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Certified Ratings Program - Product Rating Manual for Air Control Devices

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC.

The International Authority on Air System Components

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(Revised 8/08)

Certified Ratings Program -
Product Rating Manual for Air Control Devices

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Related AMCA Standards and Publications

Related Amca Publications

Standard 500-D *Laboratory Methods for Testing Dampers for Rating*

Standard 500-L *Laboratory Methods for Testing Louvers for Rating*

Publication 11 *Certified Ratings Program Operating Manual*

Publication 261 *Directory of Products Licensed to Use the AMCA Certified Ratings Seal*

Other AMCA Programs

Publication 111 *Laboratory Accreditation Program*

Applicable Forms

CRP-5 Form *Application for Air Control Certified Ratings Seals*

CRP-A Form *Application for AMCA Certified Ratings Seal*

CRP-B Form *Application for AMCA Certified Rating Seal*

CRP-L Form *Application for AMCA Certified Ratings Seal*

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Certified Ratings Program and Product Rating Manual for Air Control Devices

1. Purpose

The purpose of this manual is to prescribe proper presentation of data and other required technical procedures to be used in connection with the AMCA Certified Ratings Program for Air Control Devices. This manual should be used in conjunction with the current edition of AMCA Publication 11.

2. Scope

The products within the scope of this program are air control devices for use in general ventilation and air conditioning systems.

This program shall apply only to complete catalogued series of sizes. It shall not apply to individual sizes in a series, or part of a series of sizes, or to special units on which catalog ratings are not published.

The AMCA Certified Ratings Seal shall be used only in connection with the specifically licensed device. The AMCA Seal shall be used only on complete units. The application of the AMCA Seal to individual component parts, such as blades, frames, etc. is not permitted.

3. Definitions

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

Appurtenance – Any item in or on the inlet or discharge air stream that affects the performance of the air control device.

An appurtenance should be considered a part of the air control device if it is in place when the device is tested for performance rating, and the effect of the appurtenance is included in the cataloged performance rating.

AMCA Certified Ratings Program – A program for certifying a product's performance ratings, as defined in this document.

Performance rating(s) – Data generated from actual tested products used to derive the certified and published information.

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

Aerodynamically similar – Louvers and dampers are considered to be aerodynamically similar if the profiles of the components in the air stream are geometrically similar. The blades must be in relative position to the frame and the center-to-center dimensions are to be the same. Frame, blade stops and blade profiles may have slight variances due to manufacturing methods. Blades must have the same streamline shape in that their leading and trailing edges must be dimensionally equal. The overall angle or curvature of the blade must be the same. Slight deviations in material thickness shall not reduce the overall free area by more than 5% for dampers and 2.5% for louvers. Blade seals must have the same profile, be of the same durometer, and be secured to the blade in the same manner.

Nameplated products – AMCA 11 allows a company to nameplate another company's product line. For the purposes of this document a company can also nameplate a product line of its own (i.e., sell an identical product line under a different name). The product line must be identical to the original product line. All the requirements of AMCA 11 for licensing a nameplated product line would also apply.

3.1 Symbols

Symbol	Description
PL 1	Device inlet plane
PL 2	Device outlet plane
P_s	Static pressure
P_t	Total pressure
ΔP	Pressure drop or pressure differential

4. Data Submittal Requirements

AMCA staff shall accept for review only test data obtained in an AMCA Accredited Laboratory or the AMCA Laboratory in accordance with one or more of the test standards recognized in AMCA Publication 111 *Laboratory Accreditation Program*.

For each product category covered by this program, a separate Product Rating Requirement Subsection of testing and rating requirements is included as part of this document. The specific procedure and test data necessary for preparing performance ratings is defined in these product sections.

The following data shall be submitted with the CRP-5 application form:

4.1 Test data for each test conducted must conform to the test standard used.

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

4.3 Performance curve(s) of the test results, with test points identified. Curves shall be in accordance with the test standard used.

4.4 Dimensional drawings of each size of the product line, giving the dimensions specified in the applicable section for the type of product being submitted.

4.5 Photograph of each test setup.

5. Catalog Requirements

5.1 Required qualifying statements

In addition to the performance data specified for each product, qualifying statements shall be published to assist the user in applying the ratings information correctly.

The required qualifying statements are contained in this section and in Product Rating Requirement SubSections.

5.1.1 Statement required adjacent to the seal. 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:

"(Licensee's name) certifies that the (product designation) shown hereon (or herein) is licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 511 and comply with the requirements of the AMCA Certified Ratings Program."

5.1.1.1 Licensed water penetration and air performance. When water penetration ratings are licensed to use the AMCA Water Penetration Seal and are shown with licensed air performance ratings, the following additional statement shall be printed prominently and immediately adjacent to the reproduction of the AMCA Seal and the statement to the AMCA Seal (see Section 5.1.1 for the Seal statement):

"The AMCA Certified Ratings Seal applies to Air Performance ratings and Water Penetration ratings."

5.1.1.2 Licensed air performance only. When air performance ratings are licensed to use the AMCA Air Performance Seal, the following statement shall be shown immediately adjacent to the rating tables:

"The AMCA Certified Ratings Seal applies to Air Performance ratings only."

5.1.1.3 Licensed air leakage only. When air leakage ratings are licensed to use the AMCA Air Leakage Seal, the following statement shall be shown immediately adjacent to the ratings tables:

"The AMCA Certified Ratings Seal applies to Air Leakage ratings only."

5.1.1.4 Licensed air leakage and air performance. When air leakage ratings are licensed to use the AMCA Air Leakage Seal and are shown with licensed air performance ratings, the following statement shall be shown immediately adjacent to the rating tables:

"The AMCA Certified Ratings Seal applies to Air Leakage ratings and Air Performance ratings."

5.1.1.5 Licensed wind-driven rain and air performance. When wind-driven rain ratings are licensed to use the AMCA Wind-Driven Rain Seal and are shown with licensed air performance ratings, the following statement shall be shown immediately adjacent to the rating tables:

"The AMCA Certified Ratings Seal applies to Wind-Driven Rain ratings and Air Performance ratings."

5.1.1.6 Licensed sound and air performance. When sound ratings are licensed to use the AMCA Sound Seal and are shown with licensed air performance ratings, the following statement shall be shown immediately adjacent to the rating tables:

"The AMCA Certified Ratings Seal applies to Sound ratings and Air Performance ratings."

5.1.1.7 Licensed water penetration, air performance and wind-driven rain. When water penetration ratings are licensed to use the AMCA Water Penetration Seal and are shown with licensed air performance and wind-driven rain ratings, the following statement shall be shown immediately adjacent to the rating tables:

"The AMCA Certified Ratings Seal applies to Water Penetration, Air Performance and Wind-Driven Rain ratings."

5.1.1.8 Licensed water penetration, air performance and sound. When water penetration ratings are licensed to use the AMCA Water Penetration Seal and are shown with licensed air performance and sound ratings, the following statement shall be shown immediately adjacent to the rating tables:

"The AMCA Certified Ratings Seal applies to Water Penetration, Air Performance and Sound ratings."

5.1.2 Appurtenances. Where the published ratings include the effect of an appurtenance a statement shall be placed adjacent to the ratings such as:

"Ratings include the effect of an internally mounted actuator."

6. General Guidelines for Air Control Products

6.1 Manufacturer's responsibility

It is incumbent on the air control product manufacturers to develop catalog performance ratings of the licensed products so that the product provided to their customers performs within the tolerances allowed by the Certified Ratings Program.

This section provides general guidelines on the process of developing air performance ratings from tests, and the other separate Product Rating Requirement Sections define specific requirements for each type of product.

6.2 AMCA Staff responsibility

AMCA staff is responsible for the administration of the Certified Ratings Program by verifying that the performance ratings developed by the manufacturer were done 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.

6.3 Definitions

Definitions of specific product types are contained in the appropriate Product Rating Requirements Sections.

6.4 Rating development

The performance rating of an air control product or a series of similar products are developed from tests conducted in accordance with AMCA Standards 500-D or 500-L.

7. Check Test Tolerances

7.1 Check tests

The licensee shall maintain or cause to be maintained such manufacturing control of licensed devices manufactured by or for the licensee that, when tested in accordance with AMCA Standards 500-D or 500-L, the following tolerances shall be maintained:

7.1.1 Air performance. For air performance, the airflow at any rated pressure differential shall not be less than 90.0% of the rated airflow. If wind-driven rain is certified, a discharge loss coefficient is required (see Section 7.1.5).

7.1.2 Water penetration. For water penetration of louvers, the airflow at the point of the beginning of water penetration shall not be less than 90% of the rated airflow.

7.1.3 Air leakage. For air leakage performance, the airflow at any ΔP_s shall be less than or equal to the corresponding airflow requirement for its rated class.

7.1.4 Air leakage for spiral duct. For air leakage performance, the airflow at the rated pressure shall be less than or equal to the rating plus one cfm per 100 ft^2 of duct wall surface area.

7.1.5 Free area. The louver free area shall measure within ±5% of the published value. The published value shall be no more than the value obtained during the initial certification test or latest check test.

7.1.6 Wind-driven rain. For wind-driven rain, check test tolerances are listed in the following table:

Wind-Driven Rain Check Test Minimum Acceptable Efficiencies	
CLASS	EFFECTIVENESS
A	98%
B	90%
C	75%

Discharge loss coefficient for louvers shall not be less than 90% of the minimum value in its class.

7.1.7 Sound rating. For sound rating, the free field noise reduction ratings of the check test unit shall not be less than the published ratings minus 3 dB in each octave band.

8. Air Performance, Water Penetration and Wind-Driven Rain Product Rating Requirements for Louvers

8.1 Testing requirements

All devices tested under this section of the Certified Ratings Program shall be products AS-BUILT, unpainted, cleaned, degreased, and without additional factory-applied coating on the product surfaces which would enhance water-shedding capability. All devices tested shall be in the full open position without a screen across the air passages of the louver.

8.1.1 All testing for pressure drop determinations of louvers shall be per AMCA Standard 500-L, Figure 5.4 or Figure 5.5. Only 1220 mm x 1220 mm (48 in. x 48 in.) louvers shall be tested.

8.1.2 All testing for water penetration determination of louvers shall be in accordance with AMCA Standard 500-L, Figure 5.6. The minimum water flow rate on the wetted wall shall be 16 mL/s (0.25 gpm). The minimum droplet flow from the water flow drop manifold shall be 102 mm/hr (4 in./hr). The louver sample used for the water penetration determination shall be the same as used for the pressure drop determination.

8.1.3 All testing for wind-driven rain water penetration shall be performed in accordance with AMCA 500-L, Figure 5.11. The flow rate of water shall be 75 mL/hr (3 in./hr) at a wind velocity of 13 m/s (29 mph) with an optional extended rating at 200 mL/hr (8 in./hr) and 22 m/s (50 mph).

8.2 Calculated performance

8.2.1 Air Performance of any size louver may be calculated from tests of one size for the same design type using free area velocity versus ΔP_s within the limits of extrapolation of test data specified in Section 8.3.1.1.

8.2.1.1 Where the design blade spacing varies with size, the manufacturer shall submit test data from tests of both the closest and the widest blade spacing to show that all test data will fall within the specified tolerance.

8.2.2 Water penetration tests shall be based on tests run on a 1220 mm x 1220 mm (48 in. x 48 in.) square louver. Tests may be run on a single size for a given design type. The point of the beginning of water penetration for all sizes of that design shall be considered to be at the same free area velocity as the tested unit (see Annex C).

8.2.3 Wind-Driven Rain tests shall be based on tests run on a 990 mm x 990 mm (39 in. x 39 in.) (core area) louver or a 1220 mm x 1220 mm (48 in. x 48 in.) (outside dimension) square louver.

8.3 Published ratings

8.3.1 Air performance. Published ratings of air performance shall be a statement of the maximum ΔP_s for a specified airflow rate at standard air density and the AMCA figure or figures tested to. Pressure drop information shall be presented rounded to the nearest Pascal (example; 5 Pa or 32 Pa, not 5.1 Pa or 32.4 Pa) if using SI units in literature or presented with a maximum of two digits after the decimal point (example; 0.02 in. wg or 0.13 in. wg, not 0.025 in. wg or 0.134 in. wg) if using Inch-Pound units (I-P).

8.3.1.1 For the purpose of publishing ratings, extrapolation from test data is permissible. The portion of the curve obtained by extrapolation shall be charted with a broken line and must be a smooth continuation of the adjacent portion of the curve. The static pressure drop shall not be extrapolated more than 50 percent of the range of the test either upwards or downward. In addition, the louver test

Table 1 – Penetration Classification

Class	Effectiveness	Maximum allowed penetration of simulated rain, l/h/m^2 (oz/h/ft^2)	
		75 mm/hr (3 in./hr) rainfall & 13 m/s (29 mph) wind velocity	202.4 mm/hr (8 in.) rainfall & 22 m/s (50 mph) wind velocity
A	100% to 99%	0.75 (2.36)	4 (12.6)
B	98.9% to 95%	3.75 (11.8)	20 (67.8)
C	94.9% to 80%	15.0 (47.1)	80 (251)
D	Below 80%	Greater than 15.0 (47.1)	Greater than 80 (251)

These classifications apply at various core velocities.

size shall be included on published results of each catalog series.

