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ANSI/ASHRAE Standard 195-2024
Method of Test for Rating Air Terminal Unit Controls

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NOTE

Approved addenda, errata, or interpretations for this standard can be downloaded free of charge from the ASHRAE website at www.ashrae.org/technology.

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FOREWORD

ANSI/ASHRAE Standard 195 specifies instrumentation and facilities, test installation methods, and procedures for determining the accuracy and stability of airflow control systems for terminal units at various airflow set points. It is intended for application in the following scenarios:

- *An HVAC system specifier indicates performance requirements for airflow control for a given project. The requirements are specified in terms of nominal flow rates, accuracy, stability, operating pressures, and other relevant conditions. Contractors or suppliers document performance of proposed equipment based on tests run and reported in accordance with this standard.*
- *A supplier of airflow controls wishing to publish the capabilities of a product executes tests and reports results in accordance with this standard. The supplier chooses the operating conditions to test and report.*

The Standard Project Committee does not envision application of this standard to field tests or acceptance tests in construction projects.

This 2024 edition of Standard 195 expands the testing options for the scope of the test. All tests in the 2013 edition apply to the combination of a controller and air terminal. This edition of the standard includes the option to test only the performance of the controller, paired with a standard air terminal. The air terminal used for this testing must meet the requirements in new Normative Appendix A. The full-system test is intended to determine the lowest airflow set point at which a full system passes the system performance tests. The controller-only test is intended to determine the lowest flow probe signal (P_{vm}) at which a controller passes the system performance tests. It does not necessarily indicate how stably or accurately a controller can maintain an airflow set point when paired with a terminal unit that is different than the standard terminal unit. For example, if the controller is paired with a terminal unit whose flow probe has lower amplification than the standard terminal unit, then the controller may not be able to control as accurately at low flow. Similarly, if the terminal unit flow probe signal or amplification degrades at low flow, then the controller may not perform as well as the controller-only test might imply.

It should be noted that ASHRAE RP 1353 tested terminal units from three manufacturers, along with controllers from four manufacturers, and consistently found the flow probe signal and amplification to be stable at flows well below what the controllers could stably and accurately control; the controller was always the limiting factor in full system performance. Similar research by Pacific Gas & Electric reached the same conclusion. Furthermore, the required amplification of the standard terminal unit is typical of the amplification factors published by many of the major variable-air-volume box manufacturers. The advantage of the controller-only tests is that it allows for an apples-to-apples comparison between controllers, regardless of which terminal unit they are paired with. It also allows controller manufacturers to provide standardized performance data for their controllers without fear of being unfairly compared to a competitor's controller paired with a terminal unit with unusually high amplification. The controller-only test only evaluates systems using velocity pressure sensing. To compare systems using other sensing technology, the full-system test is appropriate.

This standard method of test (MOT) reports performance as a pass/fail rating with respect to a control accuracy tolerance, rather than reporting a measured, numerical accuracy. It is envisioned that the standard may be extended in the future to report measured accuracy.

This standard MOT pertains to some of the same equipment as ANSI/ASHRAE Standard 130 and measures some of the same quantities. In particular, Standard 130 includes tests that measure accuracy of an airflow sensor installed in a terminal. This MOT measures the accuracy of the airflow control system, which encompasses the terminal and sensor, but also includes sensing functions and control actions integral to an airflow controller.

This standard MOT describes procedures that apply to single-duct air terminals without fans. Future versions may include procedures that apply to other air terminals.

1. PURPOSE

This standard specifies instrumentation and facilities, test installation methods, and procedures for determining the accuracy and stability of airflow control systems for terminal units at various airflow set points.

2. SCOPE

This standard applies to electronic and/or pneumatic control systems used for pressure independent airflow control in terminal units for variable-air-volume (VAV) and constant-volume (CV) air-moving systems.

3. DEFINITIONS

3.1 This section provides definitions of key terms used in this standard. For terms not defined, refer to the definitions listed in *ASHRAE Terminology of Heating, Ventilation, Air Conditioning, and Refrigeration.* [1].

airflow: the unit volume displacement of standard air per unit time, normally measured in standard cubic feet per minute (scfm) or liters per second (L/s).

air terminal: a single-duct air valve that selectively restricts or conducts passage of air between a fan system and a defined space in response to an external demand.

ammeter: a device used to measure the electrical current in a circuit.

amplification factor (F): the ratio of flow probe pressure sensor output to true velocity pressure. For example, a flow probe pressure sensor output of 1.0 in. (250 Pa) of pressure at a velocity pressure of 0.43 in. (108 Pa) would have an amplification factor of 1.0/0.43 = 2.3.

$$F = \frac{P_{vm}}{P_v}$$

where both pressures are expressed in the same units. F may be calculated from K with the following formula, where A is the nominal duct area in feet squared. The nominal duct area is calculated based on the geometry of the duct, not on the actual free area.

$$F = \left(\frac{1096A}{K\sqrt{\rho}}\right)^2$$

auto-zero feature: any automatic means of adjusting the zero calibration point of a pressure or velocity transducer.

controlled air terminal: a single-duct air valve that automatically modulates the volume of air delivered to or removed from a defined space in response to an external demand.

controller-only test: used to measure the performance of a controller and actuator independent from the air terminal unit.

differential pressure: difference in pressure between any two locations in a system.

equivalent diameter: diameter of a circular-duct equivalent that will have a cross-sectional area that is equal to that of a particular rectangular duct. The equivalent diameter is calculated by the following equation:

$$D_e = \left(4 \times \frac{A}{\pi}\right)^{0.5}$$

where A is the cross-sectional area.

flow coefficient (K-factor): standard airflow, in cubic feet per minute, corresponding to a flow probe pressure sensor output of 1 in. of water. K may be calculated from the amplification factor, F, with the following formula, where A is the nominal duct area in feet squared (meters squared):

$$K = \left(\frac{1096A}{\sqrt{\rho F}}\right)$$

K is used with some terminal unit controls to calculate standard airflow using the following equation, where Q is airflow in cubic feet per minute and P_{vm} is flow sensor output in in. of water (Pa):

$$Q = K \times \sqrt{P_{vm}}$$

flow probe signal (P_{vm}): output of a velocity pressure flow probe (typically an amplified velocity pressure).

full-system test: measures the combined performance of a controller, actuator, and air terminal unit.

national measurement standard: measurement standard recognized by national authority to serve in a state or economy as the basis for assigning quantity values to other measurement standards.

pressure: force exerted per unit area.

reference airflow measuring system: combination of sensing devices and data acquisition hardware and software that produces the airflow value against which the system under test (SUT) is compared.