AMCA Publication 211-13

Certified Ratings Program - Product Rating Manual for Fan Air Performance

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC.

The International Authority on Air System Components

AMCA Publication 211-13

Certified Ratings Program
Product Rating Manual for Fan Air Performance

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Objections

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Related AMCA Documents

AMCA Publication 11	*Certified Ratings Program Operating Manual*
ANSI/AMCA Standard 99	*Standards Handbook*
AMCA Publication 111	*Laboratory Accreditation Program*
AMCA Publication 200	*Air Systems*
AMCA Standard 205	*Energy Efficiency Classification for Fans*
ANSI/AMCA Standard 210	*Laboratory Methods of Testing Fans for Certified Aerodynamic Performance*
ANSI/AMCA Standard 220	*Laboratory Methods of Testing Air Curtain Units for Aerodynamic Performance Rating*
ANSI/AMCA Standard 230	*Laboratory Methods of Testing Air Circulating Fans for Rating and Certification*
ANSI/AMCA Standard 240	*Laboratory Methods of Testing Positive Pressure Ventilators for Aerodynamic Performance Rating*
ANSI/AMCA Standard 250	*Laboratory Methods of Testing Jet Tunnel Fans for Performance*
AMCA Standard 260	*Laboratory Methods of Testing Induced Flow Fans for Rating*
AMCA Publication 311	*Certified Ratings Program - Product Rating Manual for Fan Sound Performance*

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1. Purpose and Scope

The purpose of this manual is to prescribe technical procedures to be used in connection with the AMCA Certified Ratings Program for Fans - Air Performance.

Products that can be licensed by AMCA to bear the AMCA Certified Ratings Seal are those defined in AMCA Standard 99, Section 0068, ISO 13349 and IEC 60335-2-80, and are within the product scope of AMCA International.

The program applies only to fans, and is not applicable to their component parts such as fan impellers and housings.

2. Normative References

AMCA Publication 11, *Certified Ratings Program - Operating Manual*
ANSI/AMCA Standard 99, *Standards Handbook*
AMCA Publication 111, *Laboratory Accreditation Program*
AMCA Publication 200, *Air Systems*
AMCA Standard 205, *Energy Efficiency Classification for Fans*
ANSI/AMCA Standard 210, *Laboratory Methods of Testing Fans for Certified Aerodynamic Performance*
ANSI/AMCA Standard 220, *Laboratory Methods of Testing Air Curtain Units for Aerodynamic Performance Rating*
ANSI/AMCA Standard 230, *Laboratory Methods of Testing Air Circulating Fans for Rating*
ANSI/AMCA Standard 240, *Laboratory Methods of Testing Positive Pressure Ventilators for Aerodynamic Performance Rating*
ANSI/AMCA Standard 250, *Laboratory Methods of Testing Jet Tunnel Fans for Performance*
AMCA Standard 260, *Laboratory Methods of Testing Induced Flow Fans for Rating*
AMCA Publication 311, *Certified Ratings Program - Product Rating Manual for Fan Sound Performance*
ISO 5801, *Industrial Fans -- Performance Testing Using Standardized Airways*
ISO 13350, *Industrial Fans -- Performance Testing of Jet Fans*

3. Definitions

All definitions found in AMCA Publication 11, as well as the following, apply to this program.

3.1 Appurtenance (accessory)
Any item in or on the inlet or discharge air stream that affects the performance of the fan.

3.2 AMCA Certified Ratings Program - Air Performance
A program for certifying a product's aerodynamic performance ratings, as defined in this document.

3.3 Performance rating(s)
A statement of the pressure performance and power versus airflow at a given speed at standard inlet air density or other specified density. Efficiency may also be included in the performance ratings at the option of the licensee. Power shall be specified as impeller, shaft, or motor power, as appropriate. The rating may be published in tabular and/or graphical format. Specific performance rating requirements are given in the Product Rating Requirement Sections of this document.

3.4 Shall and should
The word "shall" is understood to be a mandatory requirement and the word "should" is understood to be advisory.

3.5 Constant speed
Test data are converted to a single speed before catalog data are generated.

3.6 As-run speed
Test data are not converted to a single speed before catalog data are generated.

4. Data Submittal Requirements

The following data shall be submitted with the CRP-8 application form:

Test data for each test conducted (observations of all variables measured for each test point), which must conform to the test standard used.

Results of the test(s) corrected to standard air density, and constant speed, where applicable.

Drawings of each size of the product line, showing the dimensions specified in Annex A for the type of product being submitted.

Photograph of each test setup.

5. Drive Methods

Various methods may be used to drive the test unit and measure the power input to the fan. The power measurements may or may not include the power transmission losses, but for fans supplied with shaft and bearings, the bearing loss-

es shall be included in the fan power input measurement. See Annex D for more information for allowable methods of accounting for bearing and/or power transmission losses when calculating test data to other sizes and speeds.

Direct driven fans using "low-slip" (e.g. squirrel cage induction motors) motors may be driven by a dynamometer or a calibrated motor when the fan power rating is the output power of the dynamometer or calibrated motor. When the fan power rating is the motor input watts, the fan shall be driven by its own motor. Direct driven fans using "high slip" (e.g. shaded pole or capacitor start motor) motors shall be driven by their own motors, and the power rating shall be the motor input watts.

Motor calibrations shall be performed by the AMCA Testing Laboratory, the motor manufacturer, or by an AMCA Accredited Laboratory. Motor calibrations shall be performed at the voltage and frequency to be used for the fan test. The motor calibration shall be conducted at the motor's operating temperature.

6. Ducted Inlet Simulation

Ducted inlet performance may be determined by using an inlet bell, or an inlet bell and one diameter of inlet duct.

7. Catalog Requirements

7.1 Scope of certification

This program applies to fans within the scope of AMCA International for which performance rating catalogs are published and made available to the public. When only a portion of a cataloged series of sizes are licensed, at least a majority of the sizes cataloged shall be licensed. It does not apply to special units for which performance ratings are not published. When performance ratings for both licensed and nonlicensed products are contained in the same catalog, there must be a clear distinction made between licensed and nonlicensed products, as required AMCA 11, Section 11. The same requirement applies if some catalog performance data are not licensed.

7.2 Statement required adjacent to the seal

7.2.1 Licensed products statement

In catalogs containing ratings of licensed products, the following statement shall be printed prominently and immediately adjacent to the reproduction of the AMCA Certified Ratings Seal, except as noted in Section 10.5 of the Certified Ratings Program Operating Manual.

"[*Licensee's name*] certifies that the [*product description*] shown herein is(are) licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 211 (and Publication 311 if sound is also certified) and comply with the requirements of the AMCA Certified Ratings Program."

7.2.2 Additional FEG statement requirements

In cases where some models within a product line are FEG Certified, but others are not, provide the following statements in addition to the qualifying statement:

"The AMCA Certified Ratings Seal applies to air performance (and sound) for Models XXX (or models on pages XX-XX) only."

"The AMCA Certified Ratings Seal applies to the Fan Efficiency Grade for Models XXX (or models on pages XX-XX) only."

7.3 Application statements

Immediately adjacent to the ratings, not with the Seal, shall be shown the qualifying statements required in the Rating Method Details (Sections 9.1 through 9.10).

7.4 Noncertified efficiency, FEG, and/or sound ratings

Where noncertified efficiency, FEG, and/or sound ratings are shown adjacent to the certified air performance ratings, the following statement shall be shown prominently adjacent to the sound ratings:

"The AMCA Certified Ratings Seal applies to air performance [add *sound*, *efficiency*, and/or *Fan Efficiency Grade* as applicable] ratings only."

7.5 The AMCA Certified Ratings Seals

7.5.1 FEG Seal usage

7.5.1.1 All models FEG-Certified

Use the AMCA Sound & Air Performance FEG Seal or AMCA Air Performance FEG Seal (whichever is applicable)

with the qualifying statement as usual. The AMCA Seal (blue & yellow) may also be used, if desired by Licensee.

7.5.1.2 Some models FEG-Certified
Use the AMCA Sound & Air Performance Seal or AMCA Air Performance Seal (whichever is applicable) for models which are not AMCA Certified for FEG. In addition, use AMCA Sound & Air Performance FEG Seal, AMCA Air Performance FEG Seal, or generic FEG Seal (whichever is applicable) for models which are AMCA Certified for FEG. See Section 7.2.2 for additional statement requirements.

7.5.2 Certification/Seal types
Air Performance Seal
Sound and Air Performance Seal
Air and Efficiency Performance Seal
Air, Efficiency, and Sound Performance Seal
CFM/Watt Seal
Positive Pressure Ventilator Seal
Air Performance for Induced Flow Fan Seal
Air and Sound Performance for Induced Flow Fan Seal
Circulating Fan Performance Seal
FEG Seal
FEG Air Performance Seal
FEG Sound and Air Performance Seal
Induced Flow Fan Air Performance Seal
Induced Flow Fan Air and Sound Performance Seal
Smoke Management Fan Performance
Smoke Management Fan Performance Reversible

7.6 Further information

See Section 9 for further information on qualifying statements and use of the Certified Ratings Program Seal.

8. Fan Performance Ratings

8.1 Manufacturer's responsibility

The fan manufacturer is responsible for developing fan performance ratings for its production fans that perform within the tolerances established by the Certified Ratings Program as defined in Section 10. Separate Product Rating Requirement Sections define specific requirements for each type of product.

8.2 AMCA Staff's responsibility

AMCA Staff is responsible for the administration of the Certified Ratings Program by verifying that the air performance ratings developed by the manufacturer were developed in accordance with the requirements of this program.

AMCA Staff is also responsible for verifying that the catalog published by the Licensee conforms to the requirements of the program.

8.3 Rating development

8.3.1 General requirements
The air performance rating of a fan or a series of similar fans are developed from tests conducted in accordance with ANSI/AMCA 210, ISO 5801, or other testing standards recognized in AMCA 111, using the same standardized airways.

The manufacturer is responsible for determining the product sizes to be tested and the number of tests that must be performed to provide the data necessary for the development of certified ratings.

8.3.2 Conversion formulae (The Fan Laws)
The Fan Laws, as defined in ANSI/AMCA 99 apply only to geometrically similar fans and can be used for calculating the performance ratings of fans from tests of fans tested at other speeds and/or smaller sizes.

8.3.3 Geometrically similar products
Products of different materials, where differences in thickness are small, shall be considered geometrically similar. Products using materials with large thickness or roughness variations are not considered similar. Where differences in thickness or roughness are large, the participant shall demonstrate similarity through comparison testing. Refer to Annex D.

8.3.4 Appurtenances (accessories)
An appurtenance (accessory) should be considered a part of the fan if it is in place when the fan is tested for performance rating, and the effect of the appurtenance (accessory) is included in the cataloged performance rating.

A fan may include various appurtenances (accessories) that affect the air performance, the effect of which may or may not be included in the performance rating of the fan. Other appurtenances (accessories) may affect the power absorbed. These may or may not be included in the performance rating of the fan.

8.3.5 Catalog performance rating
The performance rating is applicable only to the fan configuration tested, including any appurtenances (accessories) included with the fan as tested. Statements of total (mechanical) or static efficiency may be included as part of the rating.

8.3.6 Bearings and shafts
If a fan is provided with bearings, it shall be tested on its own shaft and its own bearings. The bearings shall be unmodified commercially available bearings, but may be "run in" to simulate the losses occurring in practice.

8.3.7 Bi-stable operating region
When a fan shows a region of bi-stable operation in the certified range, the catalog data over that range shall be based upon tests which yield the lower pressure and the corresponding power. The manufacturer shall inform AMCA International if bi-stable operation for the fan is possible and any appropriate requirements for the test procedure are known.

8.3.8 Published ratings
The catalog data published under the Certified Ratings Program shall contain the information listed for each rating method.

For all rating methods, the following statement shall be shown immediately adjacent to the rating tables, graphs, or charts:

"Performance certified is for installation type [*list one or more of the following*]."

A: Free inlet, Free outlet

B: Free inlet, Ducted outlet

C: Ducted inlet, Free outlet

D: Ducted inlet, Ducted outlet

8.3.9 Efficiency

8.3.9.1
Efficiency, where cataloged, may be static or total as defined in ANSI/AMCA 99 and ANSI/AMCA 210. The stated absorbed power used in these equations may be impeller, shaft, electrical input, or mechanical output power. It shall be appropriate to the particular fan arrangement and rating method. The manufacturer shall clearly state over what range of airflows the efficiencies are certified.

The following statement shall be shown immediately adjacent to the efficiency ratings:

"Efficiency ratings are fan static (or fan total) and include (or exclude) bearing and/or Power Transmission Losses."

See Annex D.

8.3.9.2 Fan Efficiency Grade (FEG) Certification
FEGs are based solely on fan total pressure. To be eligible to bear one of the AMCA International FEG seals, the requirements detailed in Sections 8.3.9.2.1 through 8.3.9.2.3 must be met.

8.3.9.2.1 Prerequisites and requirements
A prerequisite for obtaining the FEG certification seal is that the air performance of the product line must be AMCA International certified. An entire product line or individual models within a product line may obtain FEG certification. A model that has its FEG certified may display that FEG (the actual rating – not the seal) on its nameplate. The FEG shall be included in a product line's approved catalog. There is no minimum number of models required to be licensed in each product line. All products that are licensed to bear the FEG CRP Seal shall be identified in the AMCA Directory of Licensed Products.

8.3.9.2.2 Eligibility
The following fan types within AMCA 211 are ineligible to obtain the FEG certification seal:

Air Curtains
Induced Flow Fans
Energy Recovery Ventilators (Heat Recovery Ventilators)
Positive Pressure Ventilators (PPVs)

8.3.9.2.3 Determination of FEG
Certified FEGs are determined in accordance with AMCA 205-12. The data to be used in the determination of a model's FEG will be based on that model's base test data as referenced in the product line's CRP-8 application form. If the base test data is not available or incomplete, the FEG will be based on the model's certified catalog performance.

If cataloged data is used and the only certified power is the maximum fan input power, the determination of that model's FEG shall be based on the base data that was used to generate the catalog data.

Note: As defined in AMCA 205, the FEG classification applies only to fans of 750 W (1 bhp) or greater.

In the case where an axial flow fan is certified in multiple pitches and the customer is able to change the pitch, the FEG is based on the peak total efficiency within the range of pitches certified.

8.3.9.2.4 Fan Efficiency Grade Catalog Requirements
Fan Efficiency Grades (FEGs) shall be displayed either in that product line's approved catalog, listed in the AMCA International Directory of Licensed Products, or both. To be listed in the AMCA International Directory of Licensed Products, written authorization must be received from the Licensee. If listed in the Directory of Licensed Products, the peak Fan Total Efficiency will be listed with Fan Efficiency Grade for that model.

8.3.10 Rating methods
The performance rating of a fan for cataloging purposes shall be presented using one of the methods presented in Section 9.

8.4 Catalog data

All proposed catalog data is checked against the reference test data. The catalog data is considered satisfactory if it is within one quarter of the equivalent check test tolerance.

9. Rating Method Details

A summary of available rating methods is found in Annex F.

9.1 Rating method "A/B/D": centrifugal, mixed flow, axial, propeller, power roof ventilator, energy recovery ventilator (constant speed rating method)

This method applies to the following fans:

1) Belt driven fans with integral shaft and bearings rated at a constant speed.

2) Direct driven fan with low slip motors rated at a constant speed.

9.1.1 Calculated performance

The test fan performance shall be used as the basis for calculating the performance of the test fan to other speeds, to a larger fan, or series of larger fans using the Fan Laws. See Annex D for more information. Calculation to other speeds on direct drive fans requires measurement of fan input power.

9.1.2 Published data

The performance ratings of each model number shall include:

Airflow rate

Fan static pressure and/or fan total pressure

Choice of:
- Fan input power;
- maximum fan input power over the range cataloged;
- fan input power at the stated duty;
- maximum motor input watts, voltage and frequency over the range cataloged; or,
- motor input watts, voltage, and frequency at the stated duty.

Impeller speed

Inlet air density (if other than standard air)

Fan static and/or fan total efficiency (optional)

Fan Efficiency Grade (FEG) (optional)

Note: The "maximum fan input power over the range cataloged" is the peak input power value between the value at the greatest airflow and lowest airflow in all approved catalogs.

The following statements shall be shown immediately adjacent to the rating tables, graphs, or charts, and may be identified by an asterisk when appropriate:

"Power rating (watts, kW, or bhp) does not include transmission losses."

Or:

"Power rating (watts, kW, or bhp) includes transmission losses."

Note: "Transmission losses" as used in these statements refer only to belt drive losses and losses caused by addition of accessories such as shaft seals, etc. Bearing losses and coupling losses are included in the power rating.

One of the following statements appropriate for the product being rated shall be shown immediately adjacent to the rating tables, graphs or charts:

"Performance ratings do not include the effects of appurtenances (accessories)."

Or:

"Performance ratings include the effects of [*list appurtenances here*]."

See Annex D for additional rating information.

9.2 Rating method "C/E": centrifugal, mixed flow, axial, propeller, power roof ventilator, energy recovery ventilator ("as-run" speed rating method)

This method applies to the following fans:

1) Belt driven fans with integral shaft and bearings with low slip motors rated at an "as-run" speed.
2) Direct driven fans with low slip motors rated at an "as-run" speed.

The actual speed cannot differ from the nominal speed by more than 3%. Power transmission losses are included in the fan power rating.

Note: "Nominal speed" is a speed midway between the highest speed of any cataloged rating point and the lowest

speed of any cataloged rating point rounded to the nearest 5 rpm.

9.2.1 Calculated performance
The test fan performance shall be used as the basis for calculating the performance of the test fan to other "as-run" speeds, the performance of a larger fan size, or a series of larger fan sizes using the Fan Laws. See Annex D for more information. The speed used for the calculated performance shall be based on the ratio of the test fan speed at each test point to the test fan nominal speed times the nominal speed of the calculated fan.

Calculation to the other speeds for direct drive fans requires measurement of fan input power.

9.2.2 Published data
The performance ratings of each model number shall include:

Airflow rate

Fan static pressure and/or fan total pressure

Choice of:
- Maximum fan input power over the range cataloged;
- fan input power at the stated duty;
- maximum motor input watts, voltage and frequency over the range cataloged; or,
- motor input watts, voltage, and frequency at the stated duty

Actual impeller speed at each point of rating or at the nominal speed

Inlet air density (if other than standard air)

Fan static and/or fan total efficiency (optional)

Fan Efficiency Grade (FEG) (optional)

Note: The "maximum fan input power over the range cataloged" is the largest recorded input power value between the value at the greatest airflow and lowest airflow in all approved catalogs.

When a nominal speed is cataloged, the following statement shall be shown immediately adjacent to the rating table, graph or chart:

"Speed [*rpm* or *rps*] shown is nominal. Performance is based on actual speed of test."