8.3.1.2 The published ratings shall indicate the mode tested (intake or exhaust) or test data will be provided to AMCA that indicates that the data published is worst case.

8.3.2 Water penetration performance. Published ratings of water penetration performance of louvers shall be a statement of the free area velocity at which the beginning of water penetration occurs. The point of the beginning of water penetration shall be the velocity at the intersection of a simple linear regression of test data and the line of 3 mL water per square meter of free area (0.01 ounces water per square foot of free area).

The following formula is used for the simple linear regression:

$$Y = B_0 + B_1(\ln X)$$

Where:

Y= Free air velocity, m/s (fpm), result for plot of curve.

X= Water penetration, mL/m^2 (oz/ft^2), defined

And:

$$B_0 = \overline{Y}_i - B_1\overline{X}_i$$

$$B_1 = \frac{S_{xy}}{S_{xx}}$$

$$S_{xy} = \sum_{i=1}^{n}\left[(\ln X_i)Y_i\right] - \frac{\sum_{i=1}^{n}(Y_i)\sum_{i=1}^{n}(\ln X_i)}{n}$$

$$S_{xx} = \sum_{i=1}^{n}\left[(\ln X_i)^2\right] - \frac{\left[\sum_{i=1}^{n}(\ln X_i)\right]^2}{n}$$

X_i = Water penetration, mL/m^2 (oz./ft^2), at test point *i*

Y_i = Free area velocity, m/s (fpm), at test point *i*

$\overline{X}_i$ = Average (ln X_i) for *n* test points

$\overline{Y}_i$ = Average Y_i for *n* test points

n = Number of points used for regression analysis
Certified air performance is required prior to water penetration certification.

8.3.2.1 Published ratings may be shown as a curve of water penetration provided the curve is in accordance with the regression formula shown in Section 8.3.2. The grid ordinate shall be from 0 to 100 mL (0 to 0.3 oz) of water carry over per m^2 (ft^2) free area; minimum abscissa velocity shall start on an even 0.5 m/s (100 fpm) more than 0.3 m/s (60 fpm) below the velocity at the beginning of water penetration; the maximum abscissa velocity shall be up to 0.5 m/s (100 fpm) past the 100 mL (0.3 oz) of water per m^2 (ft^2) of free area with a maximum velocity of 6.5 m/s (1300 fpm) (see Annex C). The starting point of the water carryover curve shall be at 3 mL (0.01 oz) of water per m^2 (ft^2) of free area. The starting point of the curve shall be marked and/or labeled as the beginning point of water carryover, in m/s (fpm), along the 'X' axis legend. In addition, the louver test size and test duration shall be included on published results of each catalog series.

8.3.2.2 For drainable blade louvers that are separated by an architectural or recessed mullion: (1) if the mullion contains provisions to drain water from the blades and head members away from the airstream, and if louver has been tested for water penetration, the use of the AMCA Certified Rating Seal on this design is authorized when louver section falls within the catalog data, (2) if the architectural mullion does not contain provisions to drain water from the blades and head members, the use of AMCA Certified Rating Seal is not authorized.

8.3.3 Wind-driven rain performance. Published ratings for weather louvers shall be classified by their ability to reject simulated rain. Required ratings shall include wind velocity, rainfall rate, core velocity, effectiveness ratio, penetration class and discharge loss coefficient class as shown in Annex D.

8.3.3.1 Table 1 shows different classifications based on the maximum simulated rain penetration per square meter of louver. The effectiveness is determined in accordance with AMCA 500-L.

Water penetration rating at a given louver face velocity is determined by the water penetration while the louver is subjected to a selected simulated rainfall rate and wind velocity.

8.3.3.2 The discharge loss coefficient given in Table 2, shall be determined in accordance with AMCA 500-L.

8.3.4 Free area. Published ratings of air performance, water penetration and wind-driven rain shall include a table of louver free area for the product line using a maximum increment of 305 mm (12 in).

9. Leakage Product Rating Requirements for Adjustable Louvers

9.1 Testing requirements

9.1.1 All testing for air leakage through closed adjustable louvers shall be per AMCA Standard 500-L, Figure 5.4 or Figure 5.5.

9.1.2 A minimum of two tests shall be conducted on each sample. The adjustable louver shall be cycled to full open and back to full closed between each test.

9.2 Calculated performance

9.2.1 Air leakage performance of any size louver may be calculated from tests on no less than three sizes (single panel design) of the same design using a plot of L/s per m^2 (cfm/ft^2) of face area versus ΔP_s that reflects the largest value ofof L/s per m^2 (cfm/ft^2) air leakage of the louvers tested at each value of ΔP_s (see Annex E).

9.2.2 The following test sizes shall be required for test data:

a) Minimum width - maximum height
b) Maximum width - minimum height
c) Maximum width - maximum height

9.2.3 Extrapolation above the maximum test ΔP_s or below the minimum test ΔP_s shall not be permitted.

9.2.4 Extrapolation outside the test sizes shall not be permitted.

9.2.5 Where the design blade spacing varies, the manufacturer shall submit test data from tests of both the closest and widest blade spacing to show that all test data will fall within the specified tolerances.

9.3 Published ratings

9.3.1 Published ratings of air leakage performance shall be a statement of the maximum tested air leakage flow at a specified ΔP_s, a specified torque, and standard air density.

A statement shall say data are based on [the greater of: a seating torque of____ N•m/m^2 (lbf-in./ft^2) or force of ____ N (lbf); or the minimum torque or force) applied to hold the louver in the closed position. Any number above 0.2 would be the next higher number (Example: 25.2 mL/s/m^2 = 25 mL/s/m^2 and 25.3 mL/s/m^2 = 26 mL/s/m^2 (or 5.2 cfm/ft^2 = 5 cfm/ ft^2 and 5.3 cfm/ft^2 = 6 cfm/ft^2)].

A table showing the “opening torque“ may be included on the same page provided it is so labeled.

9.3.2 The rating shall indicate the mode tested (intake or exhaust) or test data will be provided to AMCA that indicates that the data published is worst case.

9.3.3 The method of torque calculations shall be clearly identified in the published data.

9.3.4 Published data shall clearly identify the certified product.

9.3.5 Published data shall state that air leakage is based on operation between 10°C - 40°C (50°F - 104°F).

10. Air Performance Product Rating Requirements for Dampers

10.1 Testing requirements

10.1.1 All testing for pressure drop determinations of single blade, multi-blade or curtain dampers in the full open position shall be per at least one AMCA Standard 500-D, Figure 5.1, 5.2, 5.3, 5.4, or 5.5.

10.1.2 The following sizes shall be tested for square and rectangular dampers:

a) 305 mm x 1220 mm (12 in. x 48 in.)
b) 305 mm x 305 mm (12 in. x 12 in.)
c) 610 mm x 610 mm (24 in. x 24 in.)
d) 914 mm x 914 mm (36 in. x 36 in.)
e) 1220 mm x 305 mm (48 in. x 12 in.)

The tolerance is +0, -6 mm (+0, -0.25 in.). If the maximum single section size is less than that shown above, a multi-section damper shall be tested if

Table 2 – Discharge Loss Coefficient Classification
(Note: The above also applies to entry loss coefficient)

Class	Discharge Loss Coefficient
1	0.4 and above
2	0.3 to 0.399
3	0.2 to 0.299
4	0.199 and below

offered by the manufacturer. If any of the sizes listed above are not offered by the manufacturer, those sizes are not required to be tested or listed. A minimum of one of the sizes listed above must be tested for a product line to be eligible for certification.

10.1.3 The following sizes (diameter) shall be tested for round dampers:

a) 305 mm (12 in.)
b) 610 mm (24 in.)
c) 914 mm (36 in.)

If the maximum size of the damper is smaller than 36 in. diameter, three dampers must be tested including the largest and smallest size plus a size midway between the two tested sizes.

10.2 Calculated performance

10.2.1 Extrapolation below the minimum test ΔP's shall be permitted (pressure drop vs. airflow plot).

10.2.2 Extrapolation above the maximum test ΔP's shall not be permitted.

10.2.3 Extrapolation outside of test sizes shall not be permitted.

10.3 Published ratings

Published ratings of air performance shall be a statement of the maximum ΔP_s for a specified airflow rate and at standard air density and the AMCA figure or figures tested for all required sizes. Ratings shall be published in tabular form, graphical form or both. See Annex F. Pressure drop information shall be presented rounded to the nearest Pascal (example; 5 Pa or 32 Pa, not 5.1 Pa or 32.4 Pa) if using SI units in literature or presented with a maximum of two digits after the decimal point (example; 0.02 in. wg or 0.13 in. wg not 0.025 in. wg or 0.134 in. wg) if using Inch-Pound units (I-P).

11. Leakage Product Rating Requirements for Dampers (Excluding Backdraft & UL Classified Dampers)

11.1 Testing requirements

11.1.1 All tests for air leakage through closed single-blade or multi-blade control dampers shall be per AMCA Standard 500-D, Figure 5.4, 5.5, or 5.8.

11.1.2 A minimum of two tests shall be conducted on each setup. The dampers shall be cycled between full open and full closed between each test.

11.1.3 The testing shall include air leakage in both modes: pressure in the direction of airflow and back pressure.

11.2 Calculated performance

11.2.1 The following test sizes shall be required for each matrix for test data:

a) 305 mm x 305 mm (12 in. x 12 in.)
b) 610 mm x 610 mm (24 in. x 24 in.)
c) 914 mm x 914 mm (36 in. x 36 in.)
d) 305 mm x 1220 mm (12 in. x 48 in.)
e) 1220 mm x 305 mm (48 in. x 12 in.)
f) Max width x 914 mm (Max width x 36 in.)

The tolerance is +0, -6 mm (+0, -0.25 in.). If the maximum single section size is less than that shown above, a multi-section damper shall be tested if offered by the manufacturer. If any of the sizes listed above are not offered by the manufacturer, those sizes are not required to be tested or listed. A minimum of one of the sizes listed above must be tested for a product line to be eligible for certification.

11.2.2 Extrapolation above the maximum test ΔP_s or below the minimum ΔP_s shall not be permitted.

11.2.3 Damper (round or round-isolation)

11.2.3.1 The minimum size damper and the maximum size damper to be rated shall be tested.

11.2.3.2 Extrapolation above the maximum test ΔP_s or below the minimum ΔP_s shall not be permitted.

11.2.3.3 Extrapolation outside the range of test sizes shall not be permitted.

11.3 Published rating

11.3.1 Published ratings of air leakage performance, except for an isolation damper, shall be a statement of the appropriate class at the specified pressure, specified torque, and standard air density. A statement shall indicate data is based on (the greater of: a seating torque of ____ N•m/m^2 (lbf-in./ft^2) or force of ____ N (lbf); or the minimum torque (or force) applied to hold the damper in the closed position.

A table showing the "opening torque" may be included on the same page provided it is so labeled.

11.3.2 Isolation damper airflow leakage performance shall be presented as follows:

Zero airflow leakage (Test per Section 8.2.3.2)

- for an individual damper:

"Zero airflow leakage (bubble test) was attained under _____ Pa (in. wg) pressure at [a seating torque of _____ N•m/m^2 (lbf-in./ft^2), or a force of ____ N (lbf), whichever is greater] applied to hold the damper in the closed position."

- for a range of damper sizes:

"Zero airflow (bubble test) leakage was attained under ____Pa (in. wg) pressure at [a seating torque of ____N•m/m^2 (lbf-in./ft^2) face area, or a force of ____ N (lbf) face area, whichever is greater] applied to hold the damper in the closed position."

11.3.3 For non-isolation dampers, the rating shall show the maximum air leakage class from all sizes tested in both modes (pressure in direction of flow, and back pressure). See Table 3.

11.3.4 The method of torque or force calculation shall be clearly identified in the published data.

11.3.5 Published data shall clearly identify the certified product.

11.3.6 Published data shall state that air leakage classification is based on operation between 10°C - 40°C (50°F - 104°F).

11.3.7 To publish air leakage ratings, air performance ratings in the full open position shall be published in accordance with Annex G.

12. Leakage Product Ratings Requirements for UL Classified Dampers Only

12.1 Testing requirements

12.1.1 All testing for air leakage through closed single-blade, multi-blade or curtain type UL Classified dampers shall be per AMCA Standard 500-D, Figure 5.4, or Figure 5.5 or Figure 5.9.

12.1.2 A first test shall be conducted with the appropriate springs, actuators or other closing devices normally supplied with the UL Classified damper, applying the closing torque or force with zero ΔP_s across the damper.

12.1.3 After the first test the damper shall be cycled open and closed. During this cycle, the highest UL rated velocity shall be applied across the open damper and the highest UL rated ΔP_s shall be applied across the closed damper.

12.1.4 A second test shall be conducted after the damper has been reclosed.

12.1.5 The testing shall include air leakage in both modes; pressure in the direction of airflow and back pressure.

12.2 Calculated performance

12.2.1 Air leakage performance of any size damper may be calculated from tests of no less than three sizes (single panel design) of the same design, using the largest value of m^3/s/m^2 (cfm/ft^2) air leakage of the dampers tested at each value of ΔP_s.

