AMCA Publication 203-90 (R2007)

Field Performance Measurement of Fan Systems

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC.

The International Authority on Air System Components

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Forward

The original edition of Publication 203 was released in 1976. This, the second edition, updates much of the information that was presented.

Annex K (estimating the power output of three phase motors) and Annex L (estimating belt drive losses) were rewritten and adjusted based on new information received from motor and drive manufacturers. Over four hundred belt drive loss tests were analyzed.

New axial fan *System Effect Factors* were established based on a test project conducted and underwritten by AMCA. These factors were incorporated in their respective, applicable field test examples shown in Annex A.

The intent of this publication is to provide information from which test procedures can be developed to meet the conditions and requirements encountered in specific field test situations. They include the proper procedure for determining various *System Effect Factors*. Numerous examples of actual field tests are presented in detail in Annex A. These examples provide sufficient guidance for the proper field testing of most fan system installations.

Authority

AMCA Publication 203 was approved by the Air Movement Control Association Membership in 1990. It was reaffirmed July, 2007.

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Related AMCA Standards and Publications

Publication 200 ***AIR SYSTEMS***

System Pressure Losses
Fan Performance Characteristics
System Effect
System Design Tolerances

Air Systems is intended to provide basic information needed to design effective and energy efficient air systems. Discussion is limited to systems where there is a clear separation of the fan inlet and outlet and does not cover applications in which fans are used only to circulate air in an open space.

Publication 201 ***FANS AND SYSTEMS***

Fan Testing and Rating
The Fan "Laws"
Air Systems
Fan and System Interaction
System Effect Factors

Fans and Systems is aimed primarily at the designer of the air moving system and discusses the effect on inlet and outlet connections of the fan's performance. System Effect Factors, which must be included in the basic design calculations, are listed for various configurations. AMCA 201-02 and AMCA 203-90 are companion documents.

Publication 202 ***TROUBLESHOOTING***

System Checklist
Fan Manufacturer's Analysis
Master Troubleshooting Appendices

Troubleshooting is intended to help identify and correct problems with the performance and operation of the air moving system after installation.

Publication 203 ***FIELD PERFORMANCE MEASUREMENTS OF FAN SYSTEMS***

Acceptance Tests
Test Methods and Instruments
Precautions
Limitations and Expected Accuracies
Calculations

Field Performance Measurements of Fan Systems reviews the various problems of making field measurements and calculating the actual performance of the fan and system. AMCA 203-90 and AMCA 201-02 are companion documents.

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Field Performance Measurement of Fan Systems

1. Introduction

Performance ratings of fans are developed from laboratory tests made according to specified procedures on standardized test setups. In North America, the standard is ANSI/AMCA Standard 210 / ANSI/ASHRAE 51 *Laboratory Methods of Testing Fans for Rating*.

In actual systems in the field, very few fans are installed in conditions reproducing those specified in the laboratory standard. This means that, in assessing the performance of the installed fan-system, consideration must be given to the effect on the fan's performance of the system connections, including elbows, obstructions in the path of the airflow, sudden changes of area, etc. The effects of system conditions on fan performance is discussed in Section 5, and more completely in AMCA Publication 201, *Fans and Systems*.

A major problem of testing in the field is the difficulty of finding suitable locations for making accurate measurements of flow rate and pressure. Sections 9.3 and 10.3 outline the requirements of suitable measurement sections.

Because these problems and others will require special consideration on each installation, it is not practical to write one standard procedure for the measurement of the performance of all fan-systems in the field. This publication offers guidelines to making performance measurements in the field which are practical and flexible enough to be applied to a wide range of fan and system combinations.

Because of the wide variety of fan types and systems encountered in the field, Annex A includes examples of a number of different field tests. In most cases, these examples are based on actual tests which have been conducted in the field.

Before performing any field test, it is strongly recommended that the following AMCA publications be carefully reviewed:

AMCA Publication 200 - *Air Systems*
AMCA Publication 201 - *Fans and Systems*
AMCA Publication 202 - *Troubleshooting*
AMCA Standard 210 - *Laboratory Methods of Testing Fans for Rating*

2. Scope

The recommendations and examples in this publication may be applied to all types of centrifugal, axial, and mixed flow fans in ducted or nonducted installations used for heating, ventilating, air conditioning, mechanical draft, industrial process, exhaust, conveying, drying, air cleaning, dust collection, etc. Although the word air is used when reference is made in the general sense to the medium being handled by the fan, gases other than air are included in the scope of this publication.

