STANDARD

# ANSI/AMCA Standard 500-D-18

# Laboratory Methods of Testing Dampers for Rating

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**Air Movement and Control Association International**

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# AMCA Publication 500-D-18

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# AMCA Publications

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# Laboratory Methods of Testing Dampers for Rating

## 1. Purpose

The purpose of this standard is to establish uniform laboratory test methods for dampers. The characteristics to be determined include, as appropriate, air leakage, pressure drop, dynamic closure and operational torque.

It is not the purpose of this standard to specify the testing procedures to be used for design, production or field testing. Similarly, it is not the purpose of this standard to indicate or establish minimum or maximum performance ratings to be used for specifying these products.

## 2. Scope

This standard may be used as a basis for testing dampers when air is used as the test gas.

A test conducted in accordance with the requirements of this standard is intended to demonstrate the performance of a damper and is not intended to determine acceptability level for a damper. It is not within the scope of this standard to indicate the actual sequence of testing.

The parties to a test for guarantee purposes may agree to exceptions to this standard in writing prior to the test. However, only a test that does not violate any mandatory requirement of this standard shall be designated as a test conducted in accordance with this standard.

For more information on damper modulating control characteristics, see Annex C.

## 3. Definitions/Units of Measurement/Symbols

### 3.1 Definitions

**3.1.1 Damper**
A device mounted in a duct or opening which is used to vary the volume of air flowing through the duct or opening. It may be operated manually or mechanically and may have one or more blades.

**3.1.1.1 Single blade damper**
A damper having one blade.

**3.1.1.2 Multi-blade damper**
A damper having more than one blade. The damper is a parallel blade damper if the blades rotate in the same direction, and it is an opposed blade damper if adjacent blades rotate in opposite directions.

**3.1.1.3 Curtain damper**
A damper that uses a folded, interlocked series of blades.

**3.1.1.4 Backdraft damper (shutter)**
A damper that, when mounted in a duct or opening, permits the flow of air in one direction only. It is normally opened by the energy of the airstream, but it may be opened and/or closed by mechanical

means. A counterbalanced backdraft damper has weights and/or springs added to the blade or blades to facilitate or impede the opening or closing action.

**3.1.2 Air control damper**
A mechanical device that does not fit the definition of a damper and that, when placed in a duct or opening, is used to regulate airflow.

**3.1.3 Free area**
The minimum area through which air can pass. It is determined by multiplying the sum of the minimum distances between intermediate blades, top blade, head and bottom blade and sill by the minimum distance between jambs. The percent of free area is the free area thus calculated, divided by the gross area of the air control damper × 100. See damper cross sections (Figure 1).

**3.1.4 Face area**
The total cross-sectional area of a damper, duct or wall opening (see Figure 1).

**3.1.5 Psychrometrics**

**3.1.5.1 Dry-bulb temperature ($t_d$)**
The air temperature measured by a dry temperature sensor.

**3.1.5.2 Wet-bulb temperature ($t_w$)**
The temperature measured by a temperature sensor covered by a water-moistened wick and exposed to air in motion. When properly measured, it is a close approximation of the temperature of adiabatic saturation.

**3.1.5.3 Total temperature ($t_t$)**
The temperature that exists by virtue of the internal and kinetic energy of the air or gas. If the air or gas is at rest, the total temperature will equal the static temperature.

**3.1.5.4 Static temperature ($t_s$)**
The temperature that exists by virtue of the internal energy of the air only.

If a portion of the internal energy is converted into kinetic energy, the static temperature will be decreased accordingly.

**3.1.5.5 Air density ($\rho$)**
The mass-per-unit volume of air.

**3.1.5.6 Standard air**
Air with a density of 1.2 kg/m$^3$ (0.075 lbm/ft$^3$), a ratio of specific heats of 1.4, a viscosity of $1.8185 \times 10^{-5}$ Pa-s ($1.222 \times 10^{-5}$ lbm/ft-s). Air at 20 °C (68 °F) temperature, 50 percent relative humidity, and 101.3207 kPa (29.92 in. Hg) barometric pressure has these properties, approximately.

**3.1.6 Pressure**

**3.1.6.1 Pressure (P)**
Force per unit area. This corresponds to energy per unit volume of fluid.

**3.1.6.2 Absolute pressure (p)**
The value of a pressure when the datum pressure is absolute zero. It is always positive.