12.2.2 The following test sizes shall be required for each matrix for test data:

a) Minimum width - maximum height
b) Maximum width - minimum height
c) Maximum width - maximum height

12.2.3 Extrapolation above the maximum test ΔP_s or below the minimum ΔP_s shall not be permitted.

12.2.4 Extrapolation outside the test sizes shall not be permitted.

12.2.5 Round damper

12.2.5.1 The minimum size damper and the maximum size damper to be rated shall be tested.

Table 3 - Leakage Classification

The following classes shall be used:

	Leakage, L/s/m^2 (cfm/ft^2)			
Pressure/Class	Required Ranges		Extended Ranges (Optional)	
	0.25 kPa (1 in. wg)	1.0 kPa (4 in. wg)	2.0 kPa (8 in. wg)	3.0 kPA (12 in. wg)
1A	15.2 (3)	N/A	N/A	N/A
1	20.3 (4)	40.6 (8)	55.9 (11)	71.1 (14)
2	50.8 (10)	102 (20)	142 (28)	178 (35)
3	203 (40)	406 (80)	569 (112)	711 (140)

12.2.5.2 The airflow leakage performance of any size damper may be calculated from the test of no less than two dampers of the same design, using the largest value of $m^3/s/m^2$ (cfm/ft^2) airflow leakage through the dampers tested at each value of ΔP_s.

12.2.5.3 Extrapolation above the maximum test ΔP_s or below the minimum ΔP_s shall not be permitted.

12.2.5.4 Extrapolation outside the range of test sizes shall not be permitted.

12.3 Published rating

12.3.1 Published rating of air leakage shall be a statement of the UL 555S published rating class.

12.3.2 Published data shall show the maximum air leakage class in both modes of flow; (i.e., pressure in direction of flow and back pressure).

12.3.3 Published data shall clearly identify the product.

12.3.4 To publish air leakage ratings, air performance ratings in the full open position shall be published. Air performance tests are to be performed on the following sizes:

a) 305 mm x 305 mm (12 in. x 12 in.)
b) 610 mm x 610 mm (24 in. x 24 in.)
c) 914 mm x 914 mm (36 in. x 36 in.)
d) 305 mm x 1220 mm (12 in. x 48 in.)
e) 1220 mm x 305 mm (48 in. x 12 in.)

Or the max single section width up to 914 mm (36 in.) in accordance with Section 10.

13. Leakage Product Rating Requirements for Backdraft Dampers

13.1 Testing requirements

13.1.1 All testing for air leakage through vertically mounted dampers shall be per AMCA Standard 500-D, Figure 5.4 or Figure 5.5.

13.1.2 All testing for air leakage through horizontally mounted dampers shall be per AMCA Standard 500-D, Figure 5.7A or Figure 5.7B with the airflow closing the damper.

13.1.3 Prior to testing for leakage the damper shall be opened 15° and allowed to close under its own force with zero ΔP_s across the damper.

13.1.4 The testing shall be conducted from the lowest rated differential pressure up to the highest.

13.1.5 A minimum of two tests shall be conducted on each sample. Between each test the damper shall be opened 15° and allowed to close under its own force with zero ΔP_s across the damper. If a motor is used, the damper shall be cycled from its full open to its full closed position between tests.

13.2 Calculated performance

13.2.1 Air leakage performance of any size damper may be calculated from tests of no less than three sizes (single panel design) of the same design, using a plot of $m^3/s/m^2$ (cfm/ft^2) of face area versus ΔP_s that reflects the largest value of $m^3/s/m^2$ (cfm/ft^2) air leakage in the dampers tested at each value of ΔP_s (see Annex C).

13.2.2 The following test sizes shall be required for each matrix for test data:

a) Minimum width - maximum height
b) Maximum width - minimum height
c) Maximum width - maximum height

13.2.3 Extrapolation above the maximum test ΔP_s or below the minimum ΔP_s shall not be permitted.

13.2.4 Extrapolation outside the test sizes shall not be permitted.

13.2.5 Round damper

13.2.5.1 The minimum size damper and the maximum size damper to be rated shall be tested.

13.2.5.2 The airflow leakage performance of any size damper may be calculated from the test of no less than two dampers of the same design, using a plot of $m^3/s/m^2$ (cfm/ft^2) face area vs. the ΔP_s that reflects the largest value of $m^3/s/m^2$ (cfm/ft^2) airflow leakage through the dampers at each value of ΔP_s.

13.2.5.3 Extrapolation above the maximum test ΔP_s or below the minimum ΔP_s shall not be permitted.

13.2.5.4 Extrapolation outside the range of test sizes shall not be permitted.

13.3 Published rating

13.3.1 Published rating of air leakage performance shall be a statement of the maximum tested air leakage flow rate at a specified ΔP_s at standard air density.

13.3.2 Published data shall show the test figure and airflow direction used during testing and shall clearly

identify the certified product.

13.3.3 Published data shall state that air leakage is based on operation between 10°C - 40°C (50°F - 104°F).

13.3.4 Air performance ratings may be published in accordance with Section 10.3.

14. Product Rating Requirements for Acoustical Louvers

14.1 Testing requirements

14.1.1 All transmission loss acoustical testing shall be in accordance with ASTM E90. Only 1220 mm x 1220 mm (48 in. x 48 in.) louvers shall be tested.

14.1.1.2 The transmission loss (dB) shall be determined for the 2nd thru 7th octave bands.

14.1.2 All testing for pressure drop determinations of louvers shall be per AMCA Standard 500-L (Fig. 5.4 or Fig. 5.5). Only 1220 mm x 1220 mm (48 in. x 48 in.) louvers shall be tested.

14.2 Calculated performance

14.2.1 Air performance of any size louver may be calculated from tests of one size for the same design type using free area velocity versus ΔP_s within the limits of extrapolation of test data specified in Section 8.3.1.1.

14.2.1.1 Where the design blade spacing varies with size, the manufacturer shall submit test data from tests of both the closest and widest blade spacing to show that all test data will fall within the specified tolerance for both static pressure drop and acoustical ratings.

14.3 Published ratings

14.3.1 Published acoustical ratings shall include pressure drop ratings on the louver.

14.3.2 Acoustical ratings shall be stated as free field noise reduction (dB) in the 2nd thru 7th octave bands. Free field noise reduction shall be determined by adding 6 dB to the transmission loss (dB).

14.3.3 Published ratings of air performance shall be a statement of the maximum ΔP_s for a specified airflow rate at standard air density and the AMCA figure or figures tested to. Pressure drop information shall be presented rounded to the nearest Pascal if using SI units in literature or presented with a maximum of two digits after the decimal point if using Inch-Pound units (I-P).

14.3.3.1 For the purpose of publishing ratings, extrapolation from test data is permissible. The portion of the curve obtained by extrapolation shall be charted with a broken line and must be a smooth continuation of the adjacent portion of the curve. The static pressure drop shall not be extrapolated more than 50 percent of the range of the test either upwards or downward. In addition, the louver test size shall be included on published results of each catalog series.

14.3.3.2 The published ratings shall indicate the mode tested (intake or exhaust) or test data will be provided to AMCA that indicates that the data published is worst case.

14.3.4 Published ratings shall include a table of louver free area for the product line using a maximum increment of 305 mm (12 in.).

15. Air Performance Product Rating Requirements for Gravity Ventilators (Excluding Louver Penthouses)

15.1 Testing requirements

15.1.1 All testing for pressure drop determinations of gravity ventilators shall be per AMCA Standard 500-L, Figure 5.4 or 5.5. For Figure 5.4 testing, the outlet chamber shall have a cross-sectional area at least nine (instead of fifteen) times the throat area of the device being tested.

A test shall consist of five or more determinations taken at approximately equal increments of airflow rate covering the range desired.

15.1.2 Gravity ventilators shall be tested with screens installed.

15.1.3 The following throat sizes shall be tested for square and rectangular gravity ventilators: 305 mm x 305 mm (12 in. x 12 in.), 458 mm x 458 mm (18 in. x 18 in.), 610 mm x 610 mm (24 in. x 24 in.), 763 mm x 763 mm (30 in. x 30 in.), 915 mm x 915 mm (36 in. x 36 in.) and 1220 mm x 1220 mm (48 in. x 48 in.). If any of these sizes are not offered by the manufacturer, those sizes are not required to be tested or listed. A minimum of one of the listed sizes must be tested to be eligible for licensing.

15.1.4 For round gravity ventilators, a minimum of three throat sizes must be tested, including the smallest, largest, and one size midway in between. If less than three sizes are offered by the manufacturer,

A Throat Inside Diameter
C Hood Size
E Height Above Base
F Hood Height

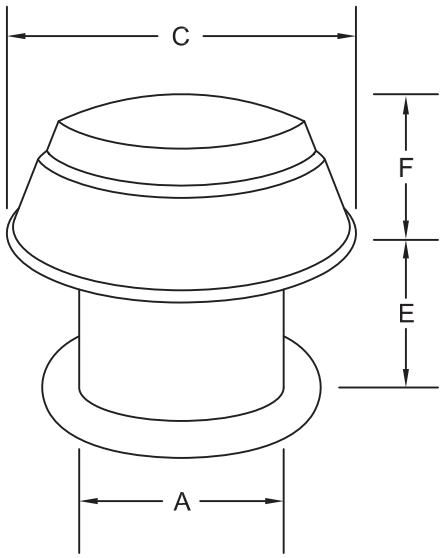


Figure 15.1 - Gravity Ventilator with Round Hood

A or B Throat Inside Dimension
C or D Hood Size
E Hood Height
F Height Above Base

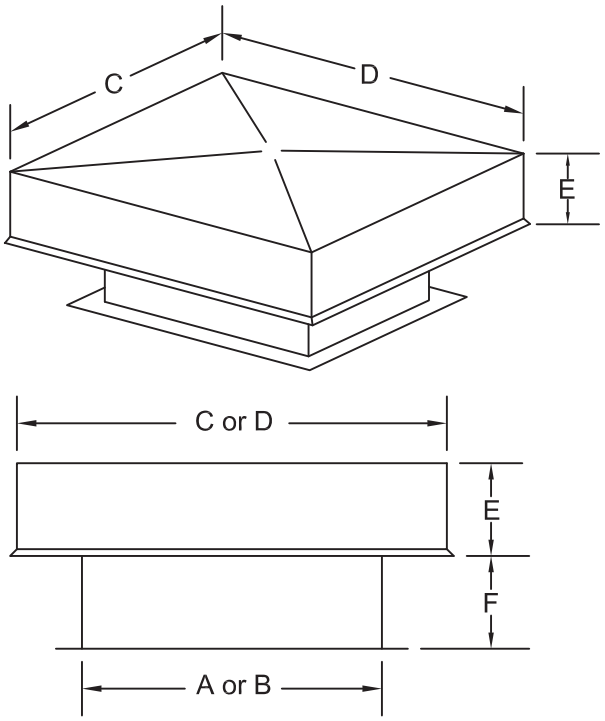


Figure 15.2 - Gravity Ventilator with Rectangular and Square Hoods

all sizes must be tested to be eligible for licensing.

15.2 Calculated performance

15.2.1 Air performance of any size gravity ventilator may be calculated from data of a tested size. The manufacturer is responsible for ensuring proper corrections are made to account for aspect ratio changes, changes in hood dimenions, etc.

15.2.2 Extrapolation above the maximum and below the minimum test pressure shall not be permitted.

15.3 Published ratings

15.3.1 Published ratings of air performance shall be a statement of the maximum ΔP_s for a specified airflow rate at standard air density, and the AMCA figure or figures tested for all required sizes. Ratings shall be published in tabular form, graphical form, or both, and shall include the figure the gravity ventilator was tested in accordance with. Pressure drop information shall be presented rounded to the nearest Pascal if using SI units in literature, or presented with a maximum of two digits after the decimal point if using Inch-Pound units (I-P).

15.3.2 The type of screen installed on the unit during the test shall be listed in the required appurtenance statement, per Section 5.1.3.

15.3.3 The published ratings shall indicate the mode tested (intake or relief).

15.3.4 The published ratings shall include a list of the tested size(s) as described in Section 15.1.3 or 15.1.4.

16. Air Performance Product Rating Requirements for Spiral Ducts

16.1 Testing requirements

16.1.1 All spiral duct air leakage testing shall be in accordance with Section 7 of ANSI/ASHRAE/SMACNA Standard 126-2000.

16.1.2 The test sample shall consist of a 600 mm (24 in.) diameter by 3000 mm (120 in.) long section of spiral duct. The ends shall be capped and sealed by the manufacturer and shall also include two pipe to barb fitting receptacles.

16.1.3 A bubble test shall be conducted prior to the leakage test to ensure there is no end cap leakage. See ANSI/AMCA 500-D-07 Section 8.2.3.2.

16.1.4 Testing shall be performed at 1.5 times the normal maximum design pressure of 2.5 kPa (10 in. wg). Testing is optional on 28, 26, 24, 22, 20, 18, 16, and 14 gauge ducts; however, testing must include all gauges that a manufacturer produces.