One of the following statements appropriate for the product being rated shall be shown immediately adjacent to the rating tables, graphs or charts:

"Performance ratings do not include the effects of appurtenances (accessories)."

Or:

"Performance ratings include the effects of [*list appurtenances here*]."

For belt driven fan, the following statement shall be shown immediately adjacent to the rating table, graph or chart and may be identified by an asterisk when appropriate:

"Power rating (watts, kW, or bhp) includes power transmission losses."

9.3 Rating method "F": centrifugal, mixed flow, axial, propeller, power roof ventilator, energy recovery ventilator

This method applies to direct driven fans with high slip motors rated at an "as-run" speed where the actual speed varies over the cataloged range of fan performance by more than 3%.

9.3.1 Calculated performance
No calculations to other speeds or sizes are permitted.

In the case of multiple speed high slip motors (shaded pole, permanent split capacitor, universal), the performance rating shall be "as-run" for each speed based on tests at each speed.

9.3.2 Published data
The performance ratings of each model number shall include:

Airflow rate

Static pressure

Maximum motor input watts, voltage and frequency over the range cataloged, or motor input watts, voltage, and frequency at the stated duty (optional if less than 500 watts)

Actual impeller speed at each point of rating or a nominal speed

Inlet air density (if other than standard air)

Fan static and/or fan total efficiency (optional)

The nominal speed shall be approximately in the middle of the actual speed range over the performance range cataloged.

When a nominal speed is cataloged the following statement shall be shown immediately adjacent to the rating tables, graphs, or charts:

"Speed [*rpm* or *rps*] shown is nominal. Performance is based on actual speed of test."

One of the following statements appropriate for the product being rated shall be shown immediately adjacent to the rating tables, graphs or charts:

"Performance ratings do not include the effects of appurtenances (accessories)."

Or:

"Performance ratings include the effects of [*list appurtenances here*]."

9.4 Rating method "G": air curtains

Air curtains may be either direct or belt driven. Power transmission losses, if any, are included in the power rating.

9.4.1 Calculated performance

9.4.1.1 Air performance

The test air curtain air performance ratings may be used as the basis for calculating the performance of the air curtain at other speeds using the Fan Laws. See Annex D for more information.

If motor input power is measured during the air performance test, fan input power may be calculated using the motor calibration curve for the motor used during the test. Fan input power at other speeds may then be calculated using the Fan Laws. Motor input power may then be calculated using a motor calibration curve for the motor typically supplied with the air curtain at the rated speed.

If fan input power is measured during the air performance test, fan input power may be used to calculate fan input power at other speeds using the Fan Laws. A motor calibration curve for the motor typically supplied with the air curtain shall then be used to determine the motor input power at the rated speed.

9.4.1.2 Multiple identical modules

Where the test of a single module is used to rate a unit composed of a group of identical modules, the airflow rate shall be the airflow rate of the single module times the number of identical modules. The power rating for a combination of identical modules shall be the input power of the single module times the number of identical modules.

Where the airflow rate of a single module is derived from a test of a unit comprised of multiple identical modules, the airflow rate of each single module shall be the total airflow rate of the unit divided by the number of modules. The power rating of a single module shall be the total motor input power of the unit divided by the number of modules.

9.4.1.3 Dissimilar multiple modules

Where necessary, airflow rate and power of a module shall be determined from a comparative test of units made up of dissimilar modules.

Example:

Air Curtain Construction	
Unit No. 1	Unit No. 2
3 "A" Modules plus 1 "B" Module	2 "A" Modules plus 1 "B" Module

The airflow rate of Module "A" is the airflow rate of Unit No.1 less the airflow rate of Unit No. 2. The motor input power rate of Module "A" is the input power of Unit No.1 less the input power of Unit No. 2

Subsequently, the airflow rate of Module "B" is the airflow rate of Unit No.1 less 3 times the airflow rate of Module "A". The motor input power of Module "B" is the motor input power of Unit No. 1 less 3 times the input power of Module "A".

9.4.1.4 Average outlet velocity

The average outlet velocity for a single module or a combination of modules shall be the airflow rate divided by the face area of the discharge nozzle.

9.4.1.5 Outlet velocity uniformity

In an air curtain unit comprised of multiple modules, the outlet velocity uniformity of the unit shall be equal to the uniformity of the module with the lowest uniformity in the unit.

9.4.1.6 Velocity projection

The velocity projection for a combination of identical modules is the same as the velocity projection found from the test of one of the single modules.

The velocity projection test of a unit with multiple identical modules shall not be used to determine the velocity projection of a single module.

The velocity projection of units comprised of multiple, dis-

similar modules shall not be derived from tests of single modules.

9.4.2 Published data
The performance ratings of each model number shall include:

Airflow rate

Average outlet velocity

Motor input power, voltage, and frequency

Outlet velocity uniformity

Inlet air density (if other than standard air)

Fan static and/or fan total efficiency (optional)

Published for only one size, which shall be stated, at standard air inlet density:

Velocity Projection

The following statement shall be shown immediately adjacent to the rating table, graph or chart:

"The AMCA Certified Ratings Seal applies to airflow rate, average outlet velocity, outlet velocity uniformity, velocity projection and power rating at free delivery only."

The manufacturer shall describe by the following statement the conditions under which the air curtain unit was tested and list the presence or absence of optional accessories and/or appurtenances (accessories) available for arrangements which are cataloged, but are not included in the certified ratings. For example:

"Rated data shown are only for base (unheated) units, as shown."

The manufacturer may provide data which lists the effects on performance in the form of correction factors due to the presence of optional appurtenances (accessories) available for arrangements which are cataloged, but are not included in the certified ratings. It shall be described by the following statement that the performance obtained using these correction factors shall not be considered a certified rating but only an approximation.

"Performance data obtained from the correction factors shown herein are only an approximation and shall not be consid-ered as part of the AMCA Certified Ratings."

9.5 Rating method "H": jet tunnel fans

9.5.1 Calculated performance
Direct-driven jet tunnel fans are rated at an "as-run" speed. The test fan performance may be used as the basis for calcu-lating the performance of other fans sizes or speeds as permitted in accordance with AMCA 250 and ISO 13350:99.

9.5.2 Published data
The catalog data published under the Certified Ratings Program shall be determined in accordance with AMCA 250 and ISO 13350:99 and conform to the following requirements:

The performance rating shall include:

Airflow rate

Nominal impeller speed

Thrust (N or lbf)

Thrust/fan input power (N/kw or lbf /bhp)

Jet tunnel fan efficiency is defined as the ratio of the air power to the impeller power, expressed as a percentage.

The following statements shall be shown immediately adjacent to the rating table, graph or chart:

"The AMCA Certified Ratings Seal applies to airflow rate at free delivery only. Speed [*rps* or *rpm*] shown is nominal. Performance is based on actual speed of test."

When the effect of an appurtenance (accessory) is included in the fan performance rating the following statement shall be shown adjacent to the ratings:

"Performance ratings include the effect of [*list appurtenances here*]."

9.6 Rating method "I": agricultural fans

This method applies to:

Agricultural fans with integral shaft and bearings supplied with a low slip motor which is rated at "as-run" speeds. Power transmission losses are included in the fan power rating;

And:

Direct drive agricultural fans supplied with low slip motors which are rated at "as-run" speeds.

9.6.1 Calculated performance
No calculations to other speeds or sizes are permitted.

9.6.2 Published data
Each fan appurtenance(s) (accessories) assembly shall have a distinct model number different from one without appurte-nance(s) (accessories) or with a different group of appurtenance(s) (accessories).

The performance rating of each model number shall include:

Airflow rate at 10 Pa (0.05 in. wg) and 30 Pa (0.125 in. wg) static pressure (Ratings at other static pressures are optional)

Actual impeller speed at each point of rating or a nominal speed

Airflow rate/motor input power (m^3/s/W or cfm/W)

Motor nameplate voltage and frequency

Motor manufacturer and model number for all motors listed for use on the fan

Inlet air density (if other than standard air)

The nominal speed shall be approximately in the middle of the actual speed range over the performance range cata-loged. The actual speed shall not differ from the nominal speed by more than 3%.

The following statement shall be shown adjacent to the rating:

"Speed [*rpm* or *rps*] shown is nominal. Performance is based on actual speed of test."

When the effect of appurtenance(s) (accessories) is includ-ed in the fan performance rating the following statement shall be shown adjacent to the ratings:

"Performance ratings include the effect of [*list appurtenanc-es here*]."

9.7 Rating method "J": positive pressure ventilators (PPVs)

9.7.1 Calculated performance
Direct driven PPVs are rated at an "as-run" speed. No calcu-lations to other speeds or sizes are permitted.

9.7.2 Published data
The catalog data published under the Certified Ratings Program shall be determined in accordance with ANSI/ AMCA 240 and conform to the following requirements:

Each PPV appurtenance(s) (accessories) assembly shall have a distinct model number different from one without appur-tenance(s) (accessories) or with a different group of appurtenance(s) (accessories).

The performance ratings of each model number shall include:

Airflow rate

Impeller speed

Setback distance

Tilt angle

Motor/engine manufacturer and model number (for all motors/engines listed for use on the PPV)

When the effect of appurtenance(s) (accessories) is includ-ed in the PPV performance rating, the following statement shall be shown adjacent to the ratings:

"Performance ratings include the effect of [*list appurtenanc-es here*]."

9.8 Rating method "K": circulating fans

9.8.1 Calculated performance
Direct driven circulating fans are rated at an "as-run" speed. No calculations to other speeds or sizes are permitted.

9.8.2 Published ratings
The catalog data published under the Certified Ratings Program shall be determined in accordance with ANSI/ AMCA 230 and conform to the following requirements:

Each fan-appurtenance(s) (accessories) assembly shall have a distinct model number different from one without appur-tenance(s) (accessories) or with a different group of appurtenances (accessories).

The performance rating shall include:

Flow and/or thrust (m^3/s, cfm; N, lbf)

Flow/motor input power (m^3/s/W, cfm/W) and or thrust/ motor input power (N/W, lbf/W)

Nominal impeller speed (rpm)

Motor nameplate voltage and frequency

Catalogs containing ratings of products licensed for aero-dynamic performance shall include the following statement:

"The AMCA Certified Ratings Seal applies at free delivery only."

The following statement shall be shown adjacent to the rating:

"Speed [*rpm* or *rps*] shown is nominal. Performance is based on actual speed of test."

When the effect of an appurtenance (accessory) is included in the fan performance rating the following statement shall be shown adjacent to the ratings:

"Performance ratings include the effect of [*list appurtenances here*]."

9.9 Rating method "L": induced flow fans

Induced flow fans are housed fans with centrifugal, mixed flow, or axial impellers used in a free discharge configuration that have an outlet airflow greater than their inlet airflow. They are used extensively in laboratory exhaust systems.

This rating method applies to induced flow fans with integral shaft and bearings rated at a constant speed. Power trans-mission losses are not included in the fan power rating (multi-speed tables, single rating tables, curves, or electronic data).

9.9.1 Calculated performance

The test fan performance may be used as the basis for calculating the performance of the test to other speeds or to a larger fan or series of larger fans using the Fan Laws. See Annex D for more information.

9.9.2 Published data

The catalog data published under the Certified Ratings Program shall be determined in accordance with AMCA 260. The test setup described in Section 7.1 of AMCA 260 shall be used to determine all performance ratings listed below with the exception of "Outlet airflow rate," which uses the setup described in Section 7.2.

The performance ratings of each model shall include:

Inlet airflow rate

Fan static pressure

Fan input power

Impeller speed

Inlet air density (if other than standard air)

Fan static efficiency (optional)

Outlet airflow rate

Outlet area

Nozzle velocity (Inlet airflow rate divided by nozzle discharge area)

For single rating performance tables, fan input power may be stated for each point of rating, or may be stated as the peak fan input power in the cataloged performance range.

The following statements shall be shown immediately adjacent to the rating tables, graphs, or charts, and may be identi-fied by an asterisk when appropriate:

"Power rating [*W*, *kW*, or *bhp*] does not include transmission losses."

"Performance ratings do not include the effects of cross winds."

One of the following statements appropriate for the product being rated shall be shown immediately adjacent to the rating tables, graphs, or charts:

"Performance ratings do not include the effects of appurtenances (accessories)."

Or:

"Performance ratings include the effects of [*list appurtenances here*]."

9.10 Rating Method "M": Residential Ventilating Fans

This rating method applies to those residential products as defined in the ENERGY STAR® Program Requirements Product Specification for Residential Ventilating Fans, Eligibility Criteria, Version 3.2. The definition restated here is, "Residential Ventilating Fan: A ceiling, wall-mounted, or remotely mounted in-line fan designed to be used in a bathroom or utility room, or a kitchen range hood, whose purpose is to move objectionable air from inside the building to the outdoors."

This rating method utilizes the motor input power and not the fan shaft input power. Ratings are developed for specific operating points for each type of fan. All ratings are determined at the as-run speeds. Motors can be either high slip or low slip motors.

9.10.1 Calculated Performance

No calculations to other speeds or sizes are permitted.

9.10.2 Published data

The performance ratings of each model in a product line shall include:

Airflow rate at prescribed operating points

Static pressure at prescribed operating points

Minimum Efficacy Level (cfm/W) at prescribed operating points

Spherical sone rating at prescribed operating points (except for in-line fans),

Actual impeller speed at each point of rating or a nominal speed

Fan static and/or fan total efficiency (optional).

The nominal speed shall be approximately in the middle of the actual speed range over the performance range cataloged. When a nominal speed is cataloged the following statement shall be shown immediately adjacent to the rating tables, graphs, or charts:

"Speed [*rpm* or *rps*] shown is nominal. Performance is based on actual speed of test."

One of the following statements appropriate for the product being rated shall be shown immediately adjacent to the rating tables, graphs or charts:

"Performance ratings do not include the effects of appurtenances (accessories)."

Or:

"Performance ratings include the effects of [*list appurtenances here*]."

9.10.3 Testing

Testing shall be accomplished, as a minimum, at the operating points found in Table 9.10.

9.10.4 ENERGY STAR

If the licensee desires to obtain ENERGY STAR approval for their product:

The licensee must be an ENERGY STAR partner;
the product must meet the performance requirements to obtain the ENERGY STAR;

the product submittal must include a one year warranty that will be provided to the purchaser; and,

the product submittal must include the required installation instruction.

The intention of the licensee to apply for ENERGY STAR status must be indicated on the submitted CRP 8 form. After testing has been completed and the application filed with AMCA International, staff will submit the required information to ENERGY STAR. Once approved, the licensee will be informed.

If the product includes lighting, it will be shipped to an accredited and recognized ENERGY STAR certification body for the luminaire certification prior to AMCA International submitting the package to ENERGY STAR for overall approval.

The significant digits and rounding requirements found in the ENERGY STAR program requirements shall be utilized for all ENERGY STAR certification procedures.

9.10.5 ENERGY STAR Enhanced Check Test Requirements

The US Environmental Protection Agency, in its ENERGY STAR program, requires the enhancements in Sections 9.10.5.1 through 9.10.5.3 to the AMCA International check test program (for those products bearing the ENERGY STAR).

Table 9.10
Operating Points for Products Using Rating Method 'M'

Product Type	Static Pressure (in. wg)	Notes
Products with an inlet or outlet duct	0.1 and 0.25	Sound only at 0.1 in. wg
Ducted range hoods	see note	Test at working speed per HVI 916
Unducted products	0.03	
In-line fans (ducted inlet and ducted outlet	0.2	No sound test required

9.10.5.1 Periodicity and Selection of Check (verification) Test Sample

For this procedure a 'check test' and a 'verification test' are the same. AMCA International is required to select models from 10% of all ENERGY STAR qualified product lines, of each type that are certified by AMCA International, for annual verification tests. To determine the number of test required per year, AMCA International staff is required to round up any fractional number (e.g., if two bath fan product lines are ENERGY STAR approved via the AMCA International certification body, one model per year from the two product lines will have to have a verification test: 10% of 2 is 0.2, rounded up is 1 per year).

The source for procurement of check test units in priority order, are:

i. Off-the Shelf (from the open market),
ii. Warehouse (for a storage depot), or
iii. Off-the-line (from the manufacturing facility).

Note that the ENERGY STAR partner shall not choose the testing sample.

The ENERGY STAR partner is required to provide a list of at least three locations where a unit(s) of the product(s) to be tested may be obtained, or a signed statement that none are available. If there are no off-the-shelf locations to obtain the unit, the ENERGY STAR partner is required to provide access to AMCA International staff to select a unit(s) from a warehouse or from off-the-line.

9.10.5.2 Check Test Criteria

The unit selected for the check test is required to meet the same ENERGY STAR performance requirements that it originally met. A check test failure will be reported to ENERGY STAR within two business days of failure. ENERGY STAR will determine the consequences of the failure. (The procedure for ENERGY STAR products does not allow for an automatic choice to ship the check test unit to the licensee for inspection or for a re-check test.)

For published data not required for ENERGY STAR approval, AMCA International's normal check test procedures apply.

9.10.5.3 Challenge Tests

In addition to the challenge test procedures found in Section 12 of AMCA 11-03, the following requirements and modifications are made for ENERGY STAR approved products:

The basis for a challenge, which must be provided, can be marketing material that claims better performance than data on record with AMCA International or a product test the challenger performs on its own. The product test data is not required to be from the AMCA International Laboratory or an AMCA International Accredited Laboratory.

10. Check Tests

Licensed products are subject to periodic check tests as defined in Section 9 of the Operating Manual. When products are check tested the check test performance shall be within the tolerance for airflow, pressure, power, and efficiency (if certified) as defined below, when compared to the catalog data published by the manufacturer.

For products cataloged using constant or as-run speed tables, the tolerance shall be applied to the catalog points only. For products cataloged using multi rating tables or curves the tolerance shall be applied over the performance range cataloged.

When Section 12.1.2 is used to rate a product line the first check test shall be conducted on a size and/or configuration not originally tested in order to validate the rating procedures.

Fans check tested with calibrated motors shall be tested at the same voltage as used for the motor calibration.

Fan check test performance shall be corrected to the cataloged air density.

Fans rated at "as-run" speeds shall be check tested at a fan air density within 1.12 to 1.2 kg/m^3 (0.07 to 0.075 lbm/ft^3).

Fans rated at a constant speed shall be tested at a speed within 5% of the cataloged speed, and the performance corrected to the cataloged speed.

The test speed of a belt driven fan tested with a calibrated motor shall be within 5% of the cataloged speed.

10.1 Centrifugal fans, mixed flow, axial fans, propeller fans, power roof ventilators, agricultural fans, positive pressure ventilators, and energy recovery ventilators

10.1.1 Test methods

Check tests will be conducted with the same inlet and outlet conditions as the original rating test.

10.1.2 Check test tolerances for fans delivered by the manufacturer

The following check test tolerances apply to all centrifugal fans, mixed flow, axial fans, propeller fans, power roof ventilators, agricultural fans, positive pressure ventilators, and energy recovery ventilators as defined in the Product Rating Requirement Sections.

