

Figure 4—Casing-Radiated-Component Test Setup

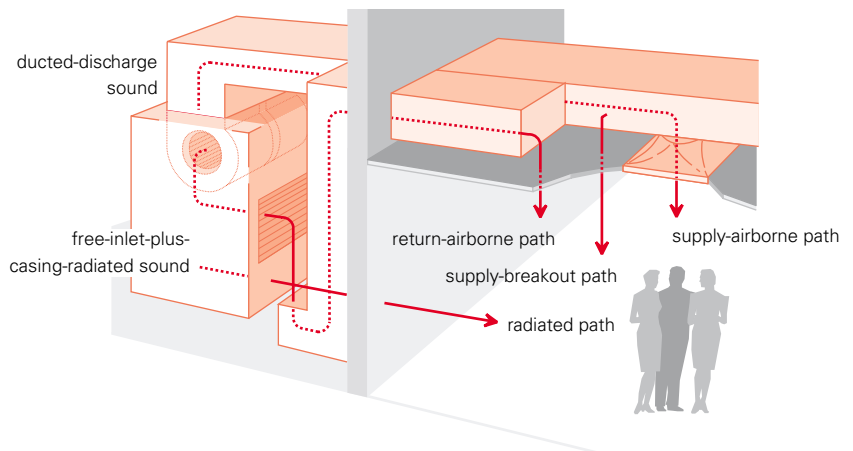


inlet sound data based on ARI 260P is unnecessary.

Test-setup parameters. Testing an entire air-handling unit in a reverberation room poses many technical challenges, ranging from calibration of the reference sound source to application of duct-end-reflection-loss corrections for ducted components. Resolving these challenges is an important step in producing a standard that not only yields accurate data, but is also widely accepted throughout the industry.

Interpolation for untested operating points. The wide range of fan operating conditions makes it impractical to test all possible operating

Figure 5—Applying Sound Ratings in an Acoustical Analysis



conditions. Recognizing this, ARI 260P allows certain predictions to be made from measured data, but only within strict guidelines.

For example, several fan speed curves with equally spaced test points must be tested to assure accuracy across the resulting “operating map.” Test points cannot be more than 5 dB apart in any one-third octave band. Furthermore, any interpolated (predicted) operating points must lie within the tested map; extrapolations outside the test range are prohibited.

This methodology provides sufficient data to develop highly accurate predictions that complement the precision of the reverberation-room measurements.

Secondary sources of sound.

Unlike other sound standards, including AMCA 300, ARI 260P requires that secondary sound sources such as return/exhaust fans and compressors be tested to determine their acoustical impact. Furthermore, any secondary source that alters the sound spectrum of the supply fan must be included in cataloged ratings.

Ratings based on sound standards without these requirements may not account for secondary sources. If acoustics are critical to the success of

an application, check with the manufacturer to verify that the equipment sound data reports this information.

Closing Thoughts

For anyone using equipment sound ratings to predict the acoustical levels for occupied spaces, or to compare various units, ARI 260P is good news:

- It addresses a wide range of air-moving products with a consistent test method.
- It assures accurate, verifiable sound data.
- It focuses on the entire unit in its common installation arrangements.
- It balances accuracy with practicality.

As with existing ARI sound standards, broad application and acceptance of ARI 260P will enable you to make equitable product comparisons and more accurately predict sound levels for occupied spaces. Some manufacturers are already rating their packaged equipment in accordance with the proposed standard.

What about custom-built equipment? The fact that ARI 260P requires sound testing of the entire unit may make it impractical for rating one-of-a-kind units, particularly since they are often too large for reverberation-room tests. Given these constraints, it is likely that sound ratings for custom-built units will continue to be based on data for the stand-alone fan, then adjusted using appurtenance-effect formulas and experience.

Until ARI 260P becomes prevalent (and beyond, for one-of-a-kind units), it is up to you to be vigilant in your comparison and application of equipment sound ratings. Ask the manufacturer how the sound ratings were established:

Was the entire unit tested, or just the fan?

Were secondary sources such as compressors and return/exhaust fans included?

Accounting for the answers in your acoustical analyses may well make the difference between an acoustically optimized installation and one that adds unnecessary cost through over-attenuation, or worse still: an under-attenuated installation with no practical means of remediation. ■

By Dave Guckelberger, applications engineer, and Brenda Bradley, information designer, The Trane Company.

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