If the manufacturer only makes a limited number of gauges, the literature must clearly state that only the gauges certified are covered.

16.2 Calculated performance

16.2.1 Air leakage performance shall be corrected from actual conditions to standard conditions using the equations shown in ANSI/ASHRAE/SMACNA Standard 126-2000 Section 7.4.

16.2.2 The calculated air leakage performance in m^3/hr (cfm) shall be converted to m^3/hr per 9.29 m^2 (cfm per 100 ft^2) of duct wall surface.

16.3 Published ratings

16.3.1 Published rating of air leakage performance shall be a statement of the maximum tested air leakage flow rate for each gauge at 3.75 kPa (15 in. wg) ΔP_s in m^3/hr per 9.29 m^2 (cfm per 100 ft^2) of duct wall surface area at standard air density.

16.3.2 Published data shall state the length, gauge and diameter of the test sample.

16.3.3 Published data shall state that air leakage is based on testing conducted between 10ºC - 40ºC (50ºF - 104ºF).

16.3.4 Published data shall clearly identify the certified product.

16.3.5 Each gauge of spiral duct published in a catalog must be certified.

Annex A. Electronic Catalogs

A.1 Introduction

This annex covers the special requirements for licensing electronic catalogs under the AMCA Certified Ratings Program for air control devices (AMCA Publication 511).

Any computer program, set of instructions, screen display or computer generated printout that provides air performance, air leakage, sound or water penetration data for an air control device shall be designated an electronic catalog.

A.2 Scope

Performance data for all products that can be licensed by AMCA to use the AMCA Certified Ratings Seal for air performance, air leakage, sound or water penetration in accordance with the requirements of AMCA Publication 511.

With the exceptions of the requirements covered in this annex, all other requirements outlined in AMCA Publication 511 must be met when certifying performance in an electronic catalog.

A.3 Allowable performance modifications

A.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 than standard air 1.201 kg/m^3 (0.075 lbm/ft^3) because of temperature, elevation, humidity, molecular weight or a combination of these factors.

Correction for known densities other than standard air are allowable, provided that the density effects are calculated as published in Section 4, AMCA Publication 200.

Corrections for elevations and temperatures other than standard conditions (sea level and 70°F) are allowable provided that the air density correction factors utilized agree with the air density correction factors published in Chart 4 (SI) or Chart 4 (IP) as appropriate, of AMCA Publication 200.

A.4 Required qualifying statements

Manufacturers often combine computerized selection with electronic cataloging of air, water, leakage 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 shall 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 performance, air leakage, sound and water penetration ratings to assist the user in applying this information correctly. The qualifying statements may be divided into primary and secondary statements.

When presenting air control devices and/or sizes licensed at different standard levels, a clear differentiation must be made between the air control devices and/or sizes that are certified and those that are not certified.; have air performance certified; have air leakage certified.

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

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

“AMCA Licensed for Air Performance.”

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

“AMCA Licensed for Air Performance w/o Appurtenances.”

A.4.1.2 When air leakage is certified and corrections, appurtenances and accessories applied to the air control device duplicate the test conditions, use the following statement:

“AMCA Licensed for Leakage.”

When air leakage is certified, but non-certified modifications for the effect of appurtenances, accessories, etc. are applied to the air control device ratings, use the following statement:

“AMCA Licensed for Leakage w/o Appurtenances.”

A.4.1.3 When air leakage and air performance is certified and correction, appurtenances and accessories applied to the air control device duplicate the test conditions, use the following statement:

“AMCA Licensed for Air Performance/Air Leakage.“

When air leakage and air performance is certified,

but non-certified modifications for the effect of appurtenances, accessories, etc. are applied to the air control device ratings, use the following statement:

“AMCA Licensed for Air Leakage/Air Performance w/o Appurtenances.”

A.4.1.4 When water penetration and air performance is certified, and corrections, appurtenances and accessories applied to the air control device duplicate the test conditions, use the following statement:

“AMCA Licensed for Air Performance/Water Penetration.“

When water penetration and air performance is certified, but non-certified modifications for the effect of appurtenances, accessories, etc. are applied to the air control device ratings, use the following statement:

“AMCA Licensed for Air Performance/Water Penetration w/o Appurtenances.”

A.4.1.5 When water penetration, air leakage and air performance is certified and corrections, appurtenances and accessories applied to the air control device duplicate the test conditions, use the following statement:

“AMCA Licensed for Air Performance/Water Penetration/Air Leakage.“

When water penetration, air leakage and air performance is certified, but non-certified modifications for the effect of appurtenances, accessories, etc. are applied to the air control device ratings, use the following statement:

“AMCA Licensed for Air Performance/Water Penetration/Air Leakage w/o Appurtenances.”

A.4.1.6 When wind-driven rain is certified and corrections, appurtenances and accessories applied to the air control device duplicate the test conditions, use the following statement:

“AMCA Licensed for Wind-Driven Rain.“

When wind-driven rain is certified, but non-certified modifications for the effect of appurtenances, accessories, etc. are applied to the air control device ratings, use the following statement:

“AMCA Licensed for Wind-Driven Rain w/o Appurtenances.”

A.4.1.7 When sound and air performance is certified and corrections, appurtenances and accessories applied to the air control device duplicate the test conditions, use the following statement:

“AMCA Licensed for Sound/Air Performance.“

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

“AMCA Licensed for Sound/Air Performance w/o Appurtenances.”

A.4.1.8 When sound, air performance and water penetration is certified and corrections, appurtenances and accessories applied to the air control device duplicate the test conditions, use the following statement:

“AMCA Licensed for Sound/Air Performance/Water Penetration.“

When sound, air performance and water penetration is certified, but non-certified modifications for the effect of appurtenances, accessories, etc. are applied to the air control device ratings, use the following statement:

“AMCA Licensed for Sound/Air Performance/Water Penetration w/o Appurtenances.”

A.4.1.9 When air performance and wind-driven rain is certified and corrections, appurtenances and accessories applied to the air control device duplicate the test conditions, use the following statement:

“AMCA Licensed for Air Performance/Wind-Driven Rain.“

When air performance and wind-driven rain is certified, but non-certified modifications for the effect of appurtenances, accessories, etc. are applied to the air control device ratings, use the following statement:

“AMCA Licensed for Air Performance/Wind-Driven Rain w/o Appurtenances.”

A.4.1.10 When air performance, water penetration and wind-driven rain is certified and corrections, appurtenances and accessories applied to the air control device duplicate the test conditions, use the following statement:

“AMCA Licensed for Air Performance/Water Penetration/Wind-Driven Rain.”

When air performance, water penetration and wind-driven rain is certified, but non-certified modifications for the effect of appurtenances, accessories, etc. are applied to the air control device ratings, use the following statement:

“AMCA Licensed for Air Performance/Water Penetration/Wind-Driven Rain w/o Appurtenances.”

A.4.2 Secondary statements. The secondary statements shall contain all other qualifying statements required by AMCA 511. 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 air control device is licensed to bear the AMCA Certified Ratings Seal and non-certified modifications have been applied to the ratings, the following additional qualifying statement shall appear on the secondary screen:

“The AMCA licensed performance data has been modified for installation, appurtenances, 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 air control device.“

A.5 Certification of electronic performance data

A printed catalog shall not be required for certification of performance data in an electronic catalog. When data is to be presented only in an electronic catalog, or the electronic catalog is submitted first, the certification process shall be the same as that when a printed catalog is submitted for certification.

When a previously certified printed catalog exists, it shall be considered primary.

A.6 Version numbers

All electronic catalogs which 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 distribution medium and on the first screen of the electronic catalog. Any change in the certification status 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.

A.7 Certified performance identification

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 being AMCA licensed or if not AMCA licensed, left blank.

Instructions for access to the AMCA Product Directory shall be included in an easily identifiable manner.

A.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 B. Example Louver Pressure Drop Plot

B.1 Test results

Table B.1

Determination	Intake ΔP Pa (in. wg)		Free Area Velocity m/s (fpm)		System Curve, Calc. From #1 (see B.3) Pa (in. wg)	
#1	104	(0.41)	8.13	(1600)		
#2	67	(0.27)	6.57	(1294)	67.9	(0.272)
#3	38	(0.15)	4.94	(974)	38.4	(0.154)
#4	15	(0.06)	3.22	(634)	16.3	(0.065)
#5	5	(0.02)	1.90	(374)	5.7	(0.0235)

Table B.2

Determination	Exhaust ΔP Pa (in. wg)		Free Area Velocity m/s (fpm)		System Curve, Calc. From #1 (see B.3) Pa (in. wg)	
#1	112	(0.44)	9.78	(1926)		
#2	72	(0.29)	7.87	(1550)	72.5	(0.290)
#3	42	(0.17)	6.04	(1190)	42.7	(0.171)
#4	19	(0.07)	4.06	(800)	19.3	(0.077)
#5	6	(0.02)	2.18	(430)	5.6	(0.022)

B.2 Extrapolation

The test data may be extrapolated 50% of the tested pressure range (see Section 8.3.1.1)

Intake = (104 - 5.2)0.5 + 104 SI
= 153

= (0.416 - 0.021)0.5 + .416 I-P
= 0.614

Exhaust = (112 - 6.2)0.5 + 112 SI
= 165

= (0.448 - 0.025)0.5 + 0.448 I-P
= 0.660

B.3 The system curve

At a fixed volume flow rate (cfm) through a given air system, a corresponding pressure loss or resistance to this flow will exist. If the flow rate is changed, the resulting pressure loss or resistance to flow will also change. The relationship governing this change for most systems is:

$$\frac{Pressure_c}{Pressure} = \left(\frac{fpm_c}{fpm} \right)^2$$

This plots as a straight line on log log paper.

System curve shown on graph:

$Pressure_C$ = $2.5(12.7/2.54)^2$ SI
= 62.5

= $0.01(2500/500)^2$ I-P
= 0.25

B.4 Published performance

For published graph performances the intake and exhaust lines should be parallel to a system curve and parallel to each other for a fixed and adjustable louver. The example determinations show minor variation due to the inability to record data accurately to one thousandth of an inch wg. Extrapolated data are shown dotted (see Figure B.1).

An adjustable louver may not be a rigid assembly. For example, flexible seals, such as are used to prevent leakage, may bend and cause the assembly to change shape. When an assembly can change shape, the system curve does not apply.

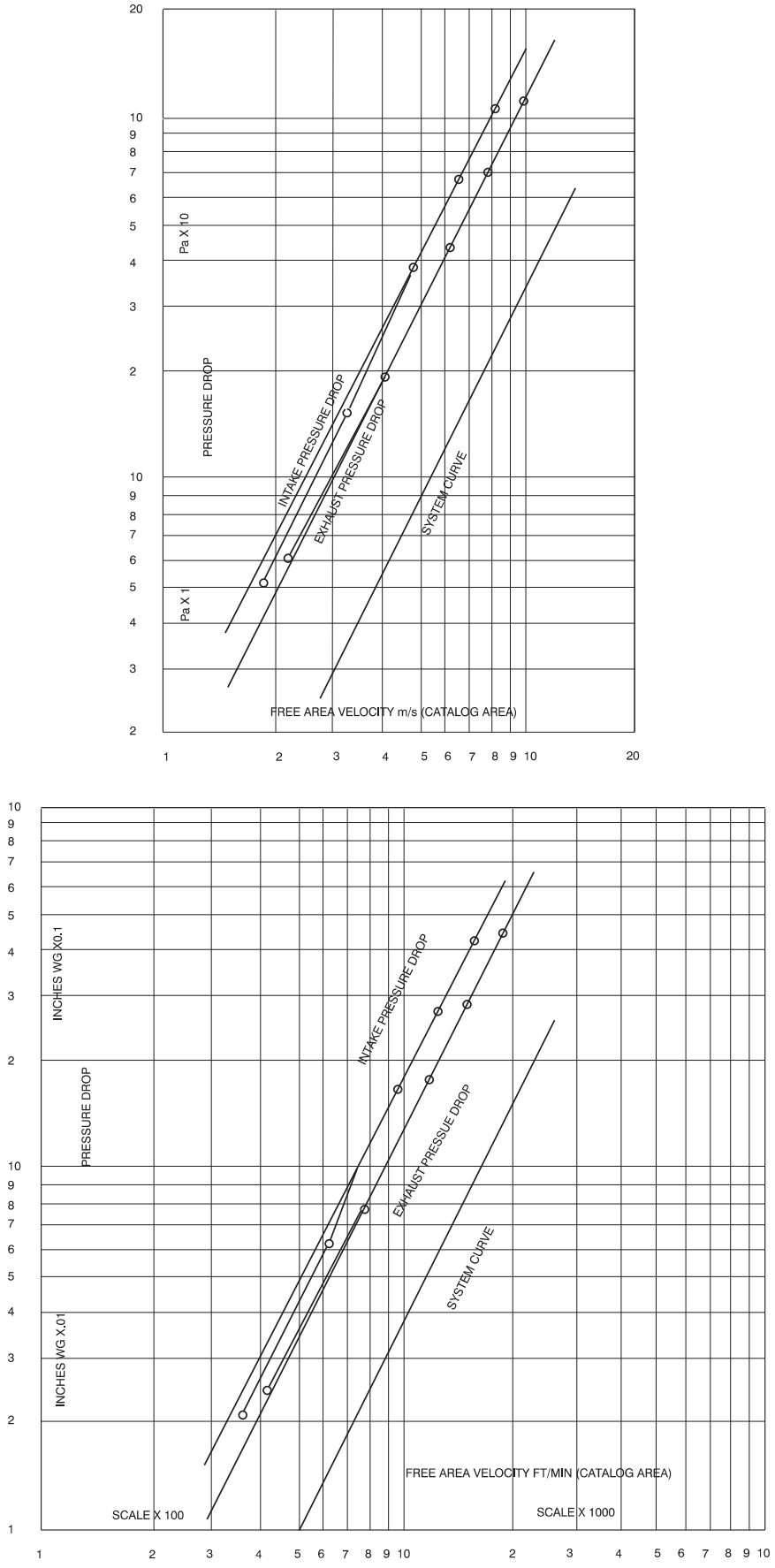


Figure B.1 Example Louver Pressure Drop Plot

B.5 Calculating discharge loss coefficient CD (for both intake and exhaust)

Using AMCA Standard 500-L Sections 8.1 and 9, calculate the flow rate Q_1 (actual flow through louver) and pressure drop P_{s1}. Plot the values of P_{s1} vs. $(Q_1)^2$ on linear graph paper.

