ANSI/AHRI Standard 431 (SI)

2020 Standard for

Performance Rating of Central Station Air-handling Unit Supply Fans

Approved by ANSI on 8 June 2023

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ICS Code: 27.200

Note:

This standard supersedes AHRI Standard 431-2014 with Addendum 1.
For I-P ratings, see ANSI/AHRI Standard 430-2020.

This standard was approved as an American National Standard (ANS) on 8 June 2023.

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PERFORMANCE RATING OF CENTRAL STATION AIR-HANDLING UNIT SUPPLY FANS

Section 1. Purpose

1.1 *Purpose.* The purpose of this standard is to establish for Central Station Air-handling Unit Supply Fans: definitions; classifications; test requirements; rating requirements; minimum data requirements for Published Ratings; marking and nameplate data; and conformance conditions.

1.1.1 *Intent.* This standard is intended for the guidance of the industry, including manufacturers, engineers, installers, contractors, and users.

1.1.2 *Review and Amendment.* This standard is subject to review and amendment as technology advances.

Section 2. Scope

2.1 *Scope.* This standard applies to Central Station Air-handling Units, as defined in Section 3.

2.1.1 This standard applies to Supply Fan ratings for Central Station Air-handling Units with Plenum Fans in a cabinet, Fan Arrays, Housed Centrifugal Fans, and Axial Fans.

(Informative Note: Fan and motor assemblies that are not intended to be separated are within the scope of this standard with the addition of the electrical power measurement method in Section 5.1.1.)

2.2 *Exclusions.*

2.2.1 This standard does not apply to unit heaters intended for free delivery of heated air or to room fan-coils as defined in AHRI Standard 440.

2.2.2 This standard does not apply to units that have direct expansion coils incorporated by the manufacturer in a matched split system air-conditioner, or as otherwise defined in AHRI Standard 210/240 or in AHRI Standard 340/360.

2.2.3 This standard does not apply to unit ventilators as defined in AHRI Standard 840.

2.2.4 This standard does not apply to DX Dedicated Outdoor Air System Units as defined in AHRI Standard 920.

2.2.5 This standard does not apply to Computer and Data Processing Room Air Conditioners as defined in AHRI Standard 1360.

Section 3. Definitions

All terms in this document will follow the standard industry definitions in the *ASHRAE Terminology* website (https://www.ashrae.org/resources--publications/free-resources/ashrae-terminology) unless otherwise defined in this Section.

3.1 *Actual Cubic Meters Per Second (Actual m^3/s), m^3/s.* The unit of airflow uncorrected for air density. All airflow in this standard is considered to be actual airflow rate.

3.2 *Appurtenances*. Equipment added to a CSAHU for purposes including but not limited to control, isolation, safety, static pressure regain, wear, etc. Appurtenances include, but are not limited to coils, filters, energy recovery devices, dampers, air-mixers, spray assemblies, eliminators, discharge plenums, and inlet plenums

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3.3 *Central Station Air-handling Unit (CSAHU).* A factory-made encased assembly consisting of a Supply Fan or Fans in parallel which may also include other necessary equipment to perform one or more of the functions of circulating, cleaning, heating, cooling, humidifying, dehumidifying and mixing of air. It shall not contain a source of mechanical cooling. The CSAHU shall have a maximum design external static pressure (ESP) greater than 250 Pa.

Note: While the ESP for a specific application may be less than 250 Pa, any units generally capable of delivering greater than 250 Pa ESP shall be considered to be a CSAHU.

3.3.1 *Ducted Fan Discharge CSAHU.* A unit that has a ducted fan outlet. (See Figure 1. Note that Figure 1 applies to Housed Centrifugal Fan and Axial Fans and that a Housed Centrifugal Fan is shown.)

3.3.2 *Unducted Fan Discharge CSAHU.* A unit containing a fan that does not have a ducted fan outlet. (See Figure 2. Note that Figure 2 applies to all fan types in the standard and that a Housed Centrifugal Fan is shown.)

3.4 *Fan Electrical Power* (FEP), kW. Electrical input power required to operate the Fan System at the Rating Point.