10.1.2.1 Airflow tolerance (T_Q)

The low limit fan pressure curve for acceptable fan air performance is derived by applying the AMCA Check Test Tolerance Curve, as found in Figure 10.1, to the catalog air performance data.

The low limit for airflow is:

$$Q\left(1-\frac{T_Q}{100}\right)$$

The low limit for pressure is:

$$P_s\left(1-\frac{T_Q}{100}\right)^2 \text{ or } P_t\left(1-\frac{T_Q}{100}\right)^2$$

Where:

T_Q is the check test tolerance
Q is fan airflow rate
P_s is fan static pressure
P_t is fan total pressure

The check test performance shall not be less than the tolerance corrected catalog data (curve or points) over the performance range cataloged.

The tolerance allowed on air performance is based on the typical measurement uncertainties that can be experienced in a fan performance test conducted under laboratory conditions. Since both the original test used to develop the cataloged data and the check test are both subject to measurement uncertainties, the AMCA Airflow Tolerance Curve allows for the combined uncertainties of the two tests and recognizes variations occurring in the production of the fan. Figure 10.1 defines the tolerance allowed at any percentage of the free air volume.

The tolerance (T_Q) curve shall be calculated by a 6th order polynomial with the following equation:

$$T_Q = (A_0 + A_1Q_F + A_2Q_F^2 + A_3Q_F^3 + A_4Q_F^4 + A_5Q_F^5 + A_6Q_F^6) \times 100$$

Where:

$$Q_F = \frac{Q_{rated}}{Q_0}$$

Q_F The fraction of free delivery fan airflow rate at the cataloged duty point

Q_{rated} The fan airflow rate at the cataloged duty point

Q_0 The cataloged free delivery airflow rate. In the absence of a catalogued free delivery airflow rate, the greater of the check test free delivery airflow rate or maximum catalogued airflow rate, at the check test speed, shall be used.

A_0 = + 0.058398
A_1 = - 0.404055
A_2 = + 2.249039
A_3 = - 6.227258
A_4 = + 9.037960
A_5 = - 6.527091
A_6 = + 1.854642

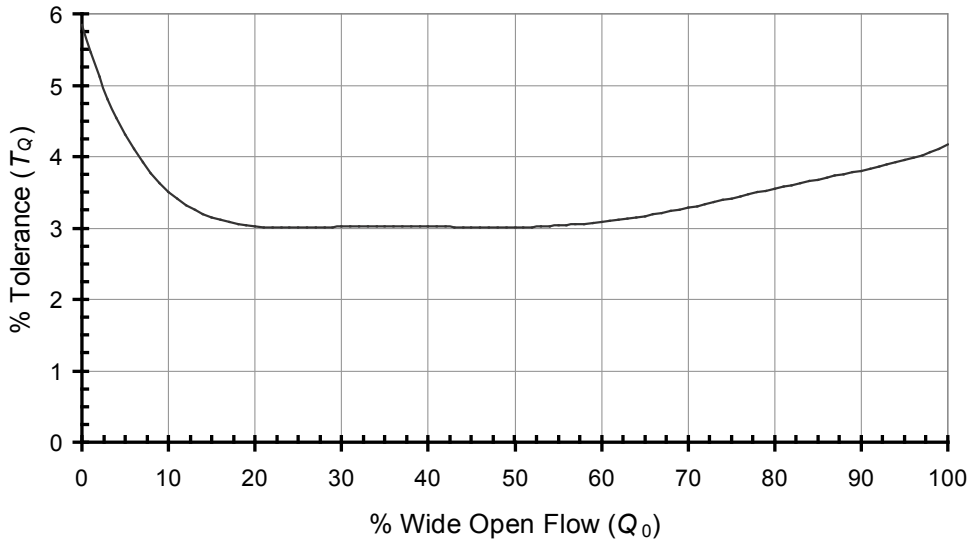


Figure 10.1
Tolerances Applied Over the Full Range of Performance

10.1.2.2 Power tolerance (T_H)
The power required by the check test fan shall not exceed the rated power (curve or points) at the measured airflow rate by more than the power tolerance, T_H. The value of T_H shall be 5% of the peak rated power over the certified range or 10% of the rated power at the measured airflow rate, whichever is less. The value of T_H shall in no case be less than 37 watts (0.05 bhp). For units rated in motor input watts the power tolerance, T_H shall be 5% of the peak rated power or 50 watts, whichever is greater.

T_H = Maximum [Minimum (5% Peak Rated Power, 10% Rated Power) , 37 watts] SI

T_H = Maximum [Minimum (5% Peak Rated Power, 10% Rated Power) , 0.05 bhp] IP

10.1.2.3 Efficiency tolerance (T_E)
The efficiency of the check test fan shall not be more than 6 percentage points below the cataloged efficiency at the measured airflow rate. The manufacturer shall clearly state over what range of airflows the efficiency's are certified.

10.1.2.4 Application of tolerances
Figure 10.2 illustrates how tolerance is applied to the catalog fan performance rating.

If the check test fan performance falls outside the airflow or power tolerance curve defined above, the following speed adjustment shall be made before the check test is considered a failure. The fan performance shall be adjusted (using fan laws for speed on both the flow and power data) within the range of -1% to +2%. If this adjustment allows the fan performance to fall within the standard flow and power tolerances, the check test is considered to have passed. This adjustment applies to check tests only and shall not be used for precertification tests.

10.1.2.5 Check test requirements for fans with certified FEG
If the check test unit (the model subject to a check test) passes the air performance check test criteria, the FEG rating for that model shall be considered to have passed the check test. If the check test performance is not within the air performance check test tolerance and the licensee will be recataloging the product line, the FEG for that model will be determined based on the revised base test data.

If an axial flow fan is certified in multiple pitches and the customer is able to change the pitch and the check test for this product line fails and performance is required to recataloged, then the FEG would have to be determined based on the revised base test data.

10.1.3 Tolerances for fans obtained in the market place
If the device's air performance is within Table 10.1 modified tolerances, no further action is taken, if outside Table 10.1 tolerances, then the procedures of AMCA 11 shall be followed.

For single rating tables, *P* is based on the maximum cataloged power at the tested speed.

10.2 Air curtains

10.2.1 Check test tolerances for air curtains delivered by the manufacturer.
The following check test tolerances apply to all Air Curtains.

10.2.1.1 Airflow rate and power tolerances
Air curtain units or modules, when operated at standard inlet air density shall perform to deliver no less than 95% of rated airflow at no more than 115% of the published input power rating. The measured check test results shall be corrected to standard air density.

Table 10.1
Tolerance Modifiers for Fans Obtained from the Marketplace

Category	Cataloged Power, *P* (kW)		Multiply Airflow Tolerance (T_Q) by:	Multiply Power Tolerance (T_W) by:	Add to Efficiency Tolerance (T_E) Points**:
	Min	Max			
1		0.74	3	*	6
2	0.75	7.4	2	1.5	5
3	7.5		1.5	1.2	4

* Power less than 0.75 kW shall not be more than 50 watts above the cataloged figure
** Where efficiency is licensed
The fan law speed adjustment in Section 10.1.2.4 shall not be used for fans obtained from the marketplace

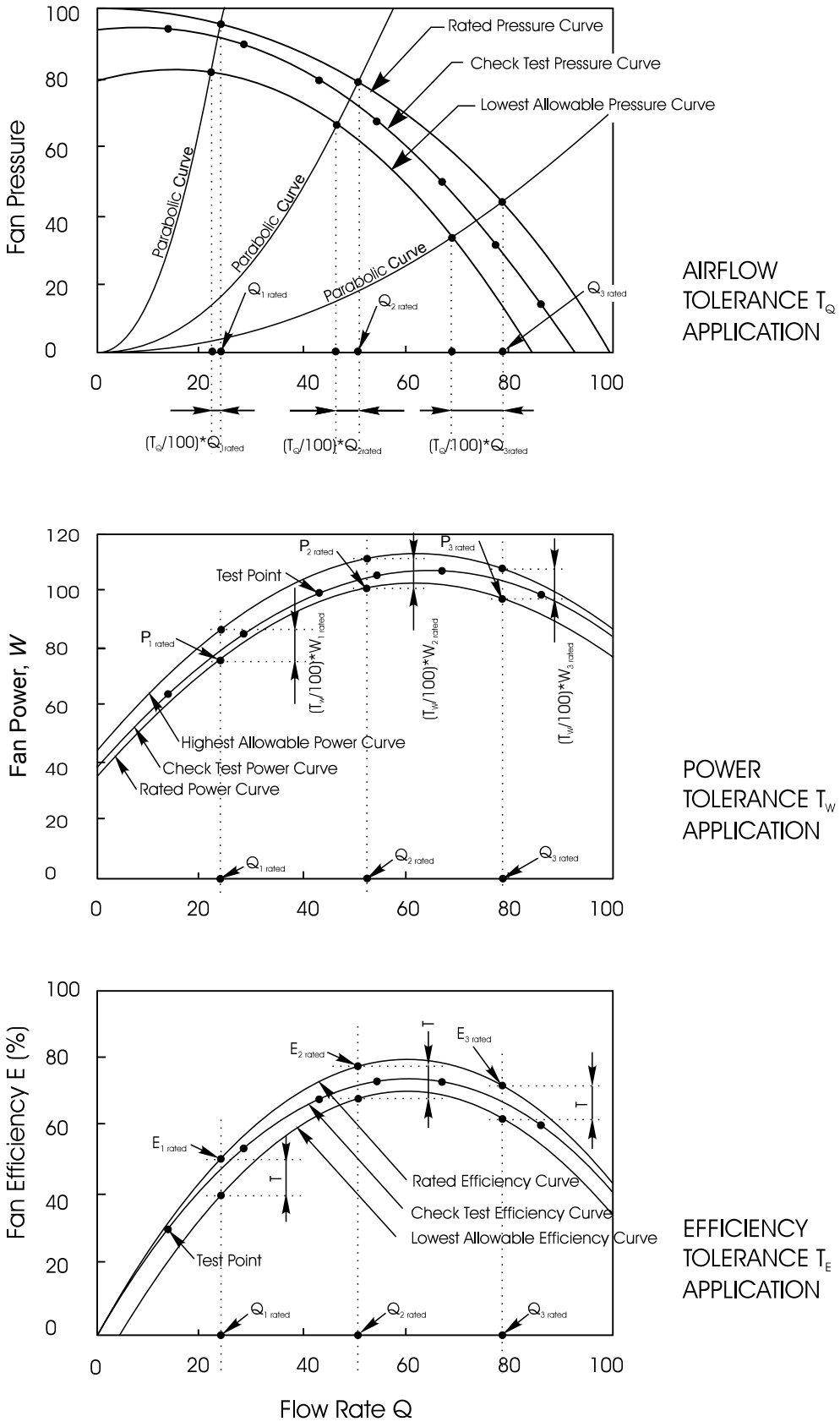


Figure 10.2
Tolerances Applied Over the Full Range of Performance

10.2.1.2 Outlet velocity uniformity tolerance
Air curtain units shall perform so that the outlet velocity uniformity is not less than 85% of the published outlet velocity uniformity.

10.2.1.3 Velocity projection tolerance
Air curtain units shall perform so that the average core velocity measured is not less than 85% of the average core velocity at each distance published.

10.2.1.4 Efficiency tolerance
The efficiency of the check test air curtain shall not be more than 6 percentage points below the cataloged efficiency at the measured airflow rate.

10.2.2 Check test tolerances for air curtains obtained in the market place.
The following check test tolerances apply to all Air Curtains.

10.2.2.1 Airflow rate and power tolerances
Air curtain units or modules, when operated at standard inlet air density shall perform to deliver no less than 90% of rated airflow at no more than 130% of the published input power rating. The measured check test results shall be corrected to standard air density.

10.2.2.2 Outlet velocity uniformity tolerance
Air curtain units shall perform so that the outlet velocity uniformity is not less than 70% of the published outlet velocity uniformity.

10.2.2.3 Velocity projection tolerance
Air curtain units shall perform so that the average core velocity measured is not less than 70% of the average core velocity at each distance published.

10.2.2.4 Efficiency tolerance
The efficiency of the check test air curtain shall not be more than 14 percentage points below the cataloged efficiency at the measured airflow rate.

10.3 Jet tunnel fans

10.3.1 Check test tolerances for jet tunnel fans delivered by the manufacturer
The following check test tolerances apply to all Jet Tunnel Fans.

10.3.1.1 Thrust and power tolerances
Jet Tunnel Fans shall deliver not less than 95% of their rated thrust at not more than 102% of their rated power.

10.3.1.2 Efficiency tolerance
The efficiency of the check test fan shall not be more than seven percentage points below the cataloged efficiency at the measured thrust.

10.3.2 Check test tolerances for jet tunnel fans obtained in the market place
The following check test tolerances apply to all Jet Tunnel Fans.

10.3.2.1 Thrust and power tolerances
Jet Tunnel Fans shall deliver not less than 94% of their rated thrust at not more than 105% of their rated power.

10.3.2.2 Efficiency tolerance
The efficiency of the check test fan shall not be more than nine percentage points below the cataloged efficiency at the measured thrust.

10.4 Circulating fans

10.4.1 Check test tolerances for circulating fans delivered by the manufacturer
The following check test tolerances apply to all fans:

10.4.1.1 Thrust and power tolerances
Circulating fans shall deliver no less than 95% of their rated thrust at no more than 110% of the input power rating.

10.4.2 Check test tolerances for circulating fans obtained on the open market
The following check test tolerances apply to all circulating fans.

10.4.2.1 Thrust and power tolerances
Circulating fans shall deliver no less than 90% of their rated thrust at no more than 120% of the input power rating.

10.5 Induced flow fans

Inlet airflow rate, fan pressure (static), fan input power, and efficiency check test tolerances, as described in Section 10.1, shall be applicable to induced flow fans with the following additions:

The outlet airflow check test tolerance is based on the inlet airflow and the percent tolerance is twice the tolerance described in Section 10.1.

Induced flow fan outlet area (wind band outlet area) shall measure within ±2% of the published value.

11. Product Rating Requirements for Centrifugal and Mixed Flow Fans

11.1 Product configuration

11.1.1 Basic conditions
All determinations for centrifugal fan performance ratings are to be based on unobstructed inlet and outlet except for the structural features of the fan involved, or appurtenances

(accessories) in place that are shown or described as being in place as an integral part of the fan in the published catalog. Where appurtenances (accessories) are included as part of the fan configuration they shall be in place during the test and shall be typical of the appurtenances (accessories) provided to the public.

11.1.2 Nonsimilar products

When various width centrifugal impellers or various diameter impellers are used in the same scroll housings, the fans are not considered geometrically similar. The performance of: various width impellers in the same housing, various width impellers in a housing that varies in width only, and various diameters of impellers in the same housing, may be derived by interpolation between tested fans, provided that a clear relationship of the variable to the fan performance can be demonstrated. Calculation to larger sizes may be based on interpolated performance, provided that requirements of Annex A for similarity are met. It is incumbent on the manufacturer to establish the validity of the relationship and to ensure that the interpolation method used is consistent and results in ratings within the Certified Ratings Program tolerance.

11.1.3 Air stream restrictions

If the fan is designed so that motors, sheaves, bearings, and shafts are in the air stream, they shall be in place during the test. Sizes of these components shall be as typically provided to the public.

11.1.4 Arrangements and classes

Where a centrifugal fan is manufactured in various arrangements or classes, any arrangement or class may be tested and used as the basis of performance ratings, provided that geometric similarity exists, and that all classes are identical in design except for heavier material gauges.

The effect of internal restrictions, such as tie rods, reinforcing rings, and bearing supports in the impeller inlet may be accounted for by the use of rating factors.

Rating factors may be published to modify the performance rating of an unrestricted fan to account for the performance changes caused by restrictions in the air stream. The rating factor may be based on the manufacturers experience and need not be the subject of separate validation tests. It is incumbent on the manufacturer to ensure that performance ratings obtained by the use of rating factors result in performance ratings that are within the Certified Ratings Program tolerances.

11.2 Test conditions

11.2.1 Test methods

The air performance ratings of a fan or a series of similar fans shall be developed from tests conducted in accordance with ANSI/AMCA 210, ISO 5801, or other testing standards recognized in AMCA 111. The test method shall be consistent with the test setup of the reference test standard.

11.2.2 Electric power requirements

When electrical input power is cataloged the tested motor shall be operated at the catalog voltage and frequency or where a voltage range is stated, it shall be the mean voltage. In addition the temperature of the motor winding has to be stable for each tested operating point.

11.3 Test data submittal requirements

11.3.1 Test data

The test data submitted to AMCA International shall include the raw test data as defined in ANSI/AMCA 210, ISO 5801, or other standards recognized in AMCA 111. The test standard used shall be identified by the issuing organisation, number and year of issue.
The test data shall be calculated to standard inlet air density and may be calculated to a constant speed.

11.3.2 Test range

The test shall cover the performance range to be cataloged, except that performance may be extrapolated to zero fan static pressure, provided that the airflow so obtained does not exceed the highest test airflow by more than 10%. The portion of the curve obtained by extrapolation shall be a smooth continuation of the curve. In the case of the total or fan static pressure curve, the extrapolation to zero must have the same or smaller radius of curvature as the adjacent portion of the curve, but in no case can it be concave upward.

Extrapolation of the power curve shall be by a straight-line tangent to the adjacent portion of the curve.

12. Product Rating Requirements for Axial Fans

12.1 Product configuration

12.1.1 Basic conditions

All determinations for axial fan performance ratings are to be based on unobstructed inlet and outlet except for the structural features of the fan involved, or appurtenances (accessories) in place that are shown or described as being in place as an integral part of the fan in the published catalog. Where appurtenances (accessories) are included as part of the fan configuration they shall be in place during the test and shall be typical of the appurtenances (accessories) provided to the public.

12.1.2 Interpolation and solidity

12.1.2.1 Interpolation of data

The performance of a series of axial fans that are identical except for one variable (such as blade pitch angle, number of blades, hub to tip diameter ratio, etc.) may be derived by interpolation between tested fans, provided that a clear relationship of the variable to the fan performance can be demonstrated. Calculation to larger sizes may be based on interpolated performance provided that the requirements of proportionality are met. It is incumbent upon the manufacturer to establish the validity of the relationship and to ensure that the interpolation method used is consistent and results in ratings within the Certified Ratings Program tolerances.

12.1.2.2 Solidity and other identities

The performance of an axial fan product line that is geometrically similar with the exception of the fan blades, can be derived using solidity, changing blade numbers and chord while maintaining blade profile shape (same airfoil sections) and blade solidity (ratio of total of blade chords divided by swept circumference). In such cases it may be possible to derive the aerodynamic performance (but not the sound) of the fan range or parts thereof, by testing a number of units (a minimum of three sizes) and demonstrating that a clear relationship exists between the fan performance and the variable(s).