By graphical or calculation methods find the best straight line through the plotted points and passing through zero (see Figure B.2). If isolated points fall outside the 5% differential pressure band about the best mean line, repeat the tests at the relevant flow rates to check validity of test data.

If groups of points still fall outside the ±5% band indicating the test results do not follow a linear relationship between $(Q_1)^2$ and P_{s1} draw the best line (curve) through the points and zero (see Figure B.3). Only individual test points for P_{s1} can be used to calculate C_D. The situation must be clearly indicated in the report.

The discharge loss coefficient C_D shall be calculated for each ventilation air flow rate (Q_1) used in the test.

$$C_D = \frac{Actual\ Flow}{Theoretical\ Flow}$$

$$Theoretical\ Flow = A_C\sqrt{2P_{s1}/\rho_1} \qquad \text{SI}$$

$$Theoretical\ Flow = 1097 A_C\sqrt{P_{s1}/\rho_1} \qquad \text{I-P}$$

Where:

A_c = core area, m^2 (ft^2)
P_{s1} = pressure drop across opening, Pa (in. wg)
ρ_1 = density, kg/m^3 (lbm/ft^3)

Calculate the average C_D from all of the test points provided all of the points fall inside of the ±5% band otherwise list C_D values for each flow rate.

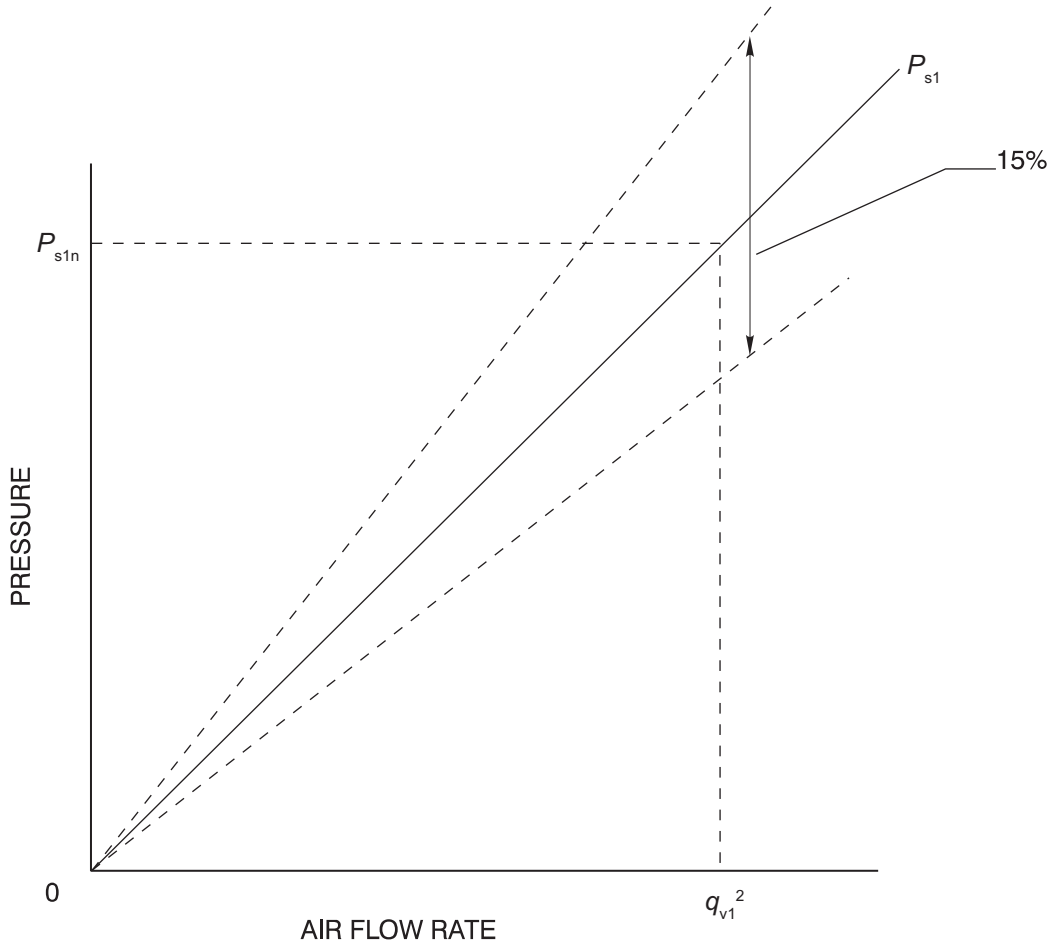


Figure B.2 – Air Flow Rate vs Pressure Loss Straight Line Characteristics for P_{s1} vs $(Q_1)^2$

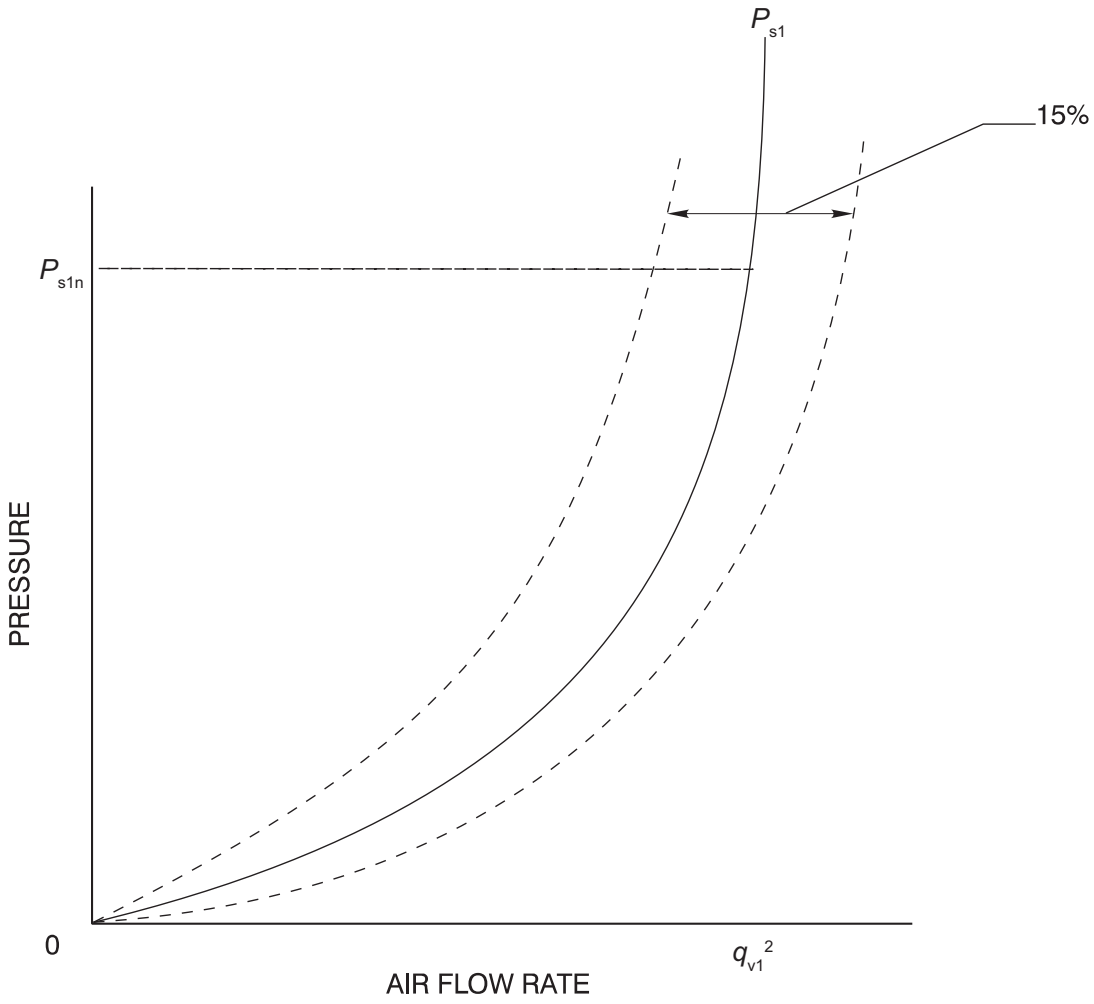


Figure B.3 – Air Flow Rate vs Pressure Loss, Best Line (Curve) Characteristics, for P_{s1} vs $(Q_1)^2$

Annex C. Example Louver Water Penetration Plot

C.1 Test results

Table C.1 Test Results

Determination	Water Carryover (X_i) mL/m^2 (oz. per ft^2)	Free Area Velocity (Y_i) m/s (fpm)
#1	2.23 (0.007)	3.23 (635)
#2	7.00 (0.022)	3.55 (698)
#3	70.35 (0.221)	4.06 (799)
#4	879.86 (2.764)	4.60 (905)

C.2 Linear regression formula results

The results of the linear regression calculated in accordance with Section 8.3.2 are:

$Y = B_0 + B_1 (\ln X)$
$= 3.08 + 0.227 (\ln X)$ (SI)

$Y = B_O + B_1 (\ln X)$
$= 862 + 44.7 (\ln X)$ (I-P)

C.2.1 Smoothed curve

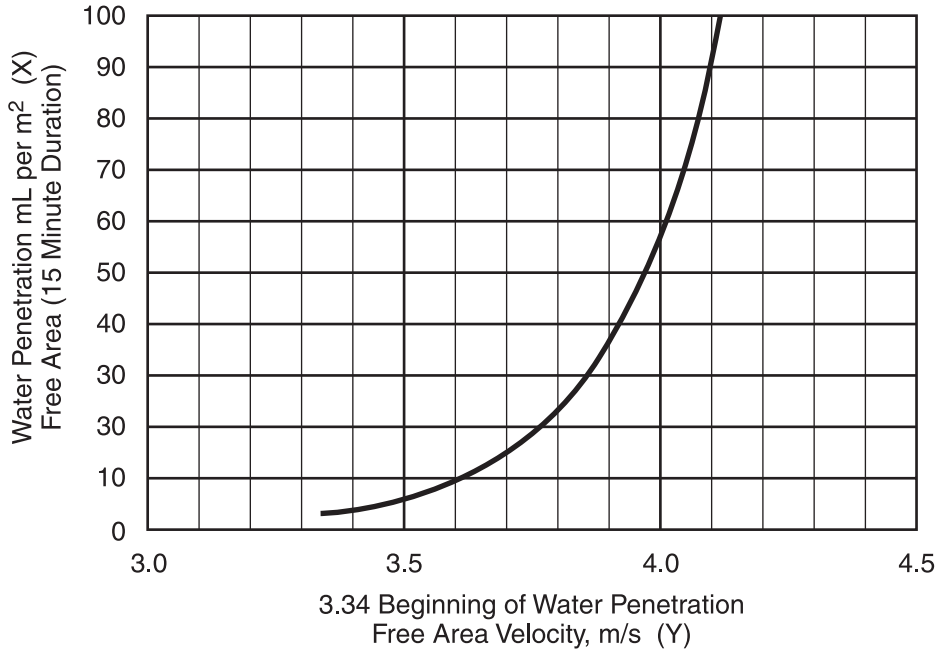
Table C.2

SI		I-P	
Water Penetration mL/m^2	**F.A. Velocity (*Y*)** m/s	**Water Penetration (*X*)** oz/ft^2	**F.A. Velocity (*Y*)** fpm
3	3.33	0.01	657
10	3.6	0.02	688
25	3.81	0.05	729
50	3.97	0.1	760
75	4.06	0.2	791
100	4.13	0.3	809

C.3 Example plots

Figure C.1 curve is plotted in accordance with Section 8.3.2.

