PRODUCT APPLICATION

A technical bulletin for engineers, contractors and students in the air movement and control industry

Understanding the Development of Fan Sound Data and the Product Rating Process

Sound is a very important consideration in the selection and application of fans. If not properly evaluated, fan sound can turn an otherwise completely acceptable application into an acoustic disaster. Despite this, fan sound continues to be one of the most misunderstood topics in the air handling industry.

To provide a better understanding and point of reference on how fan sound is developed, rated, applied, and controlled, this is the first in a series of four Product Application Guides covering this topic.

- Part 1 - Understanding the Development of Fan Sound Data and the Product Rating Process FA/120-23
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- Part 3 - Radiated Sound, FA/122-23
- Part 4 - Sound Criteria, Attenuation Techniques and Preventive Measures to Limit Sound Problems, FA/123-23

Quality air handling, conditioning, control, and distribution products that perform in accordance with published data do not occur by accident. It is the result of extensive aerodynamic testing and sound testing following a comprehensive product development plan.

A manufacturer's product development and testing must be state of the art, in accordance with current industry standards. Products that are independently third-party tested and performance certified assure the specifying engineer, installing contactor, and facility owner that the products and equipment installed will perform as stated by the manufacturer. This article provides an overview and insight into the thoroughness with which products are tested and rated for acoustic performance.

The development process

Product development starts with aerodynamic and acoustic performance goals often determined by the marketplace. Computational fluid dynamics (CFD) and design history guide the making of a prototype that will satisfy the desired goals. Aerodynamic tests should be performed in Air Movement and Control Association International, Inc. (AMCA) registered air test chambers to determine aerodynamic performance in accordance with AMCA Standard 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating". Acoustic (sound) performance is obtained by tests in an AMCA-registered sound facility to determine inlet and outlet sound power levels. Tests are conducted in strict accordance with AMCA Standard 300, "Reverberant Room Method for Sound Testing of Fans."

An AMCA 300 reverberant room test method consists of measuring the sound pressure levels produced by a fan, and those produced by a reference sound source (RSS) in the same acoustic environment, i.e., the semi-reverberant room. The RSS sound power level has been previously determined and calibrated by tests conducted at a nationally recognized independent acoustic laboratory. The sound power of a fan is determined

by substitution. The sound level of the calibrated reference sound source is measured in a semi-reverberant room. The difference (amount of sound absorbed by the room) between the calibration numbers and what is measured is added to the measured values for the test fan. Tests and published sound power levels should be for both the inlet and outlet of the fan.