See the additional requirements for the precertification check test in Section 12.4.

12.1.2.3 Establishing relationship

The procedure for establishing the relationship is the responsibility of the manufacturer, but it must be based on data derived from tests conducted to the same standard and test methods as that used for the remainder of the range.

12.1.3 Air stream restrictions

If the fan is designed so that motors, sheaves, bearings, and shafts are in the air stream, they shall be in place during the test. Sizes of these components shall be as typically provided to the public. A dummy or simulated motor may be used when the fan power is measured using a dynamometer.

12.2 Test conditions

12.2.1 Test methods

The air performance ratings of a fan or a series of similar fans shall be developed from tests conducted in accordance with ANSI/AMCA 210, ISO 5801, or other testing standards recognized in AMCA Publication 111. The test method shall be consistent with the test setup of the reference test standard.

12.2.2 Electric power requirements

When electrical input power is cataloged the tested motor shall be operated at the catalog voltage and frequency or where a voltage range is stated, it shall be the mean voltage. In addition the temperature of the motor winding has to be stable for each tested operating point.

12.3 Test data submittal requirements

12.3.1 Test data

The test data submitted to AMCA International shall include the raw test data as defined in ANSI/AMCA 210, ISO 5801, or other standards recognized in AMCA 111. The test standard used shall be identified by issuing organisation, number and year of issue.

The test data shall be calculated to standard inlet air density and may be calculated to a constant speed.

12.3.2 Test range

The test shall cover the performance range to be cataloged, except that performance may be extrapolated to zero fan static pressure, provided that the airflow so obtained does not exceed the highest test airflow by more than 10%. The portion of the curve obtained by extrapolation shall be a smooth continuation of the curve. In the case of the total or fan static pressure curve, the extrapolation to zero must have the same or smaller radius of curvature as the adjacent portion of the curve, but in no case can it be concave upward.

Extrapolation of the power curve shall be by a straight line tangent to the adjacent portion of the curve.

12.4 Precertification check tests

When Section 12.1.2.2 is used to rate a product line the precertification check test shall be conducted on a size and/or configuration not originally tested in order to validate the rating procedure. In all other cases the precertification check test shall be conducted on a size and configuration tested to establish the product's rating.

13. Product Rating Requirements for Propeller Fans

13.1 Product configuration

13.1.1 Basic conditions

All determinations for propeller fan performance ratings are to be based on unobstructed inlet and outlet except for the structural features of the fan involved, or appurtenances (accessories) in place that are shown or described as being in place as an integral part of the fan in the published catalog. Where appurtenances (accessories) are included as part of the fan configuration they shall be in place during the test and shall be typical of the appurtenances (accessories) provided to the public.

13.1.2 Interpolation of data

The performance of a series of propeller fans that are identical except for one variable (for example blade pitch angle, number of blades) may be derived by interpolation between tested fans, provided that a clear relationship of the variable to the fan performance can be demonstrated. Calculation to larger sizes may be based on interpolated performance provided that the requirements of proportionality are met. It is incumbent upon the manufacturer to establish the validity of the relationship and to ensure that the interpolation method used is consistent and results in ratings within the check test tolerances.

13.1.3 Air stream restrictions

If the fan is designed so that motors, sheaves, bearings, and shafts are in the air stream, they shall be in place during the test. Sizes of these components shall be as typically provided to the public. A dummy or simulated motor may be used when the fan power is measured using a dynamometer.

13.2 Test conditions

13.2.1 Test methods

The air performance ratings of a fan or a series of similar fans shall be developed from tests conducted in accordance with ANSI/AMCA 210, ISO 5801, or other testing standards recognized in AMCA 111. The test method shall be consistent with the test setup of the reference test standard.

13.2.2 Electric power requirements

When electrical input power is cataloged the tested motor shall be operated at the catalog voltage and frequency or where a voltage range is stated, it shall be the mean voltage. In addition the temperature of the motor winding has to be stable for each tested operating point.

13.3 Test data submittal requirements

13.3.1 Test data

The test data submitted to AMCA International shall include the raw test data as defined in ANSI/AMCA 210, ISO 5801, or other standards recognized in AMCA 111. The test standard used shall be identified by issuing organisation, number and year of issue.

The test data shall be calculated to standard inlet air density and may be calculated to a constant speed.

13.3.2 Test range

The test shall cover the performance range to be cataloged, except that performance may be extrapolated to zero fan static pressure, provided that the airflow so obtained does not exceed the highest test airflow by more than 10%. The portion of the curve obtained by extrapolation shall be a smooth continuation of the curve. In the case of the total or fan static pressure curve, the extrapolation to zero must have the same or smaller radius of curvature as the adjacent portion of the curve, but in no case can it be concave upward.

Extrapolation of the power curve shall be by a straight line tangent to the adjacent portion of the curve.

14. Product Rating Requirements for Power Roof Ventilators (PRVs)

14.1 Product configurations

14.1.1 Basic conditions

All determinations for PRV performance ratings are to be based on unobstructed inlet and outlet except for the structural features of the fan involved, or appurtenances (accessories) in place that are shown or described as being in place as an integral part of the PRV in the published catalog. Where appurtenances (accessories) are included as part of the fan configuration they shall be in place during the test and shall be typical of the appurtenances (accessories) provided to the public.

14.1.2 Interpolation of data

The performance of a series of PRVs that are identical except for one variable (such as blade pitch angle, number of blades) may be derived by interpolation between tested PRVs, provided that a clear relationship of the variable to the PRV performance can be demonstrated. Calculation to larger sizes may be based on interpolated performance provided that the requirements of proportionality are met. It is incumbent upon the manufacturer to establish the validity of the relationship and to ensure that the interpolation method used is consistent and results in ratings within the check test tolerances.

14.1.3 Air stream restrictions

If the PRV is designed so that motors, sheaves, bearings, and shafts are in the air stream, they shall be in place during the test. Sizes of these components shall be as typically provided to the public. A dummy or simulated motor may be used when the fan power is measured using a dynamometer.

14.1.4 Roof curb installations

PRVs usually installed on roof curbs shall be tested upon a simulated curb conforming to the minimum recommended curb height and inside dimensions shown in the catalog. In the absence of recommendations, the curb height shall not exceed 150 mm (6 in.) and the inside dimensions shall be at least 100 mm (4 in.) less than the inside dimensions of the curb cap for units up to and including 750 mm (30 in.) impeller diameter, and at least 200 mm (8 in.) less than the curb cap for units with impeller diameters over 750 mm (30 in.) diameter.

14.1.5 Simulated roofs
All PRVs with hoods that direct the air downward toward the roof shall be tested with a simulated roof that is flat and normal to the axis of the PRV. The simulated roof shall extend beyond the maximum overhang of the hood a distance of one half impeller diameter in all directions, however one side of the hood may be blocked by the floor or a wall of the test setup.

14.2 Test conditions

14.2.1 Test methods
The air performance ratings of a fan or a series of similar fans shall be developed from tests conducted in accordance with ANSI/AMCA 210, ISO 5801, or other testing standards recognized in AMCA 111. The test method shall be consistent with the test setup of the reference test standard.

14.2.2 Electric power requirements
When electrical input power is cataloged the motor shall be operated at the catalog voltage(s) and frequency.

14.3 Test data submittal requirements

14.3.1 Test data
The test data shall be calculated to standard inlet air density and may be calculated to a constant speed.

14.3.2 Test range
The test shall cover the performance range to be cataloged, except that performance may be extrapolated to zero fan static pressure, provided that the airflow so obtained does not exceed the highest test airflow by more than 10%. The portion of the curve obtained by extrapolation shall be a smooth continuation of the curve. In the case of the total or fan static pressure curve, the extrapolation to zero must have the same or smaller radius of curvature as the adjacent portion of the curve, but in no case can it be concave upward.

Extrapolation of the power curve shall be by a straight line tangent to the adjacent portion of the curve.

14.4 Exhaust/supply units

Axial exhaust/supply or axial combination exhaust/supply/circulate PRVs shall be rated separately for exhaust and supply performance. A single rating may be used provided the performance in both the exhaust and supply mode result in performance, verified by tests, that is within the Certified Ratings Program tolerances.

Rating factors may be published to modify the performance rating of an exhaust PRV to obtain the performance rating of the PRV in the supply mode, or vice versa. Rating so obtained may be certified under this program provided that the rating factors are based on tests of the PRV in both the exhaust and supply mode. It is incumbent on the manufacturer to ensure that performance ratings obtained by the use of rating factors result in performance ratings that are within the Certified Ratings Program tolerances.

15. Product Rating Requirements for Jet Tunnel Fans

15.1 Test setups

15.1.1 Rating methods
The test figures used for rating tests shall be those given in ANSI/AMCA 250 or ISO 13350.

15.2 Product configuration

The fan shall be tested as-sold and as intended for operation in a typical installation. A fan sold and intended for operation with a guard and attenuator shall be tested with the guard and attenuator in place. Published ratings shall indicate whether the effects of a guard and attenuator are included in the ratings.

15.2.1 Basic conditions
All determinations for jet tunnel fan performance are to be based on unobstructed inlet and outlet except for the structural features of the fan involved and the test rig, or the appurtenances (accessories) in place that are shown or described as being in place as an integral part of the fan described in the published catalog. Where appurtenances (accessories) are included as part of the fan configuration they shall be in place during the test and shall be typical of the appurtenances (accessories) provided to the public.

15.2.2 Non-similar products
The aerodynamic performance of fan assemblies which differ in impeller design (see figures in Annex A), tip diameter and motor physical size shall be determined by actual test. The only interpolation permitted shall be for a speed that lies between the speeds of two actual tests, and for pitch angles that lie between the pitch angles of two actual tests, conducted according to the above conditions.

15.2.3 Air stream restrictions
If the fan is designed so that motor, sheaves, bearing(s) and shaft(s) are in the air stream, they shall be in place during the test. Sizes of these components shall be as typically provided to the public.

15.3 Test conditions

15.3.1 Test method
The air performance ratings of a fan shall be developed from tests conducted in accordance with ANSI/AMCA 250 or ISO

13350. The test setup shall be consistent with the test setup of the standard referenced.

15.3.2 Electric power requirements

When electrical input power is cataloged the tested motor shall be operated at the catalog voltage and frequency or where a voltage range is stated, it shall be the mean voltage. In addition the temperature of the motor winding has to be stable for each tested operating point.

15.4 Test data submittal requirements

15.4.1 Test data

The test data submitted to AMCA shall include the raw test data as defined in ANSI/AMCA 250 or ISO 13350. The test standard used shall be identified by issuing organisation, number and year of issue.

16. Product Rating Requirements for Air Curtains

16.1 Conformance to standards

Rating test setups shall be conducted in accordance with the requirements of ANSI/AMCA 220.

16.2 Product configuration

16.2.1 Basic conditions

All performance ratings determinations for an air curtain unit or module are to be based on a complete unit with unobstructed inlet and outlet except for structural features of the air curtain unit or module involved, or appurtenances (accessories) in place that are shown or described as being in place as an integral part of the air curtain unit or module in the published catalog. Where appurtenances (accessories) are included as part of the unit configuration, they shall be in place during the test and shall be typical of the appurtenances (accessories) provided to the public.

16.2.2 Nonsimilar products

If in the construction of a module, a series is achieved by varying one aspect of the fan, such as the width or diameter of impellers in the same housings, or varying blade pitch angle, number of blades, hub to tip diameter ratio, the results so obtained are not considered geometrically similar and performance ratings must be determined from a separate test.

16.2.3 Air stream restrictions

If the air curtain unit or module is designed so that motors, sheaves, belts, guards, bearings, and shafts are in the air stream, they shall be in place during the test. Sizes of these components shall be the same as typically provided to the public.

16.3 Test conditions

16.3.1 Test methods

The air performance ratings of an air curtain unit shall be developed from tests conducted in accordance with ANSI/AMCA 220. The test method shall be consistent with the test setup of the reference standard.

16.3.2 Electric power requirements

When electrical input power is cataloged the motor shall be operated at the catalog voltage and frequency or where a voltage range is stated, it shall be the mean voltage. It may be necessary to consider the influence of motor temperature on results.

16.3.3 Outlet nozzle

Air curtain units or modules with adjustable nozzle directions will be tested with the nozzle or vanes directed as close to 15 degrees outward as possible.

16.3.4 Variable volume control

Air curtain units or modules with variable flow rate control will be tested with the control set for maximum volume.

16.3.5 Heating/cooling sections

If the manufacturer chooses not to catalog an unheated/uncooled air curtain unit product line, the test made on the heated/cooled units will only be a rating for units with the same arrangements of modules and identical heating/cooling modules.

Units with heating/cooling modules as part of the base unit will be tested with the heating/cooling section inactive.

16.3.6 Velocity projection

All air curtain units for which the velocity projection data are to be published shall be tested in accordance with ANSI/AMCA 220 for velocity projection.

16.4 Test data submittal requirements

16.4.1 Test data

The test data shall include the raw test data as defined in ANSI/AMCA 220.

The test data shall be calculated to standard inlet air density. The reduced data shall include the calculated values of performance for airflow rate, average outlet velocity, outlet velocity uniformity, velocity projection and power rating at a constant speed.

16.4.2 Outlet velocity uniformity

The results of the outlet velocity uniformity test shall be presented in the form of a table and for each velocity projection. The calculated arithmetic average of the peak velocities will

be shown with the standard deviation as a percentage of the average. Uniformity is 100 less the percentage deviation.

If a unit has multiple nozzles, a table for each nozzle will be presented in the form outlined.

16.4.3 Velocity projection

The results or the velocity projection test will be presented in the form of a table. The distance from the nozzle will be listed with the average core velocity shown.

17. Product Rating Requirements For Agricultural Fans

17.1 Product configuration

17.1.1 Basic conditions

All determinations of agricultural fan performance are to be made with unobstructed inlet and outlet except for the structural features of the fan and the appurtenance(s) (accessories) with which the fan is to be rated and represented or described in a catalog.

17.1.2 Belt tensioning systems

All agricultural belt drive fans shall be furnished and tested with means of maintaining belt tension, cog (timing) belt drive, or other drive systems that will maintain running speed during the normal life of the fan.

The drive system tested shall be the same as that furnished on the fan as sold to the end user.

17.1.3 Bearings and shafts

If the fan is provided with bearings, it shall be tested on its own shaft and its own bearings as typically supplied on the fan provided to the public. The bearing shall include seals and lubricant as typically provided to the public, but may be “run in” to minimise losses.

17.1.4 Air stream restrictions

If the fan is designed so that motors, sheaves, bearings, and shafts are in the air stream, they shall be in place during the test. Sizes of these components shall be as typically provided to the public.

17.2 Catalog photographs or illustrations

Photographs or illustrations shall be included adjacent to the performance ratings and shall be representative of the fan and assembled fan appurtenance(s) (accessories) for which ratings are certified.

17.3 Test conditions

17.3.1 Test methods

The air performance ratings of a fan shall be developed from tests conducted in accordance with ANSI/AMCA 210, ISO 5801, or other testing standards recognized in AMCA 111. The test method shall be consistent with the test setup of the reference test standard.

17.3.2 Power measurement

The motor input power in watts shall be measured for each test point.

17.3.3 Test voltage

Agricultural fans shall be tested at the motor nameplate voltage. If the motor nameplate voltage is shown as 208 230 volts and the fan is to be rated at both voltages the fan shall be tested at both voltages.

17.3.4 Motor calibration

Motor calibrations shall be performed at the voltage and frequency to be used for the fan test. Motor calibrations shall be performed by the AMCA Testing Laboratory, the motor manufacturer, or by an AMCA Accredited Laboratory.

The motor calibrator shall provide a certified calibration curve complete with values of hot efficiency.

17.4 Test data submittal requirements

17.4.1 Test data

The test data shall be calculated to standard inlet air density and may be calculated to a constant speed.

The reduced data shall include the calculated values of airflow, fan static pressure, motor input watts, cfm/watt and the speed at each test point.

17.4.2 Description and related data

A complete description of the fan tested, including any/all appurtenances (accessories) in place as tested shall be submitted with the test data.

A complete identification of the motor used on the test fan, including the manufacturer and model number shall be submitted with the test data. If the motor was calibrated the calibration curve for the motor shall also be submitted.

17.4.3 Dimensional data

Basic dimensional data on the test fan shall include appurtenance(s) (accessories).

17.5 Alternate motors

Other makes or models of motors may be used as alternates to the motor used on the test fan provided that they have equal or higher efficiency. Alternate motors may be listed at the time of the initial certification, and additions or changes to the list of alternate motors can be made after certification. AMCA shall be notified prior to the use of additional alter-

nate motors, or changes to listed motors. Equivalency of alternate motors shall be substantiated by submittal of calibration curve of the alternate motor showing equal or better efficiency compared to the test fan motor, or by a test of the fan with the alternate motor verifying equal or better cfm/watt performance.

18. Product Rating Requirements for Positive Pressure Ventilators

18.1 Test setups

Rating test setup shall be conducted in accordance with the requirements of ANSI/AMCA 240.

18.2 Product configuration

18.2.1 Basic conditions

All determinations of PPV performance are to be made with unobstructed inlet and outlet except for the structural features of the PPV and the appurtenance(s) (accessories) with which the PPV is to be rated and represented or described in the published catalog. Where appurtenances (accessories) are included as part of the fan configuration, they shall be in place during the test and shall be typical of the appurtenances (accessories) provided to the public.

18.2.2 Fume exhaust systems

All gasoline powered PPVs shall be furnished and tested with means for a direct, closed connection between the PPV engine exhaust and the laboratory exhaust removal system. This piece shall include a cylindrical section with an opening having an outside diameter of 41 mm (1.625 in.) for connection with the exhaust removal system and be constructed and installed such that interference with airflow near the PPV inlet and outlet is minimized.

18.2.3 Belt tensioning systems

All belt drive PPVs shall be furnished and tested with means of maintaining belt tension, cog (timing) belt drive, or other drive systems that will maintain running speed during the normal life of the PPV.

The drive system shall be the same as that furnished on the PPV as sold to the end user.

18.2.4 Bearings and shafts

If the PPV is provided with bearings, it shall be tested on its own shaft and its own bearings as typically supplied on the PPV provided to the public. The bearing shall include seals and lubricant as typically provided to the public.

18.2.5 Air stream restrictions.

If the PPV is designed so that motors, sheaves, bearings, and shafts are in the air stream, they shall be in place during the test. Sizes of these components shall be as typically provided to the public.

18.3 Catalog photographs or illustrations

If photographs or illustrations are included adjacent to the performance ratings, they shall be representative of the assembled PPV appurtenance(s) (accessories) for which ratings are certified.

18.4 Test conditions

18.4.1 Test methods

The air performance ratings of a PPV shall be developed from tests conducted in accordance with ANSI/AMCA 240.