Louver Test Size 1220 mm x 1220 mm



Louver Test Size 48 x 48

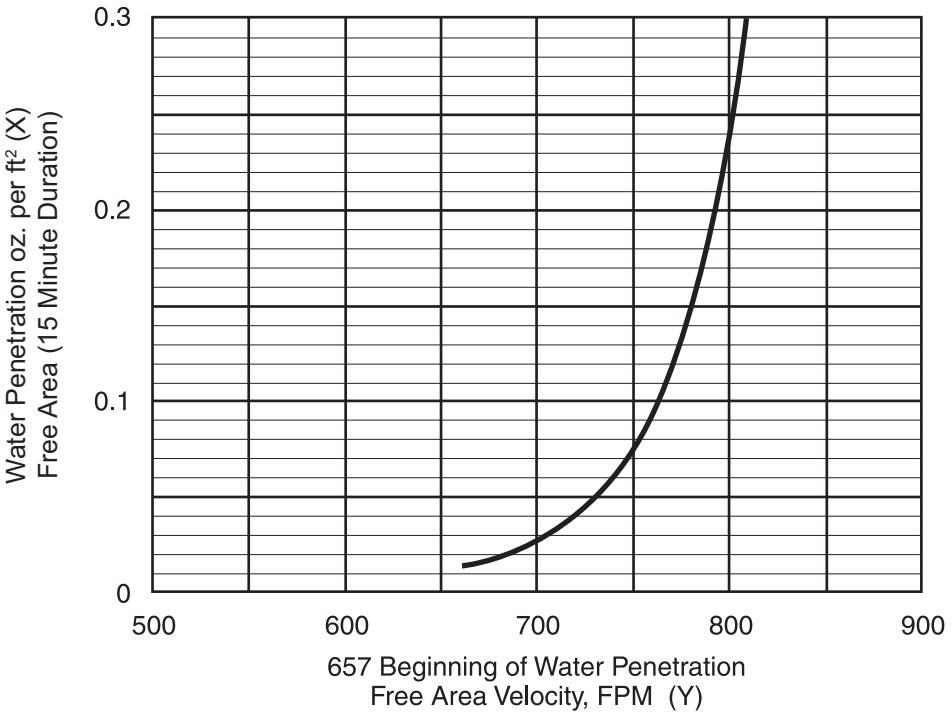


Figure C.1

Annex D. Example of Wind-Driven Rain Performance

The following test size information and tables that show the performance are required. The notes are for informational purposes and are not required.

Table D.1 Wind-Driven Rain Performance at a Wind Velocity of 13 m/s (29 mph) and a Rainfall Rate of 76 mm/hr (3 in./hr)

Free Area Velocity[1] m/s (fpm)	Core Velocity[2] m/s (fpm)	Effectiveness Ratio[3]	Penetration Class[4]
0.8 (163)	0.5 (98)	100%	A
1.7 (328)	1.0 (197)	99.5%	A
2.5 (492)	1.5 (295)	99.2%	A
3.3 (656)	2.0 (394)	98.3%	B
4.2 (820)	2.5 (492)	97.1%	B
5.0 (984)	3.0 (591)	95.6%	B
5.8 (1148)	3.5 (689)	94.2%	C
6.7 (1311)	4.0 (787)	88.4%	C
7.5 (1476)	4.5 (886)	83.6%	C
8.3 (1640)	5.0 (984)	78.5%	D

Test size is: 1000 mm x 1000 mm (39.37 in. x 39.37 in.) core area, 1050 mm x 1080 mm (41.34 in. x 42.52 in.)
Calculated free area of test louver is .60 m^2 (6.46 ft^2)
Discharge Loss Coefficient Class[5] Intake is 2

Table D.2 Wind-Driven Rain Performance at a Wind Velocity of 22 m/s (50 mph) and a Rainfall Rate of 202.4 mm/hr (8 in./hr)

Free Area Velocity[1]	Core Velocity[2] m/s (fpm)	Effectiveness Ratio[3]	Penetration Class[4]
0.8 (163)	0.5 (98)	100%	A
1.7 (328)	1.0 (197)	99.5%	A
2.5 (492)	1.5 (295)	99.2%	A
3.3 (656)	2.0 (394)	98.3%	B
4.2 (820)	2.5 (492)	97.1%	B
5.0 (984)	3.0 (591)	95.6%	B
5.8 (1148)	3.5 (689)	94.2%	C
6.7 (1311)	4.0 (787)	88.4%	C
7.5 (1476)	4.5 (886)	83.6%	C
8.3 (1640)	5.0 (984)	78.5%	D

Test size is: 1000 mm x 1000 mm (39.37 in. x 39.37 in.) core area, 1050 mm x 1080 mm (41.34 in. x 42.52 in.)
Calculated free area of test louver is .60 m^2 (6.46 ft^2)
Discharge Loss Coefficient Class[5] Intake is 2

Notes:

1. Not required.

2. Core area is the open area of the louver face (face area less louver frames). Core Velocity is the airflow

velocity through the Core Area of the louver. 5 m/s is the maximum core velocity utilized in this test.

3. Multiple test points at 100% effectiveness ratio need not be shown.

4. Wind-Driven Rain Penetration Classes:

Class	Effectiveness
A	100% to 99%
B	98.9% to 95%
C	94.9% to 80%
D	Below 80%

5. Discharge Loss Coefficient is calculated by dividing a louvers' actual airflow rate vs. a theoretical airflow for the opening. It provides an indication of the louvers' airflow characteristics.

   Discharge Loss Classes:

Class	Discharge Loss Coefficient
1	0.4 and above
2	0.3 to 0.399
3	0.2 to 0.299
4	0.199 and below

   (The higher the coefficient, the less resistance to airflow.)

6. Free Area of test size is calculated per AMCA Standard 500-L.

Annex E. Example Air Leakage Chart for Adjustable Louvers

E.1 Example - Single matrix test basis

Table E.1
L/s (cfm) LEAKAGE AT 250 Pa (1 in. wg) PRESSURE DIFFERENTIAL
(based on a closing torque of 8.5 N•m/m^2 or 7 lbf-in./ft^2)

Height - mm (in.) \ Louver Width - mm (in.)	305 (12)	610 (24)	915 (36)	1220 (48)	1525 (60)
305 (12)					
610 (24)					
915 (36)					
1220 (48)					
1525 (60)					

E.1.1 Single matrix test sizes

Table E.2
CATALOG SERIES LOUVER SIZES

Test	Size	Test Louvers
#1	Min W - Max Ht	305 x 1525 (12 x 60)
#2	Max W - Min Ht	1525 x 305 (60 x 12)
#3	Maw W - Max Ht	1525 x 1525 (60 x 60)

E.1.2 Single matrix test results

Table E.3
L/s per m^2 (cfm per ft^2) of Face Area (Holding Torque 8.5 N•m/m^2 or 7 lbf-in./ft^2)

Test Size mm (in.)	P_{12}Pa (in. wg)	Test	Test	P_{12}Pa (in. wg)	Test	Test
Min. W - Max.Ht 305 x 1525 (12 x 60)	+124 (0.5)	12.7 (2.5)	13.2 (2.6)*	-124 (0.5)	12.2 (2.4)	12.7 (2.5)
	+398 (1.6)	25.9 (5.1)*	25.4 (5.0)	-398 (1.6)	24.9 (4.9)	24.9 (4.9)
	+697 (2.8)	38.6 (7.6)	39.6 (7.8)	-697 (2.8)	40.1 (7.9)*	39.1 (7.7)
	+971 (3.9)	56.9 (11.2)	57.9 (11.4)	-971 (3.9)	55.9 (11.0)	63.0 (12.4)*
	+1245 (5.0)	88.9 (17.5)	93.5 (18.4)*	-1245 (5.0)	96.5 (19.0)*	94.5 (18.6)
Max. W - Min. Ht 1525 x 305 (60 x 12)	+124 (0.5)	20.8 (4.1)*	20.3 (4.0)	-124 (0.5)	20.8 (4.1)*	19.8 (3.9)
	+398 (1.6)	26.9 (5.3)	35.1 (6.9)	-398 (1.6)	35.6 (7.0)*	34.5 (6.8)
	+697 (2.9)	39.6 (7.8)	45.2 (8.9)	-697 (2.8)	45.7 (9.0)*	45.2 (8.9)
	+971 (3.9)	46.2 (9.1)*	42.2 (8.3)	-971 (3.9)	41.7 (8.2)	41.1 (8.1)
	+1245 (5.0)	40.6 (8.0)*	37.1 (7.3)	-1245 (5.0)	38.6 (7.6)	39.1 (7.7)
Max. W - Min. Ht 1525 x 1525 (60 x 60)	+124 (0.5)	5.6 (1.1)	6.1 (1.2)*	-124 (0.5)	5.6 (1.1)	5.6 (1.1)
	+398 (1.6)	8.1 (1.6)	12.2 (2.4)	-398 (1.6)	13.2 (2.6)*	12.7 (2.5)
	+697 (2.8)	15.2 (3.0)	17.8 (3.5)*	-697 (2.8)	17.3 (3.4)	12.7 (2.5)
	+971 (3.9)	18.3 (3.6)	23.4 (4.6)*	-971 (3.9)	21.8 (4.3)	21.3 (4.2)
	+1245 (5.0)	28.4 (5.6)*	27.4 (5.4)	-1245 (5.0)	26.9 (5.3)	26.9 (5.3)

*Highest leakage at listed pressure (two determinations in each mode - “direction of airflow“ and “back pressure“

E.1.3 Single Matrix Plots (see Annex E.3 for area calculation)

Symbols used are: Min - Max = Δ; Max - Min = □; Max - Max = O; Worst Case = ●

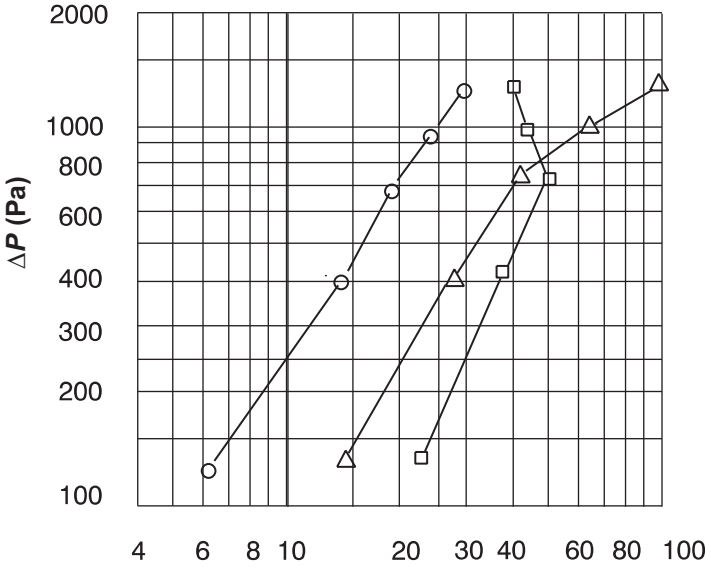


Figure E.1 Plot of Test Results (SI)

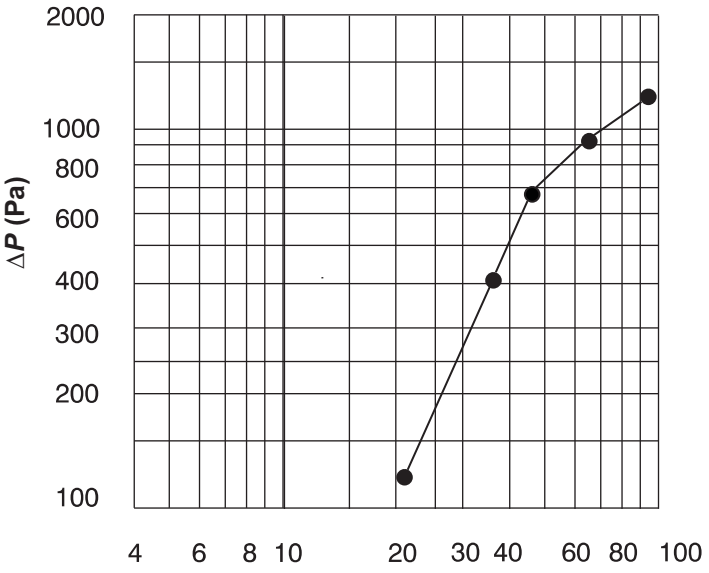


Figure E.2 Plot for Published Chart (SI)

Table E.4

INTERPOLATED LEAKAGES/SQ. METER AREA[1]	
125 Pa Δ*P* = 20.8 L/s	750 Pa Δ*P* = 49.0 L/s
250 Pa Δ*P* = 27.6 L/s	1000 Pa Δ*P* = 66.5 L/s
500 Pa Δ*P* = 39.0 L/s	1250 Pa Δ*P* = 97.1 L/s