Measurement of sound, vibration, and stress levels are not within the scope of this publication.

3. Types of Field Tests

There are three general categories of field tests:

A) **General Fan System Evaluation** - A measurement of the fan-system's performance to use as the basis of modification or adjustment of the system.

B) **Acceptance Test** - A test specified in the sales agreement to verify that the fan is achieving the specified performance.

C) **Proof of Performance Test** - A test in response to a complaint to demonstrate that the fan is meeting the specified performance requirement.

As acceptance and proof of performance tests are related to contract provisions, they are usually subject to more stringent requirements and are usually more costly than a general evaluation test. In the case of large fans used in industrial applications and of mechanical draft fans used in the electrical power generation industry the performance of a field test may be part of the purchase agreement between the fan manufacturer and the customer. In addition to Publication 203, AMCA Standard 803 *Site Performance Test Standard-Power Plant and Industrial Fans* defines the conditions which must be met to achieve higher accuracy of measurement. In new installations of this type, it is desirable to include a suitable measuring section in the design. Agreement must be reached on the test method to be used prior to performance of the test.

4. Alternatives to Field Tests

In some cases, considerations such as cost and problems of making accurate measurements may make the following alternative methods of testing worth investigation:

A) Testing the fan before installation in a laboratory equipped to perform tests in accordance with AMCA Standard 210. Limitations in laboratory test facilities may preclude tests on full size fans. In this case, the full size fan can be tested at the installation site in accordance with AMCA Standard 210. This will usually require the installation of special ductwork.

B) Testing a reduced scale model of the fan in accordance with AMCA Standard 210 and determining the performance of the full size fan as described in AMCA Publication 802, *Power Plant Fans – Establishing Performance Using Laboratory Methods*.

C) Testing a reduced scale model of the complete fan and system using the test methods outlined in this publication.

Tests conducted in accordance with AMCA Standard 210 will verify the performance characteristics of the fan but will not take into account the effect of the system connections on the fan's performance (see Section 5).

5. System Effect Factors

AMCA Publication 201, *Fans and Systems*, deals in detail with the effect of system connections on fan performance. It gives *system effect factors* for a wide variety of obstructions and configurations which may affect a fan's performance.

System Effect Factor (*SEF*) is a pressure loss which recognizes the effect of fan inlet restrictions, fan outlet restrictions, or other conditions influencing fan performance when installed in the system.

SYSTEM EFFECT FACTORS (SEFs) ARE INTENDED TO BE USED IN CONJUNCTION WITH THE SYSTEM RESISTANCE CHARACTERISTICS IN THE FAN SELECTION PROCESS. Where SEFs are not applied in the fan selection process, SEFs must be applied in the calculations of the results of field tests. This is done for the purpose of allowing direct comparison of the test results to the design static pressure calculation. Thus, for a field test, the fan static pressure is defined as:

$$P_s = P_{s2} - P_{s1} - P_{v1} + \text{SEF 1} + \text{SEF 2} + \ldots + \text{SEF n}$$

Examples of the application of SEFs in determining the results of field tests are included in Annex A.

In field tests of fan-system installations in which *system effects* have not been accounted for, it is important that their sources be recognized and their magnitudes be established prior to testing.

The alternative to dealing with a large magnitude SEF is to eliminate its source. This requires revisions to the system. This alternative course of action is recommended when swirl exists at the fan inlet (see Publication 201, Figure 9.8). The effect on fan performance as a result of swirl at the inlet is impossible to estimate accurately as the system effect is dependent upon the degree of swirl. The effect can range from a minor amount to an amount that results in the fan-system performance being completely unacceptable.

6. Fan Performance

Fan performance is a statement of fan flow rate, fan total or static pressures, and fan power input at stated fan speed and fan air density. Fan total or static efficiencies may be included. The fan air density is the density at the fan inlet. The fan flow rate is the volume flow rate at the fan inlet density.

7. Referenced Planes

Certain locations within a fan-system installation are significant to field tests. These locations are designated as follows:

Plane 1: Plane of fan inlet
Plane 2: Plane of fan outlet
Plane 3: Plane of Pitot-static tube traverse for purposes of determining flow rate
Plane 4: Plane of static pressure measurement upstream of fan
Plane 5: Plane of static pressure measurement downstream of fan

The use of the numerical designations as subscripts indicate that the values pertain to those locations.