18.4.2 Test speed

A PPV shall be tested at the speed obtained by the motor or engine of the PPV model being tested.

18.4.3 Test density

A PPV shall be tested under atmospheric conditions in which the air density is within the range of 1.14 to 1.20 kg/m^3 (0.071 to 0.075 lbm/ft^3).

18.4.4 Drive method

PPVs shall be tested while driven by their own motor or engine.

18.5 Test data submittal requirements

18.5.1 Test data

The test data submitted to AMCA shall include the raw data as defined in ANSI/AMCA 240. The test standard shall be identified by issuing organisation, number and year of issue.

18.5.2 Description and related data

A complete description of the PPV tested, including any/all appurtenances (accessories) in place as tested shall be submitted with the test data.

18.6 Alternate motors/engines

Alternate motors are permitted, however alternate engines are not.

19. Product Rating Requirements for Energy Recovery Ventilators (ERVs)/Heat Recovery Ventilators (HRVs)

19.1 Definitions

19.1.1 Energy recovery ventilator (ERV)

An ERV/HRV is an assembly of fan(s), controls, and energy recovery elements used to exhaust air from the interior

space, bring in air from outdoors, and transfer thermal energy between the two isolated air streams.

19.1.2 Energy recovery ventilator port nomenclature
The four ports of an ERV/HRV are depicted in Figure 19.1 and are:

1 = Supply Air Inlet (air from outside)

2 = Supply Air Outlet (air from equipment to space)

3 = Exhaust Air Inlet (air from space to equipment)

4 = Exhaust Air Outlet (air from equipment to outside)

19.1.3 Gross airflow
The total airflow measured at an inlet or outlet. Gross Airflow from an ERV/HRV inlet/outlet may include casing leakage and cross-leakage.

19.1.4 Electric power requirements
When electrical input power is cataloged, the tested motor on the supply side shall be operated at the catalog voltage and frequency, or where a voltage range is stated, it shall be the mean voltage. In addition, the temperature of the motor winding has to be stable for each tested operating point.

19.2 Test conditions

The test range of external fan static pressures on port 2 to determine air performance ratings for gross supply airflow shall also be used to determine the air performance ratings for gross exhaust airflow to port 3. Gross Supply Air Performance Ratings (airflow, pressure, and power) are at port 2 with port 1, port 3, and port 4 at manufacturers specified fan static pressures, with port 1 and port 3 equal. Gross Exhaust Air Performance Ratings (airflow, pressure, and power) are to port 3 with port 1, port 2, and port 4 at manufacturers specified fan static pressures, with port 2 and port 4 equal.

19.3 Catalog requirements

19.3.1 Gross supply airflow

19.3.1.1 Statements
The following statement shall be shown immediately adjacent to the rating tables, graphs, or charts:

"Air performance ratings for gross supply airflow are from port 2."

19.3.1.2 Published ratings
External fan static pressures on port 1, port 3, and port 4.

19.3.2 Gross exhaust airflow

19.3.2.1 Statements
The following statement shall be shown immediately adjacent to the rating tables, graphs, or charts:

"Air performance ratings for gross exhaust airflow are to port 3."

19.3.2.2 Published ratings
External fan static pressures on port 1, port 2, and port 4.

20. Product Rating Requirements for Circulating Fans

20.1 Test setups

20.1.1 Conformance to standards
Rating test setups shall be conducted in accordance with the requirements of ANSI/AMCA 230.

20.1.2 Rating methods
The test figures used for rating tests shall be those given in ANSI/AMCA 230.

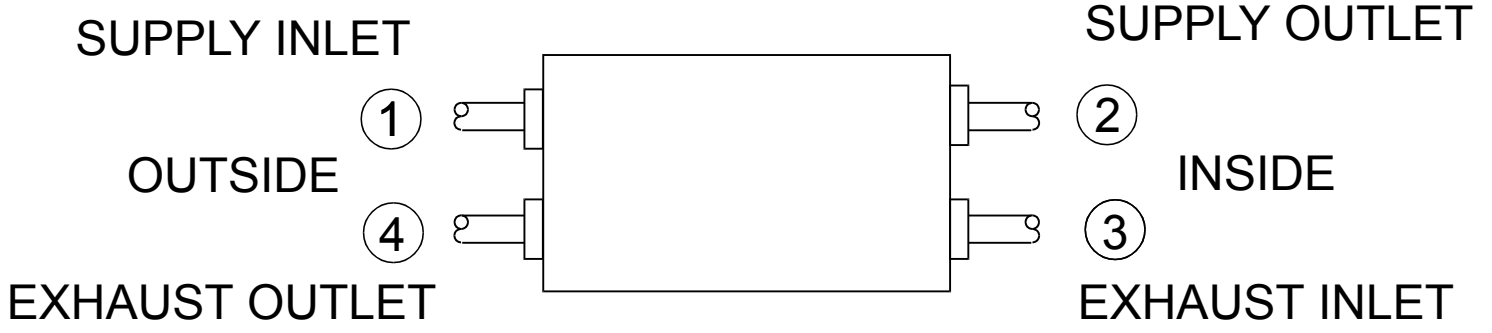


Figure 19.1
Diagram of Generic ERV

20.2 Product configuration or examples of installation

The fan shall be tested as-sold and as intended for operation in a typical installation. A fan sold and intended for operation with a guard shall be tested with the guard in place. Published ratings shall indicate whether the effect of a guard is included in the ratings.

20.2.1 Basic conditions

All determinations for air circulating fan performance are to be based on unobstructed inlet and outlet except for the structural features of the fan involved and the test rig, or the appurtenances (accessories) in place that are shown or described as being in place as an integral part of the fan described in the published catalog. Where appurtenances (accessories) are included as part of the fan configuration they shall be in place during the test and shall be typical of the appurtenances (accessories) provided to the public.

20.2.2 Non-similar products

The aerodynamic performance of fan assemblies which differ in impeller design (see figures in Annex A), tip diameter and motor physical size shall be determined by actual test. The only performance interpolation permitted shall be for a speed, which lies between the speeds of two actual tests, conducted according to the above conditions.

20.2.3 Air stream restrictions

If the fan is designed so that motor, sheaves, bearing(s) and shaft(s) are in the air stream, they shall be in place during the test. Sizes of these components shall be as typically provided to the public.

20.3 Test conditions

20.3.1 Test methods

The air performance ratings of a fan shall be developed from tests conducted in accordance with ANSI/AMCA 230 or other test standard(s) as provided for in this section. The test setup shall be consistent with the test setup of the standard referenced.

20.3.2 Test speed

A circulating fan shall be tested at the speed obtained by the motor or motor+drive of the fan model being tested.

20.3.3 Test voltage

Test voltage shall be in conformance with the requirements of ANSI/AMCA 230, Section 6.3.3.

20.4 Test data submittal requirements

The test data submitted to AMCA shall include the raw test data as defined in ANSI/AMCA 230. The test standard used shall be identified by issuing organisation, number and year of issue.

21. Product Rating Requirements for Induced Flow Fans

21.1 Basic conditions

All determinations for fan performance ratings are to be based on unobstructed inlet and outlet except for the structural features of the fan involved, or appurtenances (accessories) in place that are shown or described as being in place as an integral part of the fan in the published catalog. Where appurtenances (accessories) are included as part of the fan configuration, they shall be in place during the test and shall be typical of the appurtenances (accessories) provided to the public. The allowances found in Section 11.1 for centrifugal fans and in Section 12.1 for axial fans shall be applicable for induced flow fans.

21.2 Test setups

Induced flow fans shall be tested in accordance with AMCA 260.

21.3 Electric power requirements

When electrical input power is cataloged, the tested motor shall be operated at the catalog voltage and frequency, or where a voltage range is stated, it shall be the mean voltage. In addition, the temperature of the motor winding has to be stable for each tested operating point.

21.4 Test data submittal requirements

21.4.1 Test data

The test data submitted to AMCA International shall include the raw test data as defined in AMCA 260.

The test data shall be calculated to standard inlet air density, and may be calculated to a constant speed.

21.4.2 Test range

The test shall cover the performance range to be cataloged, except that performance may be extrapolated to zero fan static pressure, provided that the airflow so obtained does not exceed the highest test airflow by more than 10%. The portion of the curve obtained by extrapolation shall be a smooth continuation of the curve. In the case of the fan static pressure curve, the extrapolation to zero must have the same or smaller radius of curvature as the adjacent portion of the curve, but in no case can it be concave upward.

Extrapolation of the power curve shall be by a straight-line tangent to the adjacent portion of the curve.

Annex A
Dimensional Requirements (Normative)

A.1 General requirements

The manufacturer shall submit with the test data dimensional information for the test unit(s) and for all unit(s) that will be rated based on geometric similarity with a test unit. Dimensional data on both the impeller and fan unit shall be submitted.

The dimensional data shall be in sufficient detail to allow AMCA staff to verify that the precertification test unit and check test unit are physically in accordance with the dimensional data submitted.

The following illustrations are intended to provide guidelines for the minimum dimensional information that is required. These illustrations are not intended to represent all possible types and configurations of fans.

For products that are different than those shown it is necessary to provide dimensional detail for the airflow passages and impellers similar to that shown in the illustrations.

It is incumbent on the manufacturer to establish and maintain geometric similarity between the test unit and larger unit(s) that are rated based on the test unit performance data, and the Fan Laws.

A.1.1 Tolerance and precision

Absolute proportionality is not always required to maintain the validity of calculated performance using the Fan Laws. Exceptions to strict proportionality are listed below.

a) Other than those items listed in the Product Rating Requirement Section and those listed below, all design dimensions shall be proportional within ± 1%.

b) The dimensions of the following items may be greater than that derived from proportionality.

P - Panel size
T - Length to belt tube
K - Orifice depth
R - Orifice radius
M - Height above roof
I - Inside curb
F - Discharge size or area
Q - Shaft height above base
S - Shaft diameter, if shaft extends through box
V - Hood size
X - Wind band diameter

c) The number of blades, N, shall be equal for all proportional fans.

d) The number of vanes, NV, shall be equal for all proportional fans.

e) The belt tube dimension, J, may be less than that derived from proportionality or up to 7½% larger.

f) The hood height above the roof, dimension M, may be greater than that derived from proportionality. The hood depth, dimension N, may be less than that derived from proportionality provided that the sum of the N and M dimensions is proportional or greater.

A.1.2 Illustrations

In the illustrations the term size is understood to mean diameter or length and width as appropriate for the product being described.

A	Diameter at Blade Tip
B	Diameter at Blade Heel
W	Blade Width at Discharge
D	Minimum Diameter at Inlet Cone
N	Number of Blades

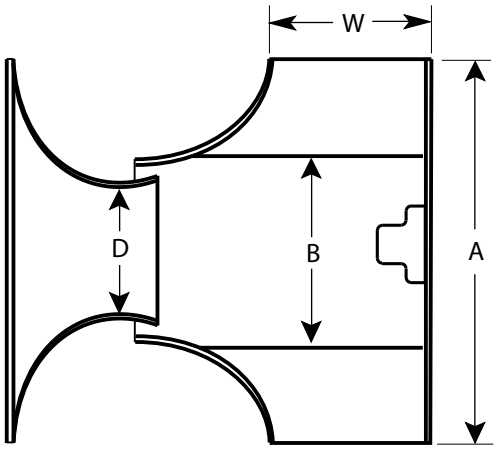


Figure A.1
Backward Inclined Centrifugal Impeller

A	Diameter at Blade Tip
B	Diameter at Blade Heel
W	Blade Width at Discharge
D	Minimum Diameter at Inlet
N	Number of Blades

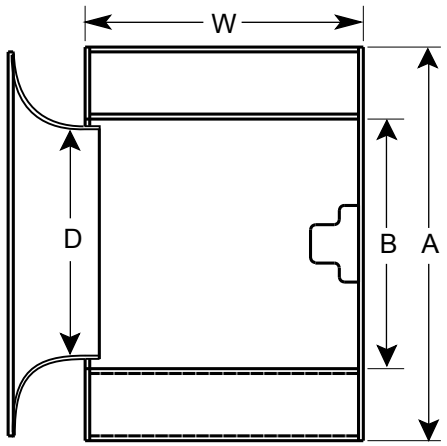


Figure A.2
Forward Curved Centrifugal Impeller

A	Diameter at Blade Tip
B	Diameter at Blade Heel
W	Blade Width at Discharge
D	Inlet Diameter
N	Number of Blades

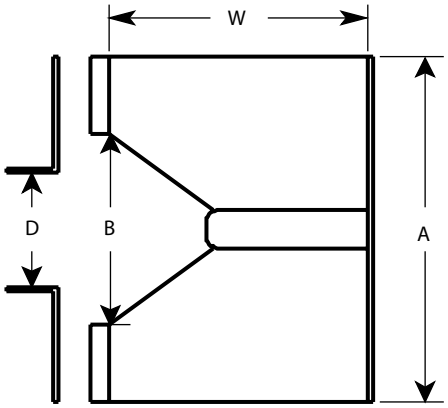


Figure A.3
Radial Centrifugal Impeller

A	Major Diameter at Discharge
A_1	Minor Diameter at Discharge
B	Major Diameter at Blade Heel
W	Blade Width at Discharge
D	Minimum Diameter at Inlet Cone
N	Number of Blades

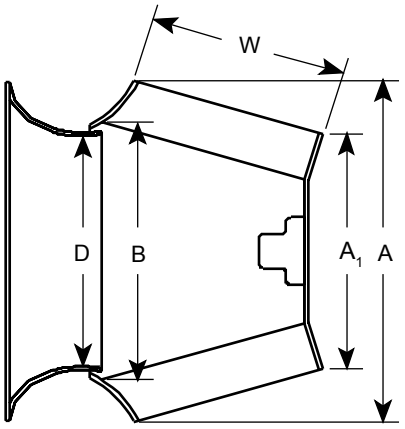


Figure A.4
Mixed Flow Impeller

A	Diameter at Blade Tip
H	Hub Diameter
G	Blade Width at Discharge
α	Pitch Angle at Tip or at a Designated Radius
N	Number of Blades

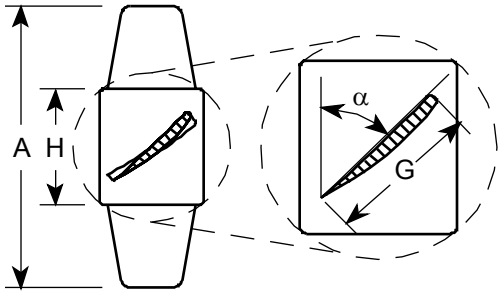


Figure A.5
Vaneaxial Propeller

A	Diameter at Blade Tip
H	Hub Diameter
G	Blade Width at Tip
α	Pitch Angle at Tip or at a Designated Radius
N	Number of Blades

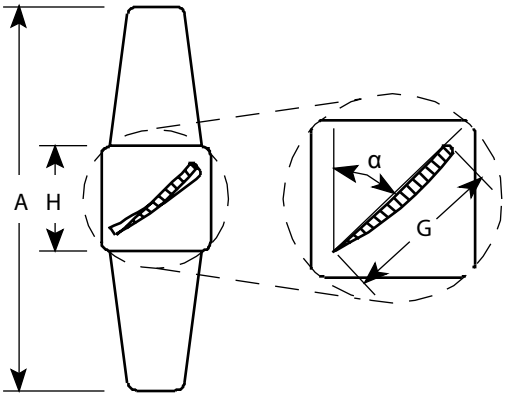


Figure A.6
Tubeaxial Propeller

A	Diameter
H	Blade Root Diameter
G	Blade Width at a Designated Radius
α	Pitch Angle at a Designated Radius
N	Number of Blades

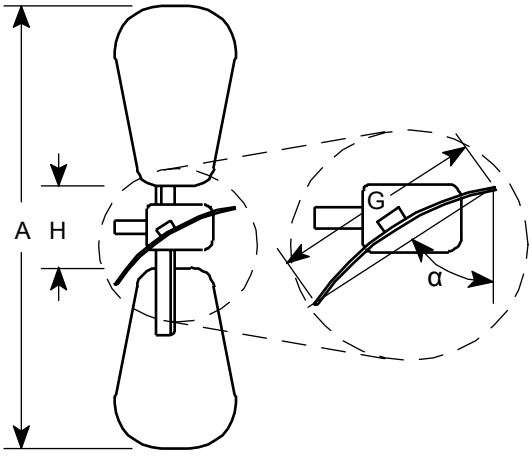
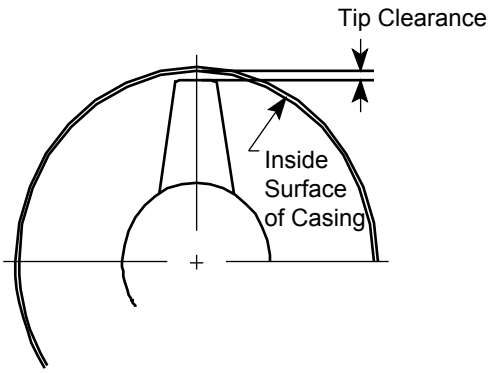


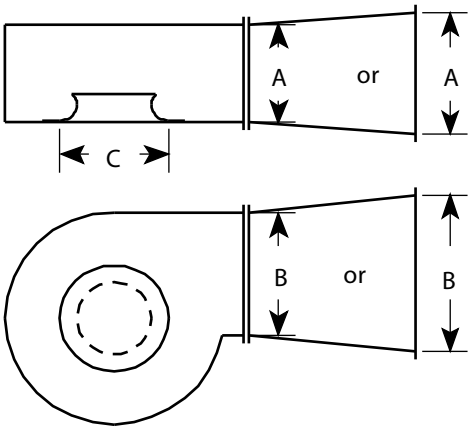
Figure A.7
Fabricated Propeller



Design tip clearance is defined as the difference between the design radius of the impeller and the design internal radius of the fan casing. Measured tip clearance is defined as the average of the tip clearance measurement for all blades taken at eight locations (45° intervals) around the fan casing.

Note: This dimension is not required for proportionality.