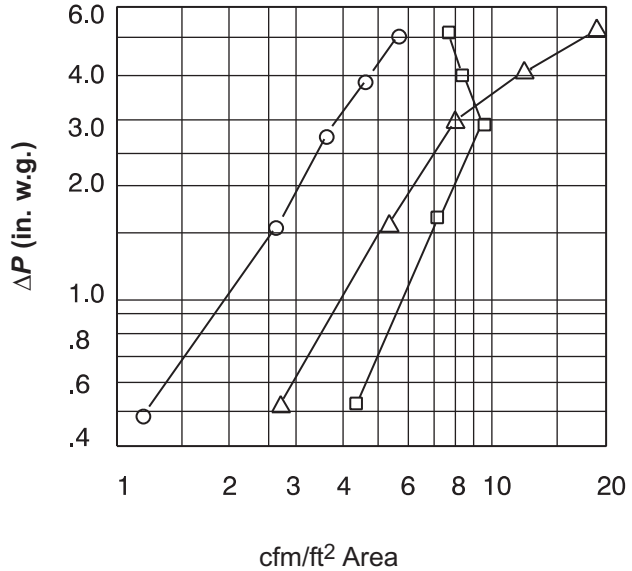


Figure E.3 Plot of Test Results (I-P)

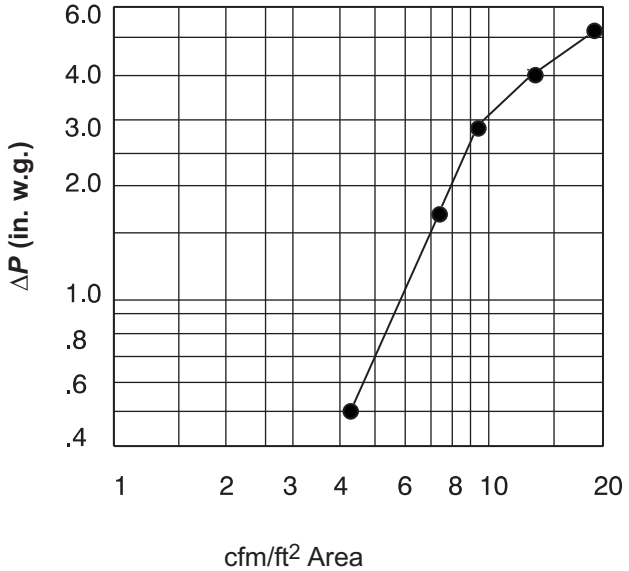


Figure E.4 Plot for Published Chart (I-P)

Table E.5

INTERPOLATED LEAKAGES/SQ. FOOT AREA[1]	
0.5 Δ*P* = 4.1 cfm	3.0 Δ*P* = 9.6 cfm
1.0 Δ*P* = 5.4 cfm	4.0 Δ*P* = 13.0 cfm
2.0 Δ*P* = 7.7 cfm	5.0 Δ*P* = 19.0 cfm

Note 1: Linear Interpolation is used to calculate leakages per area using tested values from E.1.2

E.1.4 Example of presentation of leakage chart

Table E.6
L/s (cfm) Leakage at 250 Pa (1 in. wg) pressure differential
(based on a closing torque of 8.5 N•m/m^2 or 7 lbf-in./ft^2)

Louver Width - mm (in.)

Height - mm (in.)	**305 (12)**	**610 (24)**	**915 (36)**	**1220 (48)**	**1525 (60)**
305 (12)	3 (6)	5 (11)	8 (17)	11 (22)	13 (27)
610 (24)	5 (11)	11 (22)	16 (33)	21 (44)	26 (54)
915 (36)	8 (17)	16 (33)	23 (49)	31 (65)	39 (82)
1220 (48)	11 (22)	21 (44)	31 (65)	41 (87)	52 (109)
1525 (60)	13 (27)	26 (54)	39 (82)	52 (109)	64 (136)

Table E.7
L/s (cfm) Multiplier for other pressure differentials

ΔP Pa (in. wg)	Multiplier	ΔP Pa (in. wg)	Multiplier
125 (.05)	0.75	750 (3.0)	1.77
250 (1.0)	1.00	1000 (4.0)	2.40
500 (2.0)	1.41	1250 (5.0)	3.51

Note:

Leakage in 250 Pa (1 in. wg) Pressure Differential chart above are rounded per Section 9.3.1. It is derived from interpolated data E.1.3 times the damper face area. Multipliers in chart above are derived from Interpolated Leakages per area on previous page.

E.2 Example #2 - Three matrix test basis

A: Company "A" Louvers (Testing of 3 Sizes Only – No Interpolation)

Table E.8
At 250 Pa (1 in. wg) Differential pressure,
actual leakage in L/s per m^2 (cfm/ft^2)

Size mm (in.)	Tested Leakage L/s per m^2 (cfm/ft^2)
305 x 1525 (12 x 60)	91.6 (18.03)*
1220 x 305 (48 x 12)	37.4 (7.36)
1220 x 1525 (48 x 60)	31.1 (6.12)

* The worst case leakage is 91.6 L/s per m^2 (18.03 cfm/ft^2) which is used to calculate published chart below.

Table E.9 - Example of Presentation of Leakage Chart Using 3 Sizes Tested
L/s (cfm) Leakage at 250 Pa (1 in. wg) pressure differential
(based on a closing torque of 8.5 N•m/m^2 or 7 lbf-in./ft^2)

Louver Width - mm (in.)

Height - mm (in.)	**305 (12)**	**610 (24)**	**915 (36)**	**1220 (48)**	**1525 (60)**
305 (12)	9 (18)	17 (36)	26 (54)	34 (72)	43 (90)
610 (24)	17 (36)	34 (72)	51 (108)	68 (145)	86 (181)
915 (36)	26 (54)	51 (108)	77 (163)	103 (217)	128 (271)
1220 (48)	34 (72)	68 (145)	103 (217)	137 (289)	171 (361)
1525 (60)	43 (90)	86 (181)	128 (271)	171 (361)	213 (451)

B: Company "A" Louvers (Using 3 Sizes Previously Tested in A: Plus Another)

Table E.10

Size mm (in.)	Tested Leakage L/s per m^2 (cfm/ft^2)	
305 x 1525 (12 x 60)	91.6 (18.03)*	
1220 x 305 (48 x 12)	37.4 (7.36)	
1220 x 1525 (48 x 60)	31.1 (6.12)	
610 x 1525 (24 x 60)	51.3 (10.09)*	New Size – 4th Sample
Use for sizes over 610 (24)	51.3 (10.09)	**Worst Case over 610 (24) wide**

* The worst case leakage is 91.6 L/s/m^2 (18.03 cfm/ft^2) on dampers up to 305 mm (12 in.) wide and 51.3 L/s/m^2 (10.09 cfm/ft^2) on louvers 610 mm (24 in.) and wider which are used to calculate the published chart below.

Example of Presentation of Leakage Chart Using 4 Sizes Tested

Table E.11
L/s (cfm) Leakage at 250 Pa (1 in. wg) pressure differential
(based on a closing torque of 8.5 N•m/m^2 or 7 lbf-in./ft^2)

Louver Width - mm (in.)

Height - mm (in.)	**305 (12)**	**610 (24)**	**915 (36)**	**1220 (48)**	**1525 (60)**
305 (12)	9 (18)	10 (20)	15 (31)	34 (41)	43 (51)
610 (24)	17 (36)	19 (41)	29 (61)	38 (81)	48 (101)
915 (36)	26 (54)	29 (61)	43 (91)	58 (121)	72 (152)
1220 (48)	34 (72)	38 (81)	58 (121)	77 (162)	96 (202)
1525 (60)	43 (90)	48 (101)	72 (152)	96 (202)	120 (253)

C: Company "A" Louvers (Using 4 Sizes Previously Tested in B: Plus Another)

Table E.12

Size mm (in.)	Tested Leakage L/s per m^2 (cfm/ft^2)	
305 x 1525 (12 x 60)	91.6 (18.03)*	
1220 x 305 (48 x 12)	37.4 (7.36)	
1220 x 1525 (48 x 60)	31.1 (6.12)	
610 x 1525 (24 x 60)	51.3 (10.09)*	
915 x 1525 (36 x 60)	37.8 (7.44)*	New Size – 5th Sample
Use for sizes over 915 (36)	37.8 (7.44)	**Worst Case over 915 (36) wide**

The worst case leakage is 91.6 L/s/m^2 (18.03 cfm/ft^2) on louvers up to 305 mm (12 in.) wide, 51.3 L/s/m^2 (10.09 cfm/ft^2) on louvers 601 mm (24 in.) wide and 37.8 L/s/m^2 (7.44 cfm/ft^2) on louvers 915 mm (36 in.) and wider which are used to calculate the published chart below.

Example of Presentation of Leakage Chart Using 5 Sizes Tested

Table E.13

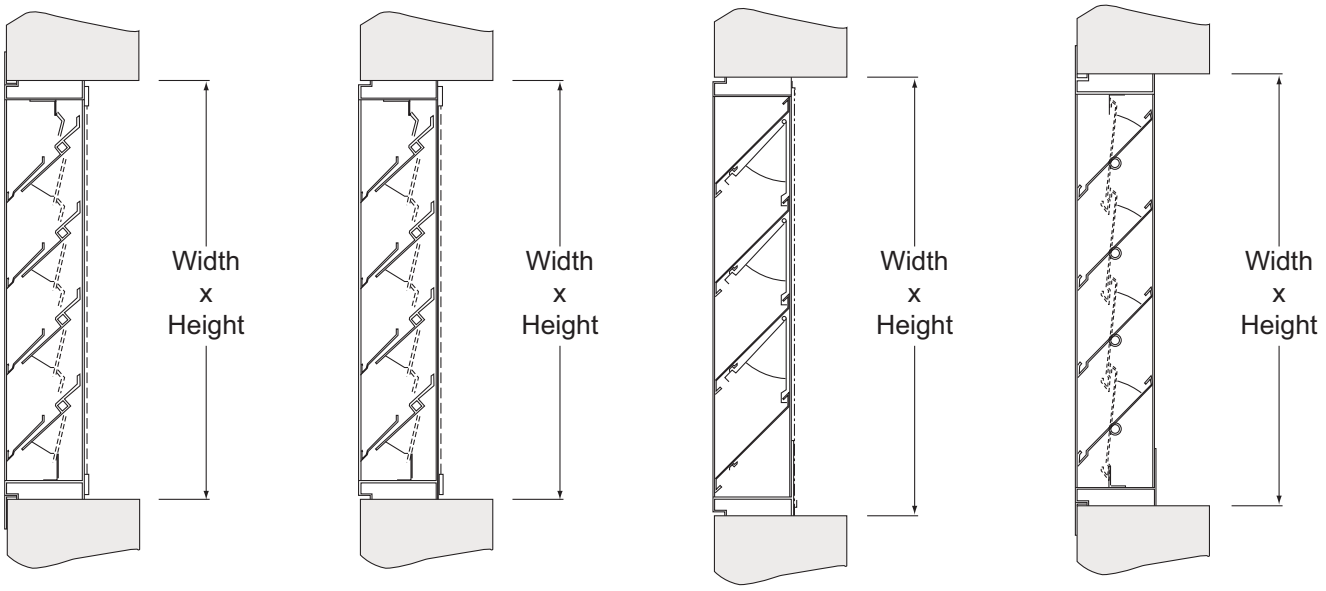
L/s (cfm) Leakage at 250 Pa (1 in. wg) pressure differential
(based on a closing torque of 8.5 N•m/m^2 or 7 lbf-in./ft^2)

Louver Width - mm (in.)