**3.1.6.3 Barometric pressure ($p_b$)**
The absolute pressure exerted by the atmosphere at the location of measurement.

**3.1.6.4 Gauge pressure**
The value of a pressure when the reference pressure is the barometric pressure at the point of measurement. It may be negative or positive.

**3.1.6.5 Velocity pressure ($P_v$)**
That portion of the air pressure that exists by virtue of the rate of motion only. It is always positive.

**3.1.6.6 Static pressure ($P_s$)**
That portion of the air pressure that exists by virtue of the degree of compression only. If expressed as gauge pressure, it may be negative or positive.

**3.1.6.7 Total pressure ($P_t$)**
The air pressure that exists by virtue of the degree of compression and the rate of motion. It is the algebraic sum of the velocity pressure and the static pressure at a point. Thus, if the air is at rest, the total pressure will equal the static pressure.

**3.1.6.8 Pressure differential ($\Delta P_{x,x}$)**
The change in static pressure across a damper.

**3.1.7 Performance variables**

**3.1.7.1 Pressure drop ($\Delta P$)**
A measure of the resistance to airflow across a damper. It is expressed as the difference in static pressure across a damper for a specific rate of airflow.

**3.1.7.2 Closure pressure**
The differential pressure across the damper when the damper is closed.

**3.1.7.3 Airflow leakage**
The amount of air passing through a damper when it is in the closed position and at a specific pressure differential. It is expressed as the volumetric rate of air passing through the damper divided by the face area.

**3.1.7.4 Ambient temperature dynamic closure**
The ability of a damper to properly travel from the full open to the full closed position while exposed to specific airflow conditions at ambient temperature (0 °C–49 °C [32 °F–120 °F]). The specific airflow conditions are the airflow face velocity when the damper is in the open position and the pressure differential across the damper in the closed position. The airflow face velocity is the velocity established with the damper in the open position. The pressure differential is established when the damper is in the closed position. All airflow measurements and pressure differential measurements are established at ambient conditions and are corrected to standard air. The damper can be tested in either a ducted or in-wall installation.

**3.1.7.5 Elevated temperature dynamic closure**
Elevated temperature dynamic closure is the ability of a damper to properly travel from the full open to the full closed position while exposed to specific airflow conditions at a specified elevated air temperature.

The specific airflow conditions are the airflow face velocity when the damper is in the open position and the pressure differential across the damper in the closed position. The airflow face velocity is the velocity established with the damper in the open position. The pressure differential is established when the damper is in the closed position. All airflow measurements and pressure differential measurements are established at ambient conditions and are corrected to standard air. This test is conducted in a ducted installation only.

#### 3.1.7.6 Ambient temperature operation
The ability of a damper to properly travel from the full open to full closed position and, if a motorized damper, back to a full open position while exposed to specific airflow conditions at ambient temperature (0 °C–49 °C [32 °F–120 °F]). The specific airflow conditions are the airflow face velocity when the damper is in the open position and the pressure differential across the damper in the closed position. The airflow face velocity is the velocity established when the damper is in the open position. The pressure differential is established when the damper is in the closed position. All airflow measurements are established at ambient conditions and are corrected to standard air.

#### 3.1.7.7 Elevated temperature operation
The operational ability of a damper to properly travel from full open to full closed position at elevated temperatures and, if a motorized damper, operate back to a full open position while exposed to specified airflow conditions. The specified airflow conditions are the airflow face velocity when the damper is in the open position and the pressure differential across the damper in the closed position. The airflow face velocity is the velocity established when the damper is in the open position. The pressure differential is established when the damper is in the closed position. All airflow measurements are established at ambient temperature conditions and are corrected to standard air.

#### 3.1.7.8 Dynamic operation torque
The torque at varying angles of rotation of the axle that operates the damper from the full open, to the full closed, and back to the full open position while exposed to specific airflow conditions. The specific airflow conditions are the airflow face velocity when the damper is in the open position and the pressure differential across the damper in the closed position. All airflow measurements and pressure differential measurements are established at ambient conditions and are corrected to standard air.