Figure A.8
Tip Clearance



A	Width of Discharge (or Evase, as applicable)
B	Height of Discharge (or Evase, as applicable)
C	Point of Inlet Radius or Inlet Collar Diameter

Figure A.9
Centrifugal Fan Housing SI - DI

S	Shaft Diameter if Shaft Extends Through Box
A	Inlet Height
B	Inlet Width
L	Inlet Box Length

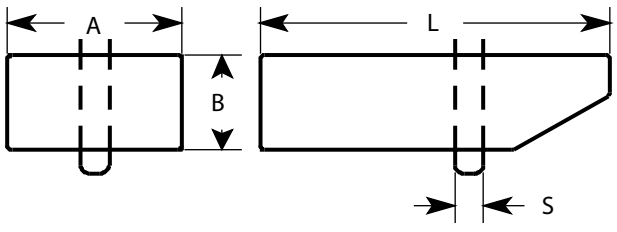


Figure A.10
Inlet Box

Q Shaft Height above Base

C Inlet Diameter at Tangent Point of Inlet Radius or Inlet Collar Diameter

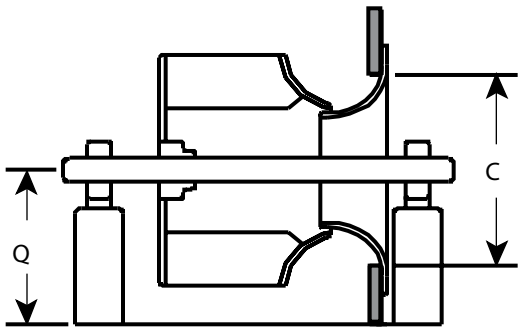


Figure A.11
Arrangement 3 Plenum Fan

Q Shaft Height above Base

C Inlet Diameter at Tangent Point of Inlet Radius or Inlet Collar Diameter

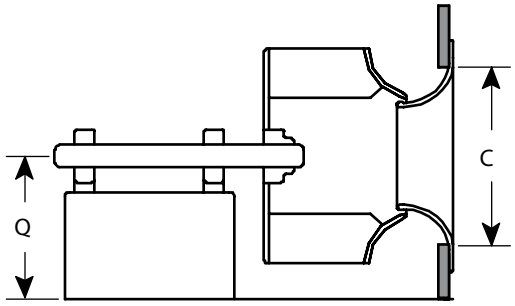


Figure A.12
Arrangement 1 Plenum Fan

P Panel Size

C Inlet Diameter at Tangent Point of Inlet Radius or Inlet Collar Diameter

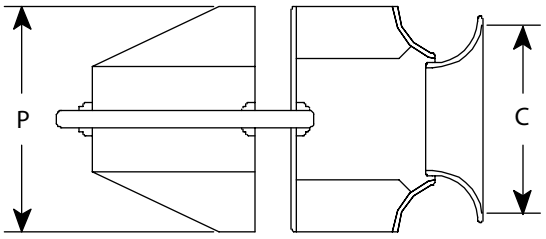
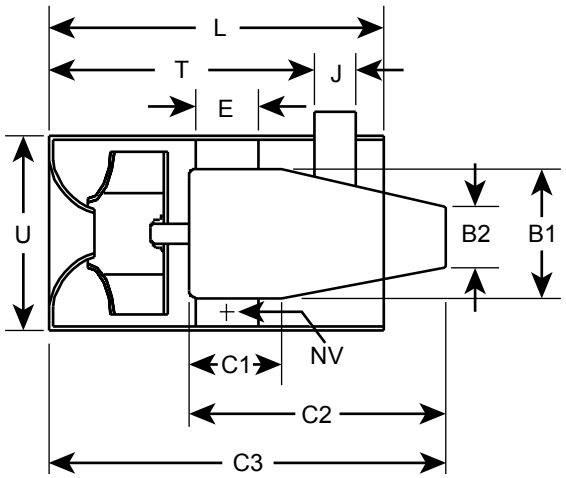


Figure A.13
Plug Fan

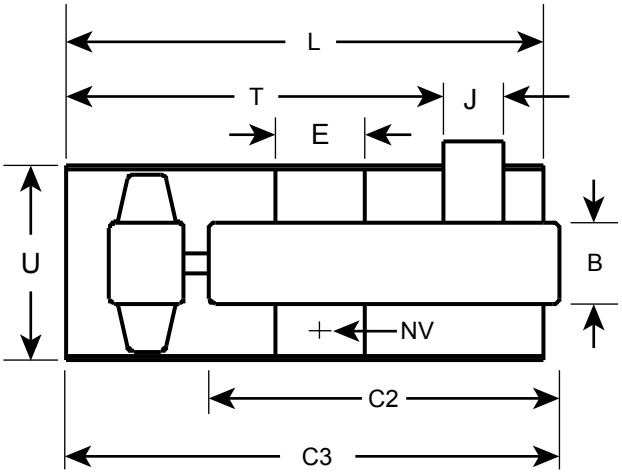
L	Tube Length
T	Length to Belt Tube
J	Belt Tube Size
E	Length of Vanes
U	Drum Diameter or Square Size
B2	Interior Drum Size at Discharge
B1	Interior Drum Size
NV	Number of Vanes
C1	Center Body Front Section
C2	Center Body Length
C3	Length to End of Center Body



Note: If C3 is less than or equal to L, then L does not need to be proportional.

Figure A.14
Inline Centrifugal Fan - Belt Drive

L	Tube Length
T	Length to Belt Tube
J	Belt Tube Size
E	Length of Vanes
U	Drum Diameter or Square Size
B	Interior Drum Size at Discharge
NV	Number of Vanes
C2	Center Body Length
C3	Length to End of Center Body



Note: If C3 is less than or equal to L, then L does not need to be proportional.

Figure A.15
Vaneaxial Fan - Belt Drive

U	Diameter - ID
B	Inside Diameter of Vanes
E	Length of Vanes
NV	Number of Vanes

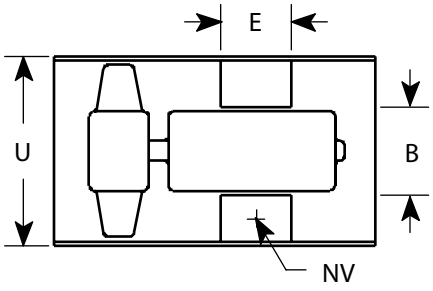


Figure A.16
Vaneaxial Fan - Direct Drive

U Diameter - ID
B Size of Drive Tube
T Length to Belt Tube
J Belt Tube Size

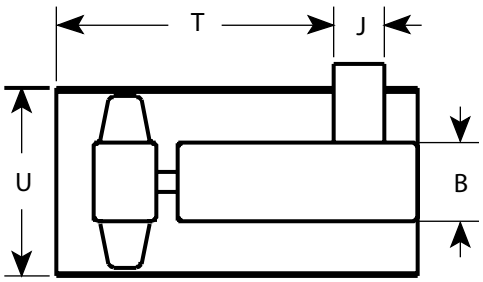


Figure A.17
Tubeaxial Fan - Belt Drive

U Diameter

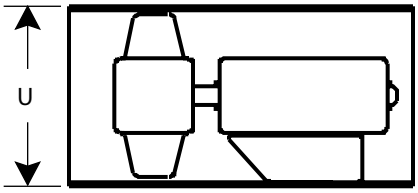


Figure A.18
Tubeaxial Fan - Direct Drive

O Orifice Diameter
K Orifice Depth
R Orifice Radius
P Panel or Ring Size

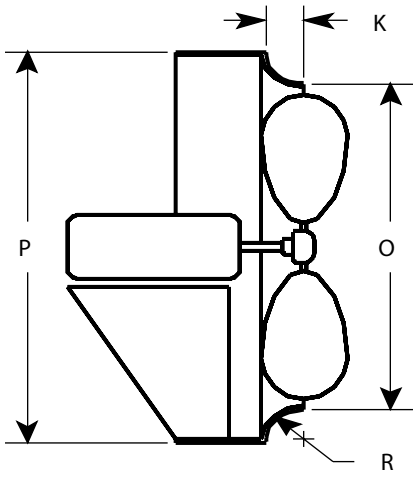


Figure A.19
Propeller Fan

N	Hood Height
V	Hood Diameter
C	Inlet Collar Diameter
I	Recommended Inside Curb Dimension
M	Minimum Height Above Roof
D_1	Inside Diameter of Discharge
D_2	Outside Diameter of Discharge

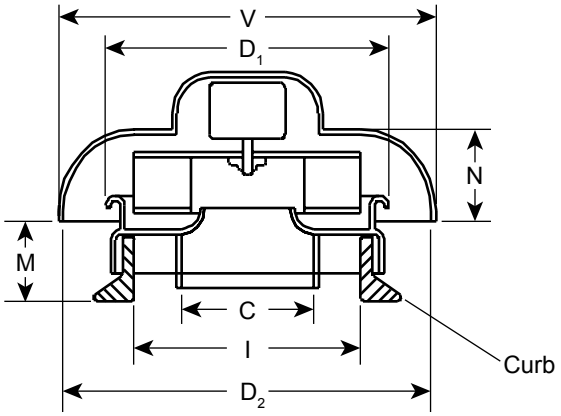


Figure A.20
Centrifugal PRV Exhaust-Down Discharge

V	Hood Diameter
C	Inlet Collar Diameter
I	Recommended Inside Curb Dimension
D_1	Inside Diameter of Discharge
D_2	Outside Diameter of Discharge

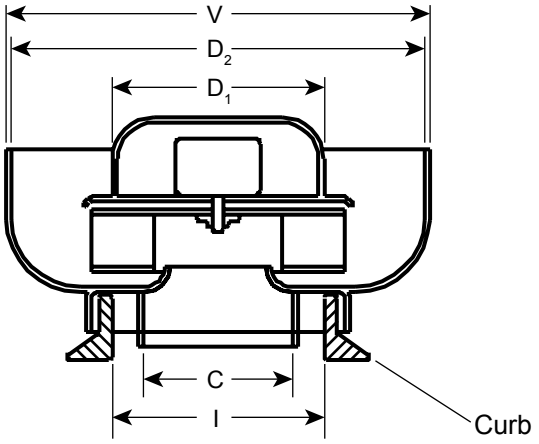


Figure A.21
Centrifugal PRV Exhaust-Up Discharge

V	Hood Diameter
C	Inlet Collar Diameter
I	Recommended Inside Curb Dimension
M	Minimum Height Above Roof
O	Orifice Diameter
K	Orifice Depth
R	Orifice Radius
D_1	Inside Diameter of Discharge
D_2	Outside Diameter of Discharge

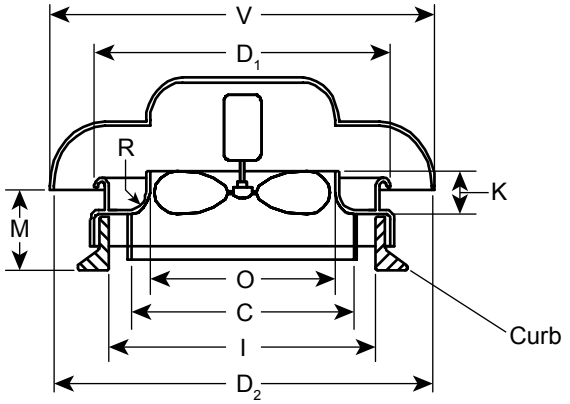


Figure A.22
Axial PRV Supply or Exhaust

V Hood Length
W Hood Width
V_1 Body, Length Offset
W_1 Body, Width Offset

N Hood Height
M Height Above Base
Y Body Size

See Figure A.9 for Required Blower Dimensions

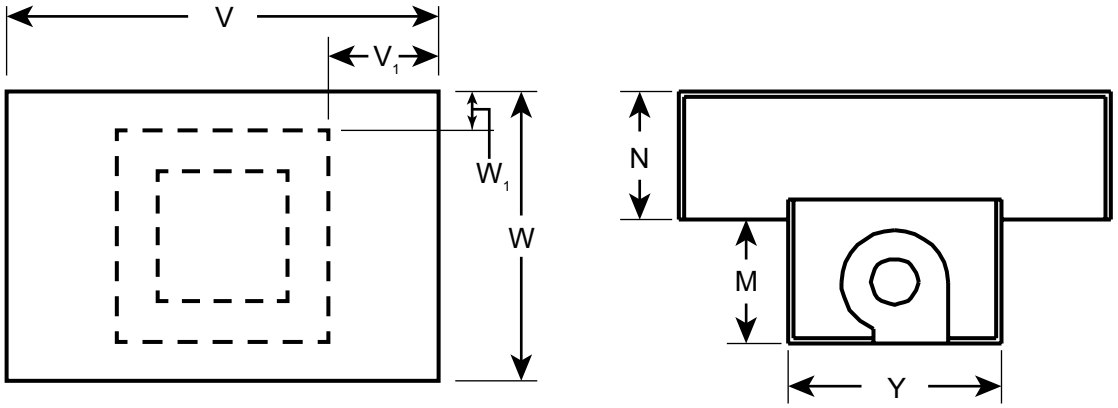


Figure A.23
Centrifugal Supply PRV

X Windband Diameter
C Inlet Collar Size (If Provided)
O Orifice Diameter
K Orifice Depth
R Orifice Radius
I Recommended Inside Curb Dim.

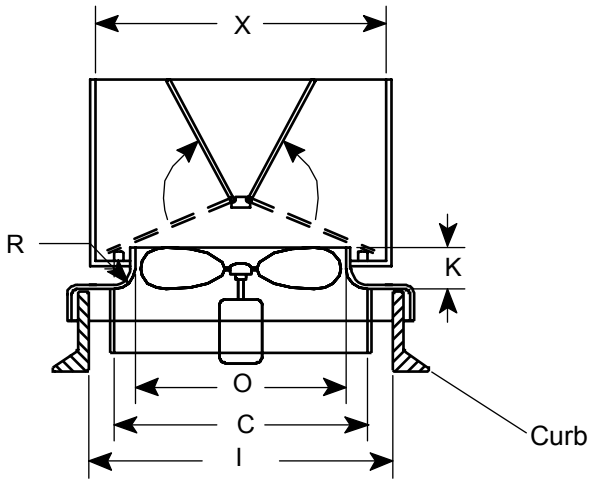


Figure A.24
Axial Upblast PRV

C Inlet Collar Size (If Provided)
X Windband Diameter, Inside
I Recommended Inside Curb Dim.

See Tubeaxial and Vaneaxial for Dim. Figures A.15 to A.18

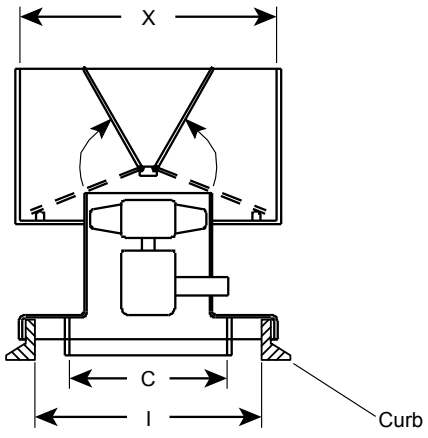


Figure A.25
Axial Upblast PRV

V Hood Length
W Hood Width

N Hood Height
M Height Above Base
C Inlet Collar Size (If Provided)
I Recommended Inside Curb Dimension

See tubeaxial Figure A.17 and A.18
for Required Fan Dimensions

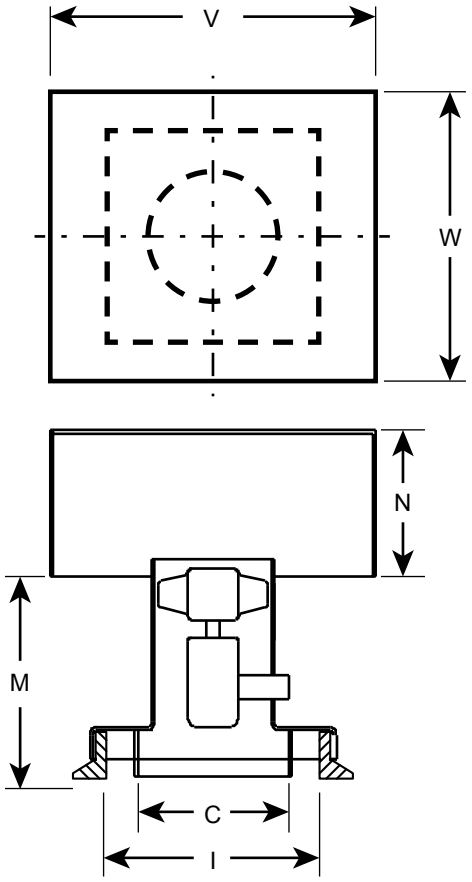


Figure A.26
Axial Supply/Exhaust PRV

V Hood Length
W Hood Width
V_1 Body, Length Offset
W_1 Body, Width Offset

N Hood Height
M Height Above Base
R Orifice Radius
K Orifice Depth
O Orifice Diameter
Y Body Size

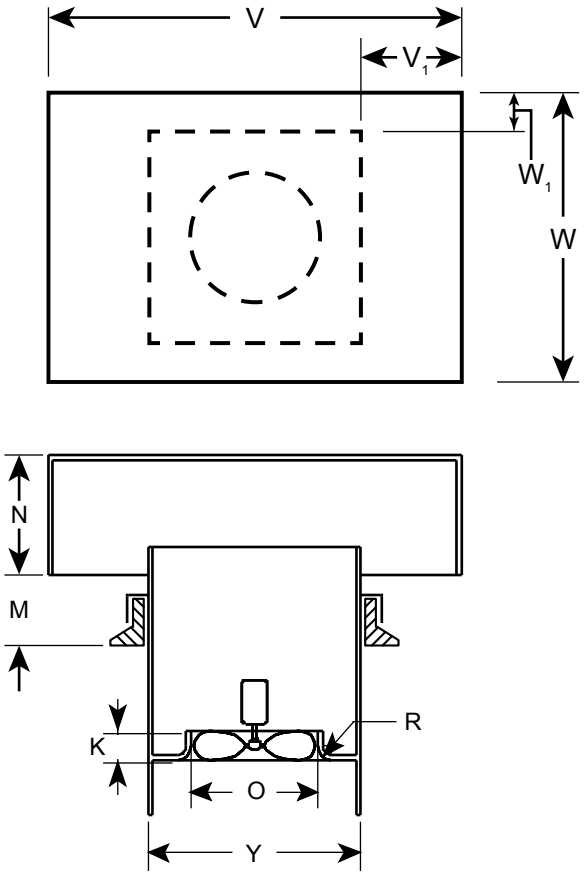


Figure A.27
Combination PRV Exhaust-Supply-Circulate

Y	Body Size
K	Orifice Depth
O	Orifice Depth
R	Orifice Radius
X	Wind Band Diameter, Inside

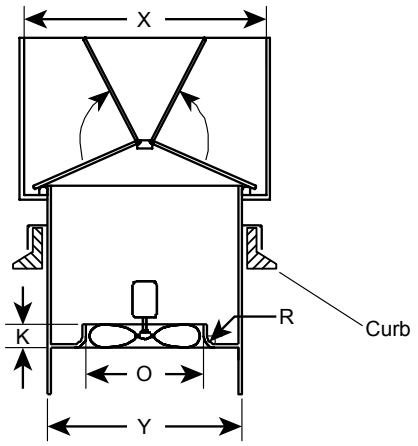
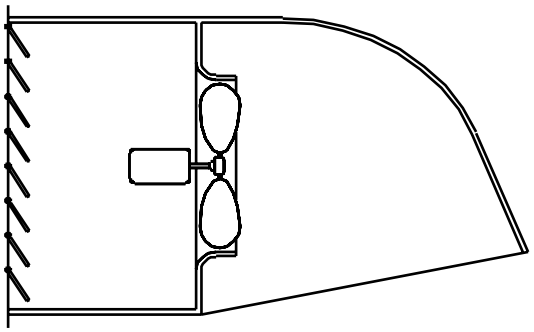