Height - mm (in.)	**305 (12)**	**610 (24)**	**915 (36)**	**1220 (48)**	**1525 (60)**
305 (12)	9 (18)	10 (20)	11 (22)	14 (30)	18 (37)
610 (24)	17 (36)	19 (41)	21 (44)	28 (59)	35 (74)
915 (36)	26 (54)	29 (61)	32 (67)	42 (89)	52 (111)
1220 (48)	34 (72)	38 (81)	42 (89)	56 (118)	70 (147)
1525 (60)	43 (90)	48 (101)	52 (111)	70 (147)	87 (184)

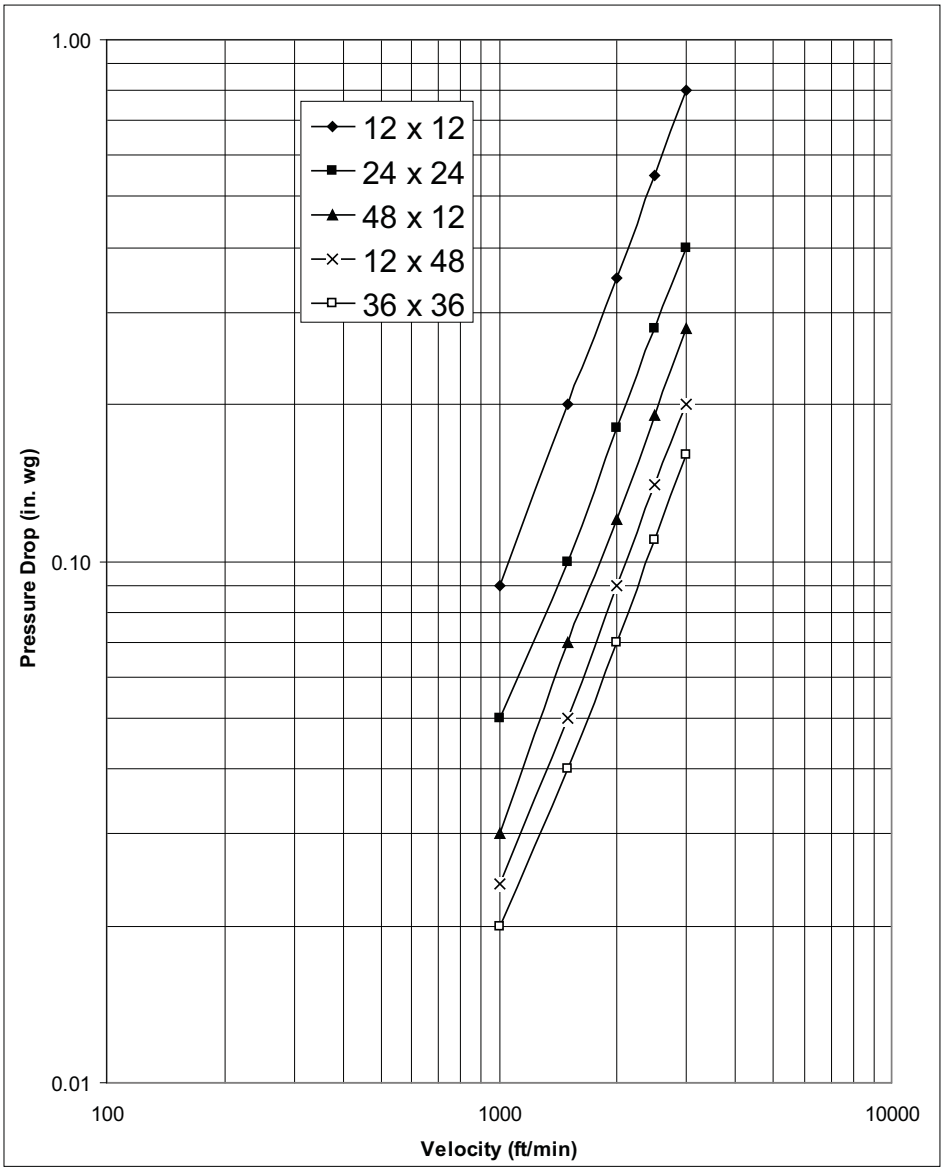
E.3 Calculating louver area

The results of an air leakage test for louvers shall be presented as a statement of the pressure differential across the device (Pa or in. wg) versus flow rate per square foot of louver face area (L/s/m^2 or cfm/ft^2) at standard air density. The area is determined by the installation method as shown in the sketches below. Results shall include a statement of the specific seating torque holding the device closed and direction of airflow.



Annex F. Example Air Performance Graph for Dampers in the Full Open Position

(I-P Units)



12 x 12

Velocity (ft/min)	Pressure Drop (in. wg)
1000	0.09
1500	0.20
2000	0.35
2500	0.55
3000	0.80

24 x 24

Velocity (ft/min)	Pressure Drop (in. wg)
1000	0.05
1500	0.10
2000	0.18
2500	0.28
3000	0.40

48 x 12

Velocity (ft/min)	Pressure Drop (in. wg)
1000	0.03
1500	0.07
2000	0.12
2500	0.19
3000	0.28

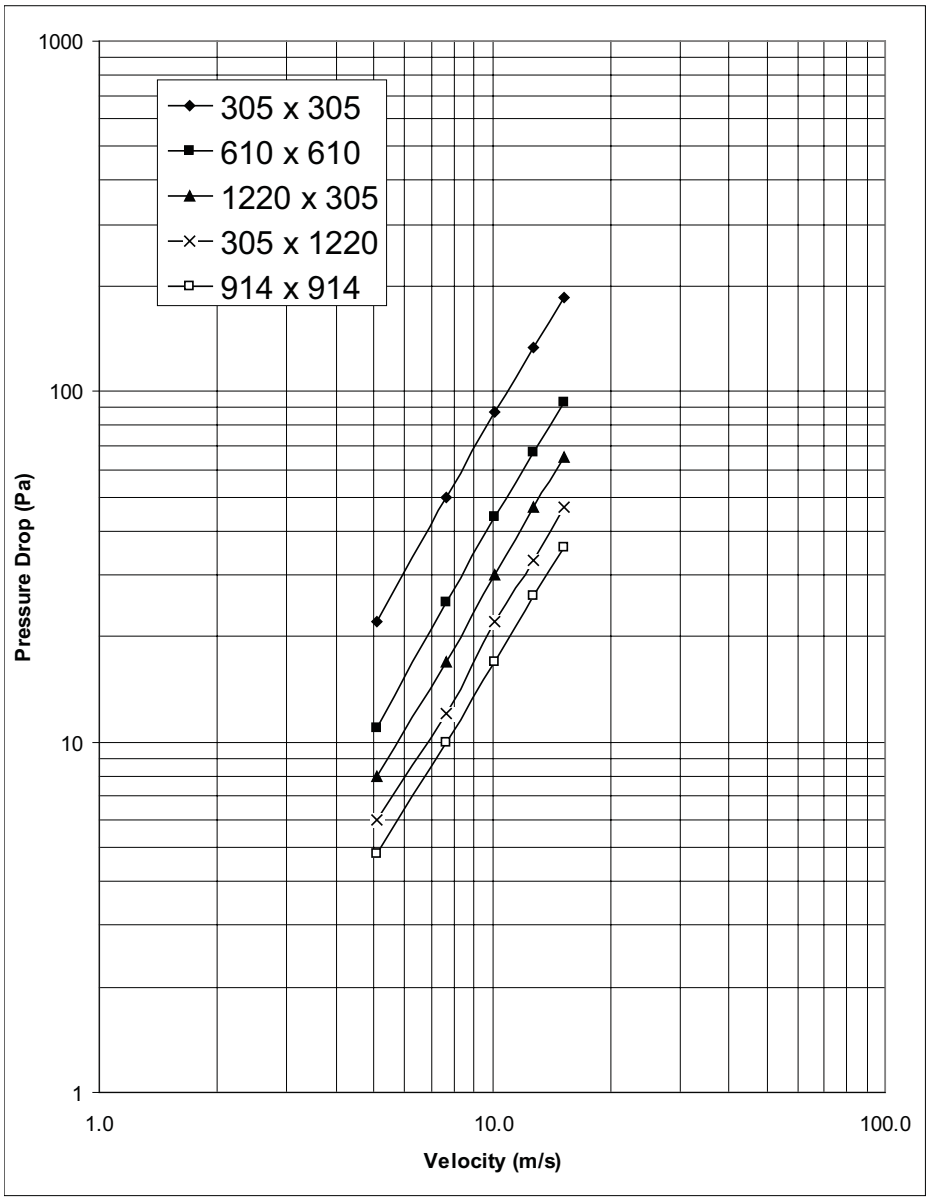
12 x 48

Velocity (ft/min)	Pressure Drop (in. wg)
1000	0.02
1500	0.05
2000	0.09
2500	0.14
3000	0.20

36 x 36

Velocity (ft/min)	Pressure Drop (in. wg)
1000	0.02
1500	0.04
2000	0.07
2500	0.11
3000	0.16

(SI Units)



305 x 305

Velocity (m/s)	Pressure Drop (Pa)
5.08	22
7.62	50
10.16	87
12.70	133
15.24	186

610 x 610

Velocity (m/s)	Pressure Drop (Pa)
5.08	11
7.62	25
10.16	44
12.70	67
15.24	93

1220 x 305

Velocity (m/s)	Pressure Drop (Pa)
5.08	8
7.62	17
10.16	30
12.70	47
15.24	65

305 x 1220

Velocity (m/s)	Pressure Drop (Pa)
5.08	6
7.62	12
10.16	22
12.70	33
15.24	47

914 x 914

Velocity (m/s)	Pressure Drop (Pa)
5.08	5
7.62	10
10.16	17
12.70	26
15.24	36

Annex G. Example Presentation of Damper Leakage Class

G.1 Actual test results from individual sizes

Table G.1

Damper Size	Leakage Class Test Results	Leakage Class Test Results	Leakage Class Test Results
Damper Width mm (in.) x Height mm (in.)	**250 Pa (1 in. wg) Class**	**1 kPa (4 in. wg) Class**	**2 kPa (8 in. wg) Class**
305 x 305 (12 x 12)	1A	2	2
610 x 610 (24 x 24)	1A	1	2
915 x 915 (36 x 36)	1A	1	N/A
305 x 1220 (12 x 48)	1	2	N/A
1220 x 305 (48 x 12)	1A	1	N/A
1525* x 915 (60* x 36)	1A	1	N/A

*This is an example of the maximum width.

G.2 Published data example

Table G.2

Damper Leakage Class	Damper Leakage Class	Damper Leakage Class
250 Pa (1 in. wg)	**1 kPa (4 in. wg)**	**2 kPa (8 in. wg)***
1	2	2

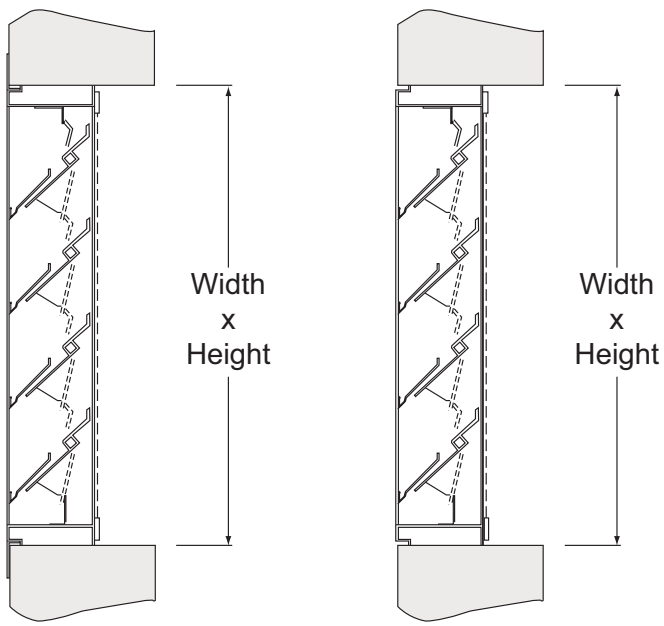
* Leakage rating at 2 kPa (8 in. wg) applies to dampers 610 mm x 610 mm (24 in. x 24 in.) or smaller.

Data is based on tests conducted with a seating torque of 6.2 N•m/m^2 (5 lbf-in./ft^2) of damper area or at a minimum of 2.8 N•m/m^2 (25 lbf-in./ft^2) used to hold the damper in the closed position. All data has been corrected to standard air density of 1.2 kg/m^3 (0.075 lbm/ft^3).

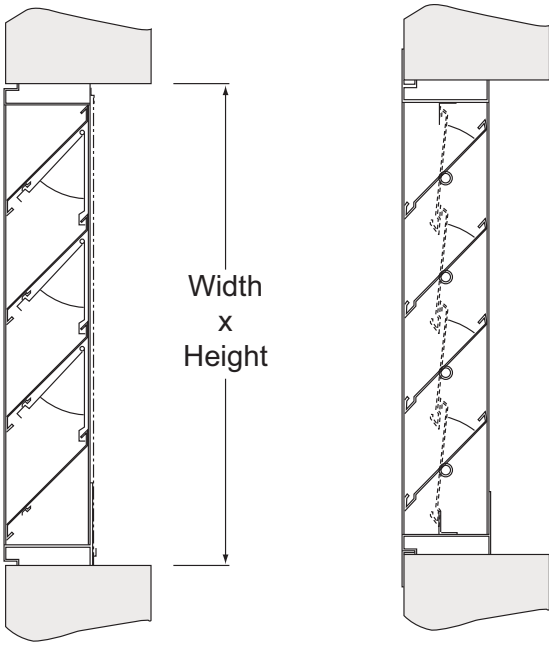
G.3. Calculating damper area

The results of an air leakage test for dampers shall be presented as a statement of pressure differential (Pa or in. wg) across the device versus the flow rate per face area of damper (L/s per m^2 or cfm/ft^2) at standard air density. The face area is determined by the installation method as shown in the sketches below.

Insert Type Installation



Flange Mount Installation



Annex H. Example Air Leakage Chart for Spiral Duct

Duct Gauge	Test Pressure kPa (in. wg)	*Leakage Rate m^3/hr (cfm)
28	3.75 (15)	2.37 (1.4)
26	3.75 (15)	2.37 (1.4)
24	3.75 (15)	1.70 (1.0)
22	3.75 (15)	1.70 (1.0)
20	3.75 (15)	1.70 (1.0)
18	3.75 (15)	2.21 (1.3)
16	3.75 (15)	1.87 (1.1)
14	3.75 (15)	2.55 (1.5)

Tests are based on a 600 mm (24 in.) diameter by 3000 mm (120 in.) spiral duct sample.

* Leakage rate is based upon m^3/hr per 9.29 m^2 (cfm per 100 ft^2) of duct wall surface area at 3.75 kPa (15 in. wg) ΔP_s.

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