### 3.1.8 Miscellaneous

#### 3.1.8.1 Shall and should
The word *shall* is to be understood as mandatory and the word *should* as advisory.

#### 3.1.8.2 Determination
A complete set of measurements for a particular point of operation of the test damper. The measurements must be sufficient to determine all appropriate performance variables as defined in Section 3.1.7.

#### 3.1.8.3 Test
A determination or a series of determinations for various points of operation of a damper.

#### 3.1.8.4 Energy factor
The ratio of the total kinetic energy of the flow to the kinetic energy corresponding to the average velocity.

#### 3.1.8.5 Seating torque
The torque specified to properly seal the test damper.

## 3.2 Units of measure

### 3.2.1 System of units
SI units (the International System of Units, *Le Systéme International d'Unités*) [1]* are the primary units employed in this standard, with I-P units (inch-pound) given as the secondary reference. SI units are based on the fundamental values of the International Bureau of Weights and Measures [1], and I-P values are based on the values of the National Institute of Standards and Technology which are, in turn, based on the values of the International Bureau.

*Bibliographic references are indicated by brackets.

#### 3.2.2 Basic units
The unit of length is the meter (m), or millimeter (mm); I-P units are the foot (ft) or the inch (in.). The unit of mass is the kilogram (kg); the I-P unit is the pound mass (lbm). The unit of time is either the minute (min) or the second (s). The unit of temperature is either the degree Celsius (°C) or the degree kelvin (K). I-P units are either the degree Fahrenheit (°F) or the degree Rankine (°R). The unit of force is the newton (N); the I-P unit is the pound (lbf).

#### 3.2.3 Airflow rate and velocity

##### 3.2.3.1 Airflow rate
The unit of volumetric airflow rate is the cubic meter per second ($m^3/s$); the I-P unit is the cubic foot per minute (cfm).

##### 3.2.3.2 Airflow velocity
The unit of airflow velocity is the meter per second (m/s); the I-P unit is the foot per minute (fpm).

#### 3.2.4 Pressure
The unit of pressure is the pascal (Pa) or the millimeter of mercury (mm Hg); the I-P unit is either the inch water gauge (in. wg) or the inch mercury column (in. Hg). Values in mm Hg or in. Hg shall be used only for barometric pressure measurements. The in. wg shall be based on a one-inch column of distilled water at 68 °F under standard gravity and a gas column balancing effect based on standard air. The in. Hg shall be based on a one-inch column of mercury at 32 °F under standard gravity in vacuo. The mm Hg shall be based on a one mm column of mercury at 0 °C under standard gravity in vacuo.

#### 3.2.5 Torque
The unit of torque is the newton-meter (N-m); the I-P unit is the pound-inch (lbf-in.).

#### 3.2.6 Gas properties
The unit of density is the kilogram per cubic meter ($kg/m^3$); the I-P unit is the pound mass per cubic foot ($lbm/ft^3$). The unit of viscosity is the pascal-second (Pa-s); the I-P unit is the pound mass per foot-second (lbm/ft-s). The SI unit of gas constant is the joule per kilogram-kelvin (J/kg-K); the I-P unit is the foot-pound per pound mass-degree Rankine, (ft-lbf/lbm-°R).

#### 3.2.7 Dimensionless groups
Various dimensionless quantities appear in the text. Any consistent system of units may be employed to evaluate these quantities unless a numerical factor is included, in which case units must be as specified.

#### 3.2.8 Physical constants
The value of standard gravitational acceleration shall be taken as 9.80665 $m/s^2$ (32.174 $ft/s^2$) at mean sea level at 45° latitude [2]. The density of distilled water at saturation pressure shall be taken as 998.278 $kg/m^3$ (62.3205 $lbm/ft^3$) at 20 °C (68 °F) [3]. The density of mercury at saturation pressure shall be taken at 13595.1 $kg/m^3$ (848.714 $lbm/ft^3$) at 0 °C (32 °F) [3]. The specific weights in $kg/m^3$ ($lbm/ft^3$) of these fluids in vacuo under standard gravity are numerically equal to their densities at corresponding temperatures.

### 3.3 Symbols and Subscripts

See Table 1.

**Table 1 — Symbols and Subscripts**

| Symbol | Description | SI Unit | I-P Unit |
|---|---|---|---|
| $a$ | Duct width | m | ft |