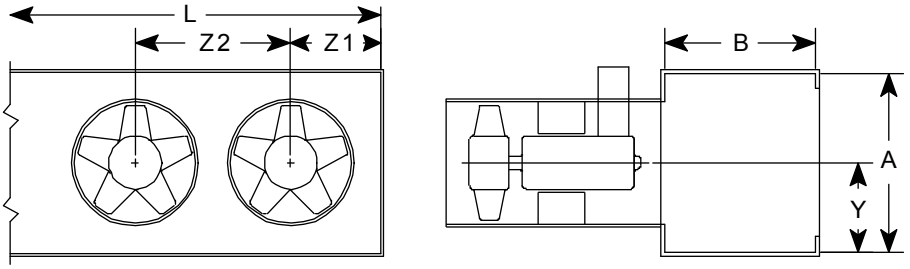
Figure A.28
Combination PRV Exhaust-Circulate



See Figure A.19 for Dimensional Requirements for Propeller Fans
Provide All Dimensions Required to Define Inlet and/or Outlet Appurtenances

Figure A.29
Agricultural Fans

L	Interior Width
Z1, Z2	Fan Spacing
A	Interior Height
B	Interior Depth
Y	Shaft Center Height



See Tubeaxial and Vaneaxial Figures A.15, A.16, A.17, and A.18 for Required Fan Dimensions

Figure A.30
Vane/Tubeaxial Air Curtain

A	Interior Height
B	Interior Depth
L	Interior Width
V	Motor Spacing (where applicable)
W	Centrifugal Fan/Housing Width
X	Shaft Center Depth
Y	Shaft Center Heigfht
Z	Centrifugal Fan/Housing Spacing

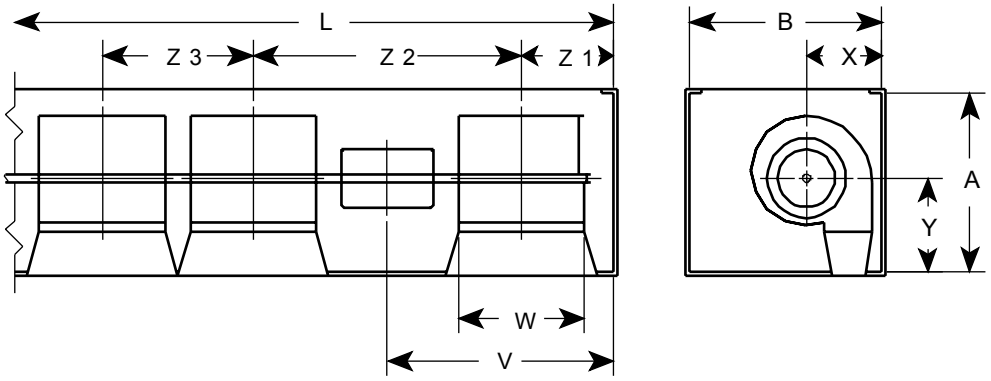


Figure A.31
Centrifugal/Tangential Air Curtain

L	Interior Width
Z1, Z2	Axial Fan Spacing
W	Impeller Diameter at Blade Tip
A	Interior Height
B	Interior Depth
K	Orifice Depth
R	Orifice Radius
O	Min. Diameter of Inlet Cone
Y	Shaft Center height

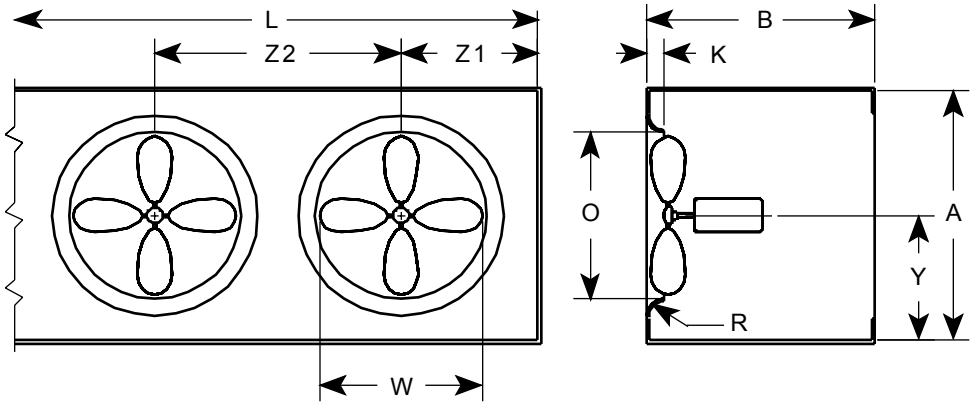


Figure A.32
Axial Air Curtain

A	Housing Dimensions
B	Inlet Length
C	Outlet Length
K	Inlet Orifice Depth
O	Minimum Diameter of Inlet Orifice

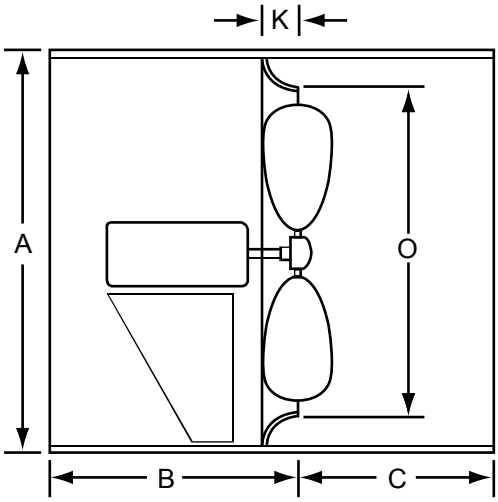
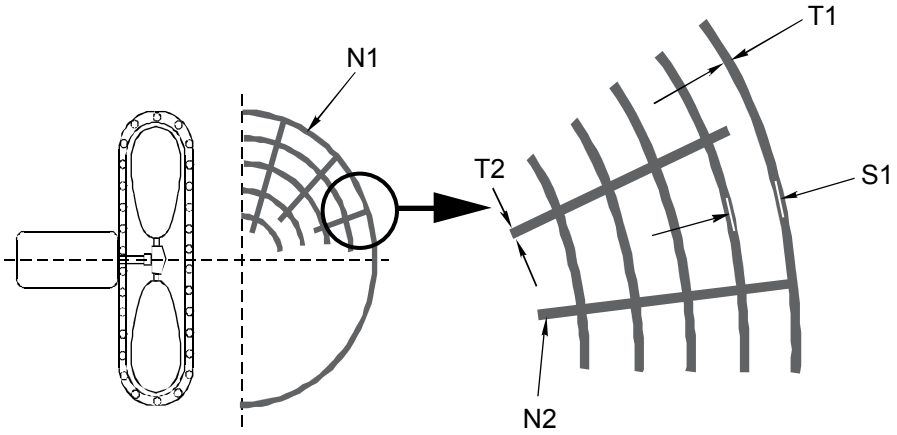


Figure A.33
Circulating Fan

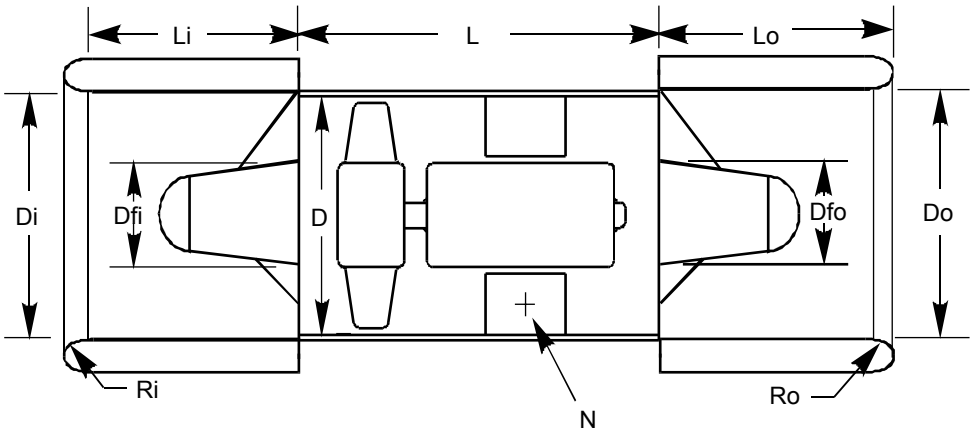
N1	Number of Rings
N2	Number of Radial Supports
T1	Ring Thickness
T2	Radial Support Thickness
S1	Ring Spacing



Note: This figure is for reporting and is not used in a proportionality review.

Figure A.34
Circulating Fan Head with Guard

L	Fan Length
Li	Inlet Silencer Length
Lo	Outlet Silencer Length
D	Fan Diameter
Di	Inlet Silencer Diameter
Do	Outlet Silencer Diameter
Dfi	Inlet Fairing Diameter
Dfo	Outlet Fairing Diameter
Ri	Inlet Bell Radius
Ro	Outlet Bell Radius
N	Number of Vanes



Note: This figure is for reporting and is not used in a proportionality review.

Figure A.35
Jet Tunnel Fan

A Nozzle inlet area after blade discharge
B Nozzle height
C Nozzle discharge area
D Windband inlet area
E Windband height
F Windband discharge area
G Overlap between nozzle and windband

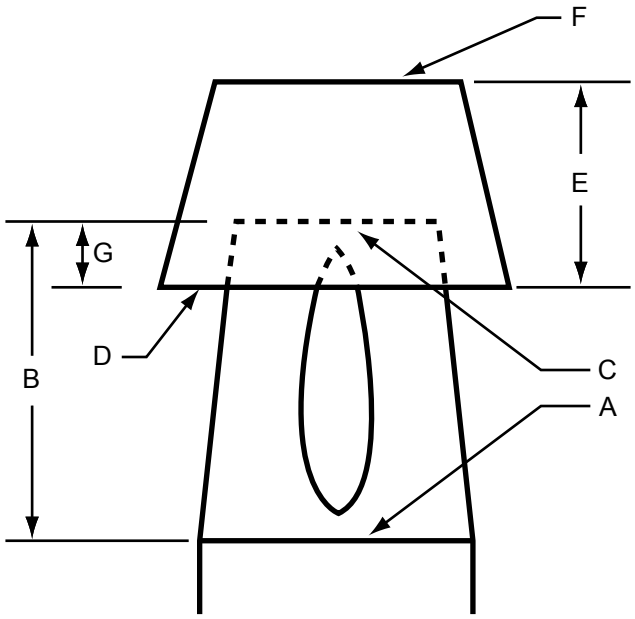


Figure A.36
Induced Flow Fan Nozzle and Windband

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC.
30 West University Drive
Arlington Heights, IL 60004-1893 U.S.A.
Tel: (847) 394-0150 • Fax: (847) 253-0088
E-Mail : info@amca.org • Web: www.amca.org

AMCA CERTIFIED RATINGS SEAL

AIR MOVEMENT APPLICATION FORM CRP 8 & CRP T

TO: AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC.

We are submitting the enclosed test results (based on tests conducted in the AMCA Laboratory or in an AMCA Accredited Laboratory in accordance with ANSI/AMCA 210/ASHRAE 51, ANSI/AMCA 230, AMCA 260, AMCA 300, ASHRAE 149 or an AMCA recognized test standard) along with the proposed catalog data, with a request for license to use the AMCA Certified Ratings Seal on the below listed product.

Application for rating:

- ☐ Air Performance
- ☐ CFM/Watt Air Performance
- ☐ Efficiency Air Performance
- ☐ PPV Air Performance
- ☐ Induced Flow Fan Air Performance
- ☐ Smoke Management Fan Performance (CRP-T)
- ☐ Smoke Management Fan Performance Reversible Operation (CRP-T)
- ☐ Residential Air Performance
- ☐ Circulating Fan Performance
- ☐ Sound & Air Performance
- ☐ Efficiency Sound & Air Performance
- ☐ Induced Flow Fan Sound & Air Performance
- ☐ Residential Sound & Air Performance
  - ☐ Inlet Sound
  - ☐ Outlet Sound
  - ☐ Total Sound
    - ☐ One-third Octave Bands
    - ☐ Octave Bands
    - ☐ Hemispherical sones
    - ☐ Spherical sones
    - ☐ LwA

Company Name Date

Address

Authorized Signature _____ Print Name

PRODUCT INFORMATION

Product Name (As to be listed on License Appendix)

SIZE	MODEL NO.	SIZE	MODEL NO.	SIZE	MODEL NO.

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CRP-8 Form - Page 1

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC.
30 West University Drive
Arlington Heights, IL 60004-1893 U.S.A.
Tel: (847) 394-0150 • Fax: (847) 253-0088
E-Mail : info@amca.org • Web: www.amca.org

SUMMARY OF TEST DATA USED FOR RATINGS

☐ Testing in an AMCA Testing Laboratory ☐ Testing in an AMCA Accredited Laboratory Location

FAN TYPE:

☐ Agricultural Fan
☐ Air Curtain
☐ Axial Fan
☐ Ceiling Ventilator
☐ Centrifugal Fan
☐ Circulating Fan
☐ Energy Recovery Ventilator
☐ Evaporative Cooler
☐ Induced Flow Fan
☐ Jet Tunnel Fan
☐ Mixed Flow Fan
☐ Positive Pressure Ventilator
☐ Propeller Fan
☐ Power Roof Ventilator
☐ Smoke Management Fan

☐ Production Sample ☐ Pre-Production Sample

Test Number					
Test Standard					
Figure No./Installation Type					
Date of Test					
Model Number					
Test Speed (rpm)					
Impeller Diameter					
Number of Blades					
Blade Pitch Angle					
Curb Height (inches)					
Sizes Rated from this Test					
Other					
Appurtenances Used During Testing					
Inlet Bell					
Shutter/Damper					
Screen(s)					
Other					

Method used for calculating sound ratings (if applicable):

	Full Octave Bands	One-Third Octave Bands
Generalized Method	☐	☐
Specific Method	☐	☐

☐ Belt Drive ☐ Direct Drive

Rating Method:

☐ A - Constant Speed, Transmission Loss Not Included
☐ B - Constant Speed, Transmission Losses Included
☐ C - As Run Speed, Transmission Losses Included, Low Slip Motor
☐ D - Direct Drive, Constant Speed, Low Slip Motor
☐ E - Direct Drive, As Run Speed, Low Slip Motor
☐ F - Direct Drive, As Run Speed, High Slip Motor
☐ G - Air Curtain
☐ H - Direct Drive, Jet Tunnel Fan, As Run Speed
☐ I - Agricultural Fan, As Run Speed, Transmission Losses Included, Low Slip Motor
☐ J - Direct Drive, PPV, As Run Speed
☐ K - Direct Drive, Circulator Fan, As Run Speed
☐ L – Induced Flow Fans

Rev. 12/07

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AMCA FAN EFFICIENCY GRADE SEAL

AIR MOVEMENT APPLICATION FORM CRP FEG

TO: AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC.

We are submitting the enclosed application (based upon AMCA 205) along with the proposed catalog data, with a request for license to use the AMCA Fan Efficiency Grade Seal on the below listed product models.

Application for rating:

☐ Fan Efficiency Grade (FEG)

Company Name Date

Address

Authorized Signature Print Name

PRODUCT INFORMATION

FAN TYPE:

☐ Agricultural Fan
☐ Axial Fan
☐ Ceiling Ventilator
☐ Centrifugal Fan
☐ Circulating Fan
☐ Evaporative Cooler
☐ Jet Tunnel Fan
☐ Mixed Flow Fan
☐ Propeller Fan
☐ Power Roof Ventilator
☐ Smoke Management Fan

1. Product Name (as listed on CRP-8 form):

2. Approved Catalog Fan Efficiency Grade is based on:

   Catalog Identification Catalog Date

3. Please use the table below to enter performance data at the point of peak total efficiency. Please note the values below are required to be shown in the approved catalog listed above. Either Fan Static Pressure or Fan Total Pressure is required, not both. If Fan Total Pressure is cataloged, the column below for Fan Static Pressure can be left blank.

MODEL NO.	FAN STATIC PRESSURE	FAN TOTAL PRESSURE	AIRFLOW	POWER

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AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC.
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Arlington Heights, IL 60004-1893 U.S.A.
Tel: (847) 394-0150 • Fax: (847) 253-0088
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MODEL NO.	FAN STATIC PRESSURE	FAN TOTAL PRESSURE	AIRFLOW	POWER

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Annex C
Electronic Catalogs (Normative)

C.1 Introduction

This Annex covers the special requirements for the use and licensing of electronic catalogs with respect to the AMCA International Certified Ratings Program for air performance (AMCA Publication 211) and sound (AMCA Publication 311).

Any computer program, web site, set of instructions, screen display or computer generated printout that provides air performance or sound data for a product line shall be designated an electronic catalog. Two main variants of an electronic catalog are “Electronic Print” and Interactive “Product Selector” software or services.

The Electronic Print variant of the electronic catalog is primarily subject to the requirements of the main body of Publication 211. An electronic catalog is considered this type of variant even if it is not an exact replica of an existing certified print catalog if the intent is to show AMCA certified performance information. Examples of Electronic Print are Adobe Acrobat files that display/print images of print catalogs. Non-interactive web site displays of data are considered Electronic Print.

This Annex focuses on the Product Selector variant. Such selectors can include software distributed on computer disk and/or presented on an interactive web site. A fundamental characteristic of a Product Selector is that the end-user is able to configure various fan design and performance criteria that the Selector uses to present suitable product design and performance information.

C.2 Scope

Performance data for all products that can be licensed by AMCA to use the AMCA Certified Ratings Seal for air performance or the AMCA Certified Ratings Seal for sound and air performance in accordance with the requirements of AMCA Publications 211 and 311 can be published in the form of an electronic catalog.

With the exceptions of the requirements covered in this Annex , all other requirements outlined in AMCA Publications 211 and 311 must be met when certifying performance in an electronic catalog.

C.3 Allowable performance modifications

C.3.1 Density correction

Air performance and sound data may continue to be licensed to use the AMCA Certified Ratings Seal where the density is different from standard air because of temperature, elevation, humidity, molecular weight or a combination of these factors.

Correction for known densities other than standard air are allowable providing that the density effects are calculated as published in AMCA Publication 200, Section 5.

Corrections for elevations and temperatures other than standard air are allowable providing that the air density correction factors utilized agree with the air density correction factors published in Chart E-1 (SI) or Chart E-2 (IP) as appropriate, of AMCA Publication 200.

C.3.2 Expanded performance data

Electronic catalogs may display performance data that is not present in printed catalogs. The cross hatched areas in the Figure C.1 show some of the areas of performance data that an electronic catalog might include, but may be excluded in a printed catalog.