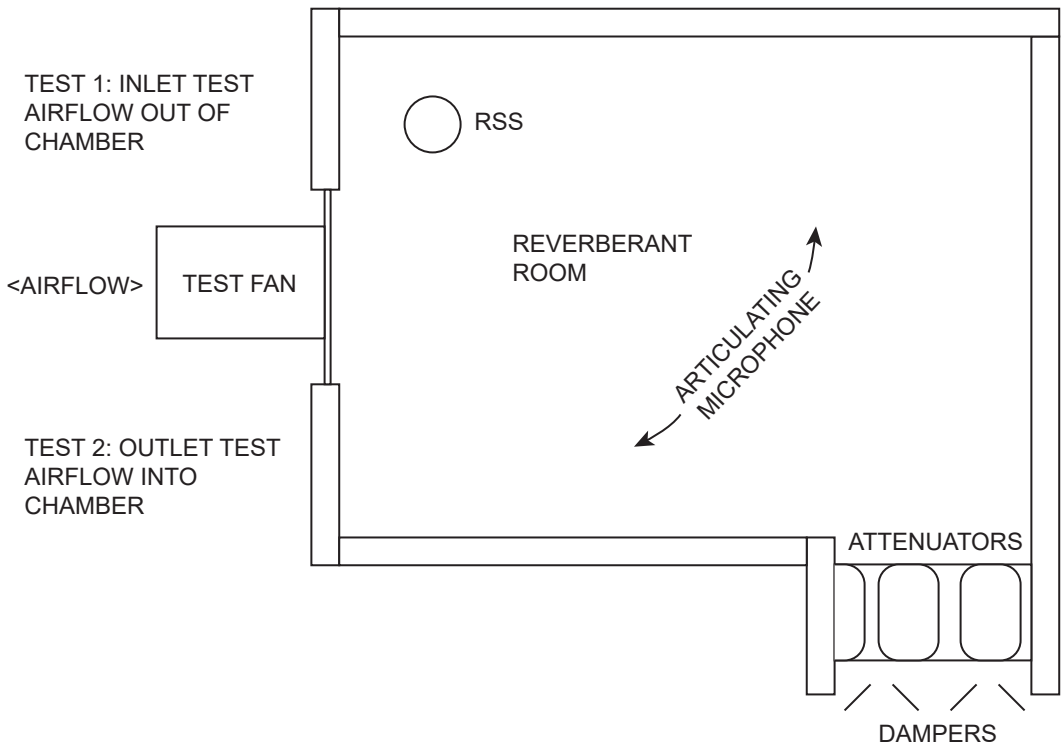
Another acoustic consideration for many fan applications is that of sound radiating from the fan's casing. Using AMCA Standard 320, "Laboratory Method of Sound Testing Fans Using Sound Intensity", a manufacturer can establish the sound power level of the sound radiating from a fan's casing. The casing-radiated sound is particularly useful when fans are to be applied in buildings next to offices or conference rooms. The concept of using sound intensity to determine sound power is relatively simple. Sound Intensity is the rate of sound energy passing through a unit area. Therefore, if a theoretical enclosure is placed around a fan and the normal average sound intensity passing through the surface area is determined, the sound power of the fan is calculated by multiplying the average sound intensity by the surface area of the enclosure.

The resulting data provided by all AMCA sound test standards is in sound power levels in dB (decibels) referenced to 10^{-12} watts. The sound power level is provided in each of eight octave bands from mid frequencies of 63 Hz to 8 KHz. All test results are consistent and in the same format regardless of the test standard used.

Product line rating process

A fan product line may consist of one size or several sizes. A key element that determines the accuracy and reliability of fan catalog ratings is how well the sound test data encompasses the range of the catalog and whether the sizes have geometric similarities. Geometric similarity requires that all dimensions and angles of a larger fan must be a constant ratio to a smaller base size which has been tested. If geometric similarity does not exist, then each fan size must be tested.

AMCA Standard 300 typical test setup for determining inlet and outlet sound power



Sound does not behave in as predictable a manner as aerodynamic data. Therefore, projections of sound power levels from test data have several rather restrictive limitations to maintain good accuracy. An extremely thorough and conservative rating process encompasses the following guidelines:

- The minimum test size must correspond to the minimum catalog size.
- Fan sizes with wheels under twelve inches in diameter must be tested individually.
- Conduct a sufficient number of tests for each product line to assure accurate and dependable ratings. Larger fans are tested using the sound intensity of extrapolated results of smaller fans.
- The minimum test speed will be within five percent of the minimum catalog speed.
- Intermediate test speeds must be within .6 and 1.6 times each other.
- The maximum test speed should approximate the maximum catalog speed.
- The number of test operating points must be no less than four and cover the entire operating range of the catalog. The operating points are incrementally spaced so that they are consistent along a constant system line when more than one size is involved. This means that all operating points are at consistent increments of “percent wide open volume.”

What about non-tested sizes and speeds? There are three distinct processes utilized depending on the situation:

1. Interpolation may be used when catalog sizes, speeds, and operating points are bracketed by known test data.
2. Extrapolation is used when catalog sizes, speeds, and operating points are larger than test data. The fan laws based upon the generalized sound format contained in AMCA Standard 301 are used.
3. An alternate method of extrapolation may be used on some products based on specific sound power. Specific sound power is the sound produced when a fan is operating at one cfm and one inch of total pressure.

AMCA Certified Ratings

A manufacturer that participates in AMCA’s Certified Ratings Program (CRP) assures the industry that the products and equipment will perform as stated by the manufacturer. The program stipulates the various rules and regulations for presenting cataloging data: AMCA 211 for aerodynamic performance and AMCA 311 for acoustic performance.

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