Air performance and sound data in the cross hatched areas may be certified provided that this data can be calculated from the fan test data by use of the Fan Laws or other methods in the product rating section.

C.3.3 Rating factors and interpolated ratings

Rating factors and interpolation between test fans allowed in AMCA Publication 211 and 311 may be applied to the air and/or sound performance to account for appurtenances, accessories, etc. Select the appropriate primary and secondary statement, depending on the certification status of the rating factor, or interpolated ratings.

C.4 Required qualifying statements

Manufacturers often combine computerized selection with electronic cataloging of air performance and sound data. This data may be corrected for the effect of accessories, appurtenances and installation conditions not included in the certified ratings. While these modification factors may not be certified, they are quite often provided by manufacturers to assist the user in applying the performance information correctly.

Qualifying statements shall be displayed with the air and/or sound performance ratings to assist the user in applying this information correctly. The qualifying statements may be divided into primary and secondary statements.

When presenting products and/or sizes licensed at differ-

ent standard levels, a clear differentiation must be made between the products and/or sizes presented that are: not certified, have air performance certified, and have air and sound performance certified.

C.4.1 Primary Statements
Primary statements must appear on the same screen as the selections.

C.4.1.1
When air performance is certified and corrections, appurtenances and accessories applied to the fan duplicate the test conditions, use the following statement:

"AMCA Licensed for Air Performance."

If license is extended to Efficiency, Fan Efficiency Grade, or Efficiency and Fan Efficiency Grade, use the statement:

"AMCA Licensed for Air Performance (and Efficiency, Fan Efficiency Grade or Efficiency and Fan Efficiency Grade)."

C.4.1.2
When fan air and sound performance is certified and corrections, appurtenances and accessories applied to the fan duplicate the test conditions, use the following statement:

"AMCA Licensed for Sound and Air Performance."

If license is extended to Efficiency, Fan Efficiency Grade, or Efficiency and Fan Efficiency Grade, use the statement:

"AMCA Licensed for Sound and Air Performance and (Efficiency, Fan Efficiency Grade or Efficiency and Fan Efficiency Grade)."

C.4.1.3
When fan air performance is certified but non-certified modifications for the effect of appurtenances and accessories, etc., are applied to the fan ratings, use the following statement:

"AMCA Licensed for Air Performance Without Appurtenances and Accessories."

If license is extended to Efficiency, Fan Efficiency Grade, or Efficiency, and Fan Efficiency Grade, use the statement:

"AMCA Licensed for Air Performance and (Efficiency, Fan Efficiency Grade or Efficiency and Fan Efficiency Grade) Without Appurtenances (Accessories)."

C.4.1.4
When fan air and sound performance is certified, but non certified modifications for the effect of appurtenances and accessories are applied to the fan ratings, use the following statement:

"AMCA Licensed for Sound and Air Performance Without Appurtenances (Accessories)."

If license is extended to efficiency and/or Fan Efficiency Grade, use the statement:

"AMCA Licensed for Sound and Air Performance and

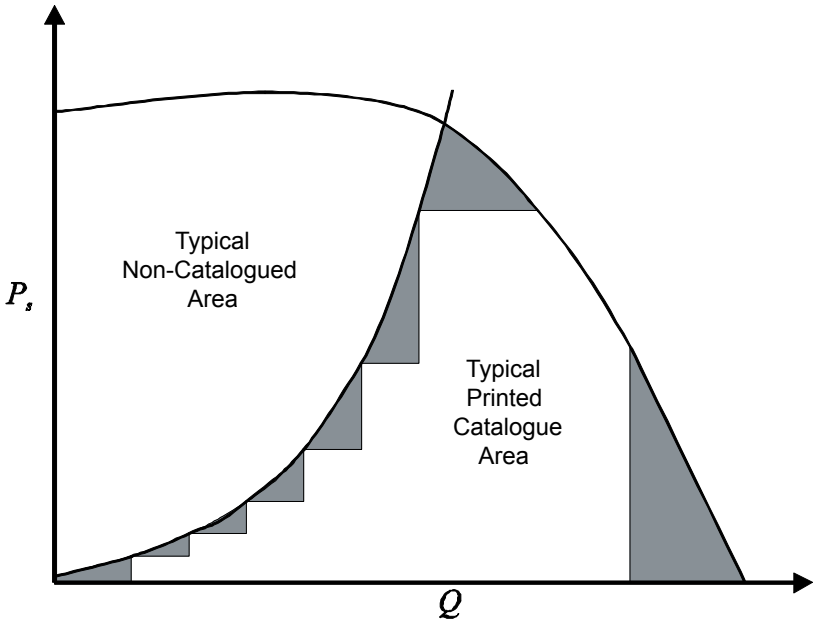

Figure C.1
Expanded Performance Data

(Efficiency, Fan Efficiency Grade or Efficiency and Fan Efficiency Grade) Without Appurtenances(Accessories)."

C.4.1.5
In addition to the above, primary statements must include the appropriate power statement from Section 9 of Publication 211, for the rating method used. This shall be incorporated by adding the following to the end of the primary statement:

"Power [kW (bhp)] includes (or excludes) drives."

C.4.2 Secondary statements
The secondary statements shall contain all other qualifying statements required by AMCA Publications 211 and 311. They may be on the primary screen, or on an easily accessible secondary screen.

Access instructions to the secondary qualifying statements shall be clearly displayed on the primary screen.

When the product is licensed to bear the AMCA Certified Ratings Seal for fan air and/or sound performance and non-certified modifications have been applied to the ratings, the following additional qualifying statements shall appear on the secondary screen:

"The AMCA licensed air and/or sound performance data has been modified for installation, appurtenances or accessories, etc. not included in the certified data. The modified performance is not AMCA licensed but is provided to aid in selection and applications of the product."

C.4.3 Required statements on printouts
All required qualifying statements shall appear on any electronic files created, saved or printed by the electronic catalog. The statements shall be adjacent to, or in the same document as referenced certified data. For purposes of this paragraph, a document is defined as a single output file. This document may print on several pages, and must be identified with sequential page counts (ex: Page 1 of 3).

C.5 Certification of electronic performance data

The ratings for each certified product in an electronic catalog shall be based on product test data obtained in accordance with appropriate AMCA International test standards.

When an Electronic Print catalog corresponds to an existing certified Print catalog, there are three possible presentations of the certified data: the Electronic Print is identical to the Print, the Electronic Print is a sub-set of the Print, and the Electronic Print is a super-set of the Print. The sub-set and super-set cases shall be considered new catalogs.

A printed catalog shall not be required for certification of performance data in an electronic catalog. All electronic catalog representations for licensed products that present performance ratings shall be subject to review per this Certified Ratings Program.

C.5.1 Electronic catalog review
AMCA International staff shall review the proposed air and/or sound performance ratings presented in an electronic catalog to verify that it is in agreement with the appropriate test data. AMCA International will advise the applicant if they find any areas in question, or disagreement with the test data, which must then be corrected before a notice of acceptability can be issued.

When changes to the electronic catalog are made, the manufacturer shall clearly identify them for review. Only these changes need to be reviewed, not the complete Product Selector or Electronic Print document. The manufacturer shall provide AMCA International with the revised item on disk or provide the means to obtain it electronically. AMCA International staff shall advise the Licensee if there are any changes or corrections required to meet the requirements of the Certified Ratings Program.

C.6 Version numbers

All electronic catalogs that contain certified data shall include a unique version number and date. The date shall be in the following notation: "January 1993." Both the version number and date shall be visible on the first screen of the electronic catalog. Any change in the certified data of any product within an electronic catalog shall require that any new version of the electronic catalog must be produced with an identifiable change in the version number. Alternatively the electronic catalog can contain revision information that lists dates and descriptions of all revisions made therein.

C.7 Identifying certified performance

In order to identify those products, which are licensed to bear the AMCA Certified Ratings Seal, electronic catalogs shall provide a product directory, which includes all products contained within the electronic catalog. The directory shall clearly identify each product as one of the following:

AMCA Licensed for Air Performance

AMCA Licensed for Sound and Air Performance

AMCA Licensed for Fan Efficiency Grade

Not AMCA Licensed or leave blank

References to licensed products shall include the corresponding Print and/or Electronic Print catalog identification

references. Instructions for access to this product directory shall be included in an easily identifiable manner.

When both certified and non-certified performance is presented together in the viewable area of a screen or in a document, the certified performance must be clearly identified. This shall include explanatory text adjacent to the performance, and may also include visual changes to the presentation of the performance (thickness, color, style, font, etc.).

C.8 AMCA directory listings

Electronic catalogs containing certified data shall be listed in the AMCA Directory of Licensed Products along with printed catalogs for licensed products.

Annex D
Guidelines for Development of Fan Performance Ratings (Informative)

D.1 Introduction

There are a number of factors that affect fan performance ratings when using the Fan Laws to calculate the ratings of fans from the test of a single fan at a single speed.

D.2 Similarity

The following guidelines are intended to provide an understanding of the various factors that affect the calculated fan performance.

D.2.1 Geometricly similar products

Fans are geometrically similar if the surfaces of the fan parts in their airflow passages are geometrically similar. This implies that linear dimensions of those parts and their relative positions are proportional and the angles defining the position and shape of these surfaces are equal. The conditions of proportionality include thickness of the parts completely immerged in the airflow, clearances between impeller and stationary parts, and roughness of the surfaces of fan parts exposed to the airflow. Exact geometric similarity between fans is seldom obtained, but small deviations in similarity are acceptable if they produce performance deviations substantially smaller than the allowable performance tolerance.

Fans covered by this program should be considered similar even if the proportions of impeller hubs (it does not apply to the boss of the impellers of axial fans), fan shafts, fan bearing housings, motors and drives that are in the flow passage vary but result in net flow areas within 7.5% of that derived from proportionality. The effects of bolts, nuts, rivets, etc. should be considered negligible.

The thickness of the fan parts (e.g., single thickness blades and vanes, thin braces etc.) immersed in the airflow should be considered geometrically similar even if they slightly depart from exact proportionality. If the thickness and/or roughness of such parts depart significantly from proportionality then the parts should not be considered geometrically similar unless the fan manufacturer demonstrates through comparison testing that these deviations from similarity produce performance deviations substantially smaller than the allowable performance tolerance.

D.2.2 Kinematic similarity

Complete kinematic similarity between two fans requires that the velocity vectors at corresponding points in the gas stream be proportional in magnitude and equal in direction. This implies geometric similarity, similar flow surface boundary layers, and similar gas density variations. Geometrically similar fans are considered kinematically similar provided that the gas density variations are negligible. This assumption is generally true when the absolute fan pressure ratio does not exceed 1.025 (fan pressure rise of 2.5 kPa (10.0 in. wg)).

D.2.3 Dynamic similarity

Complete dynamic similarity between two fans requires that all forces at corresponding points in their flow field are proportional. This implies Reynolds number and Mach number equality between the test fan and the calculated fan. It is rarely possible to achieve both Reynolds number and Mach number equality between two fans. For fans, it is generally possible to ignore Mach number effects. Variation in Reynolds numbers can be important and should not be ignored in all cases.

Excluding the effects of Reynolds number fans within the scope of their program can be considered kinematically and dynamically similar when they are geometrically similar.

D.3 Compressibility

The general Fan Laws defined in ANSI/AMCA 99 include the effects of compressibility. For incompressible flow, the (K_p/K_{pc}) term is taken as 1. Some effects of compressibility exist in all fan performance, but the effects are small for fan total pressures up to 2.5 kPa (10 in. wg) and are therefore generally ignored for fan performance below this pressure.

The fan manufacturer may use either the compressible or incompressible Fan Laws for conversion of test data to other speeds and sizes; however, it is recommended that the compressible Fan Laws be used to calculate fan performance ratings at static pressures above 2.5 kPa (10 in. wg). In this case, stating the reference barometric pressure is useful.

D.4 Test fan sizes and test speeds

The fan laws are derived assuming that the fan performance is independent of Reynolds number. It has been established that fan performance is not independent of Reynolds number and therefore the effect of Reynolds numbers should be considered in developing fan performance ratings.

Fan Reynolds number is defined as:

$$\mathrm{Re} = \frac{\pi \rho N D^2}{C_R \mu}$$

Where:

		SI	I-P
N	Speed	Rev/sec	rpm
C_R	Constant	1	60
D	Diameter	meters	feet
ρ	Density	kg/m^3	lb/ft^3
μ	Absolute viscosity	N-s/m^2	lbm/ft•s

Fan Reynolds number, Re, at standard air density:

$Re = 0.2073 \times 106 \times ND^2$ (SI)

or

$321.4 \times ND^2$ (I-P)

Fan Reynolds number effects in general vary with the type of fan, appurtenances, and point of operation. The effect of fan Reynolds number on performance decreases with increasing fan Reynolds number, and for every family of geometrically similar units it is possible to define a threshold fan Reynolds number, above which the fan performance is essentially independent of the Reynolds number.

Experimental data has found that the threshold fan Reynolds numbers for various types of fans are approximately:

Airfoil centrifugal and axial fans	2.0×10^6
Backward inclined, flat-bladed centrifugal fans	1.0×10^6
Forward curved centrifugal fans	0.8×10^6
Radial bladed centrifugal fans	0.4×10^6
Propeller fans	0.8×10^6

The effect of fan Reynolds number can generally be disregarded under the following conditions:

1. When the test fan is tested above the threshold Reynolds number and all calculated performance ratings are at or above the threshold Reynolds number.

2. When test fan results are calculated to other speeds that result in Reynolds numbers equal to 0.67 of the test Reynolds number or greater, or to larger sizes that result in Reynolds equal to 0.67 of the test fan Reynolds number or greater.

When calculating to speeds less than the test fan speed or to larger sizes at speeds resulting in Reynolds numbers lower than the test fan, the effect of Reynolds number may become significant and should be evaluated by the fan manufacturer. It is recommended that the test fan be tested at several speeds over the range that will be cataloged, including one test within 5% of the lowest cataloged speed. From these tests the effect of fan Reynolds number can be evaluated to determine correction for fan Reynolds number and should be included in the fan's performance rating. The effects of fan Reynolds number on calculated fan performance can be minimized by careful selection of the test fan speed, or these effects may be accounted for by developing fan Reynolds number factors to be applied to the calculated performance.

Since larger fans tend to perform better than smaller geometrically similar fans, it is advisable to test a number of fan sizes from the geometrically similar series. If not all sizes in the series have been tested then the performance rating of a larger fan can be developed from the test of a smaller fan, e.g. utilizing fan laws.

If a fan series has one or more fans, which are not geometrically similar, then all non geometrically similar fans should be tested for rating.

If the highest blade tip speed within the rated performance range of the fan is equal or lower than 152 m/s (30,000 fpm) then the fan should be tested at a number of speeds within the range or at least should be tested at one speed which should not be higher by more than 5% from the lowest rated speed in the range. The performance for other speeds within the rated performance range should be developed from the closest lower tested speed by using fan laws if only one test speed is used. If more than one test speed is used, fan laws or an interpolation method should be used.

If the lowest blade tip speed within the rated performance range of that fan is higher than 152 m/s (30,000 fpm) then the fan can be tested at a number of speeds within the range or at least should be tested at one speed which should not be lower by more than 5% from the highest rated speed in the range. The performance for other speeds within the rated performance range should be calculated from the closest higher tested speed by using fan laws if only one test speed is used. If more than one test speed is used, fan laws or an interpolation method should be used.

If the highest blade tip speed in the range of the rated performance is higher than 152 m/s (30,000 fpm) and the lowest blade tip speed is lower than 152 m/s (30,000 fpm), the performance range should be divided in two sub-ranges by the speed at which the blade tip speed is equal to 152 m/s (30,000 fpm). In each sub-range the rules from the previous two paragraphs should be applied accordingly.

D.5 Power transmission losses

For fans that are cataloged with power ratings that include the drive loss (bearing drag, V-belt drag losses, coupling losses, losses caused by addition of accessories such as shaft seals, etc.) the power loss of both the bearings and drive elements may be accounted for separately when calculating the test fan rating to other speeds or sizes. The power loss of the drive and bearings of the test fan shall be determined by test, which then can be subtracted from the measured test fan power including the drive loss to obtain the fan power to be used to calculate the test fan data to other speeds or sizes. The actual bearing and drive loss at the calculated speed and size must then be added to the calculated fan power to obtain the cataloged fan power rating. It is the responsibility of the fan manufacturer to establish the actual bearing and drive loss power at calculated conditions by test or from data obtained from the bearing and drive manufacturer. Where input powers are specified it is necessary to account for motor losses.

Fans, other than those where the impeller is mounted on the prime mover shaft, are equipped with bearings and, in some cases, couplings. The power consumed by these components is included in the fan power rating.

Since the power consumed by the bearings does not change with speed and size in the same similarity relationship as the Fan Laws, it is permissible to subtract the bearing loss from the power measurement of the test fan before calculating the fan performance to other speeds or sizes, and then adding back the actual bearing loss for the calculated speed or size. The bearing loss of the test fan can be determined by test. It is the manufacturers responsibility to establish the actual bearing loss power at calculated conditions by test or from data obtained from the bearing manufacturer.

Annex E
Reference Material (Informative)

1. AMCA Publication 802, *Industrial Process and Power Generation Fans: Establishing Performance Using Laboratory Models*

2. Howitt, I., *Geometric Similarity*, AMCA Paper 1065

3. Clarke, M.S., *Dynamic Similarity*, AMCA Paper 1066

4. Bohanon, H.R., *Dimensionless Coefficients*, AMCA Paper 1030

5. Phelan, J.J., Russell, S.H., and Zeluff, W.C., *A Study of the Influence of Reynolds Numbers on the Performance of Centrifugal Fans*, ASME Paper 78-WP/PTC-1, 1978

6. AMCA Publication 11, *Certified Ratings Program, Operating Manual*

Annex F
Summary of Available Rating Methods (Informative)

	A	B	C	D	E	F
Speed	Constant	Constant	As-Run	Constant	As-Run	As-Run
Drive	Belt or Direct	Belt	Belt	Direct	Direct	Direct
Includes Drive Losses	No	Yes	Yes	N/A	N/A	N/A
Input Power	Fan	Fan	Fan	Fan or Motor[1]	Fan or Motor[1]	Volts & Hz Fan/Motor when greater than 500 Watts
Integral Shaft or Bearing	Yes	Yes	Yes	No	No	No
Motor Slip	N/A	N/A	Low	Low	Low	High
Can use Fan Laws for speed & size changes	Yes	Yes	Yes	See Note 2	See Note 2	No

Notes:

1. Agricultural fans (Section 17) catalog cfm/watt.

2. Calculation to other speeds requires measurement of fan input power.

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The Air Movement and Control Association International, Inc. is a not-for-profit international association of the world's manufacturers of related air system equipment primarily, but limited to: fans, louvers, dampers, air curtains, airflow measurement stations, acoustic attenuators, and other air system components for the industrial, commercial and residential markets.