3.5 *Fan System*. Includes the Supply Fan, motor, and may include belt transmission, and/or a Motor Controller.

3.6 *Full Face Opening Axial Discharge.* Where the discharge opening of the CSAHU is the same cross-sectional dimensions as the interior of the CSAHU's casing and the direction of the airflow is parallel with the shaft of the fan or fans.

3.7 *Motor Controller*. A power electronic device that regulates the speed of a motor.

3.8 *Power Connection.* One or more points on the exterior and/or interior of the CSAHU intended for providing electricity from the supply mains to the unit. The points may supply multiple motors or Motor Controllers.

3.9 *Power Drive System (PDS):* An adjustable-speed electric AC power drive system, which includes a motor and the semiconductor power converter with means for control, protection, monitoring, and measurement of motors.

3.10 *Published Rating.* A statement of the assigned values of those performance characteristics, under stated Rating Conditions, by which a unit may be chosen to fit its application. These values apply to all units of like nominal capacity and type (identification) produced by the same manufacturer. As used herein, the term Published Rating includes the rating of all performance characteristics shown on the unit or published in specifications, advertising or other literature controlled by the manufacturer, at stated Rating Conditions.

3.11 *Rating Conditions.* Any set of operating conditions under which a single level of performance results and causes only that level of performance to occur.

3.12 *Rating Point*. A single airflow, air density, and pressure point within the published operating range of the fan.

3.13 *"Shall" or "Should".* "Shall" or "should" shall be interpreted as follows:

3.13.1 *Shall.* Where "shall" or "shall not" is used for a provision specified, that provision is mandatory if compliance with the standard is claimed.

3.13.2 *Should.* "Should" is used to indicate provisions which are not mandatory but which are desirable as good practice.

3.14 *Standard Air.* Air weighing 1.2 kg/m^3 which approximates dry air at 21°C and at a barometric pressure of 101.3 kPa.

3.15 *Supply Fan.* The fan that provides enough pressure to overcome the supply air restriction and may provide some or all of the pressure to overcome the return air restriction to provide air into the conditioned space.

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3.15.1 *Axial Fan*. A housed fan that moves air in the general direction of the axis about which it rotates. This includes tubeaxial fans, centaxial fans, and vaneaxial fans. Fan rotor or wheel within a tubular-type casing that includes supports for either Belt Drive or Direct Drive.

3.15.2 *Belt Drive*. Driver and driven fans with positive belted connections for rotations at any speed.

3.15.3 *Direct Drive.* Driver and driven fans with positive direct connections for rotations at the same speed.

3.15.4 *Fan Array*. A matrix of regularly spaced direct-drive Supply Fans operating in parallel with inflow from a common inlet plenum and with outflow into a common outlet plenum. All impellers and motors must be of Identical Construction. All Operating Fans must run at the same speed. If applicable, all Variable Frequency Drives must be programmed to provide identical frequency and voltage.

3.15.4.1 *Contained Fan.* Fans in a Fan Array that are within substantially uniform enclosure(s) and do not aerodynamically interact with each other within the array.

3.15.4.2 *Partially Contained Fan.* Fans in a Fan Array that are within non-uniform enclosure(s) and some Supply Fans aerodynamically interact with each other within the array.

3.15.4.3 *Uncontained Fan.* Fans in an array that aerodynamically interact with each other.

3.15.5 *Fan Housing*. The stationary element which guides the air before and after the fan's impeller.

3.15.6 *Housed Centrifugal Fan*. Fan in which the air enters the impeller axially and leaves it substantially in a radial direction. Fan rotor or wheel within a scroll-type casing (shroud) that includes supports for either Belt Drive or Direct Drive.

3.15.7 *Identical Construction*. A product which has the same manufacturer, the same model number, and is intended to have the same performance under the same conditions. Exception: the model numbers may differ if the only difference between the models is something which does not affect performance (e.g. color).

3.15.8 *Operating Fan*. Any Supply Fan which is designated by the CSAHU manufacturer to be energized and rotating at the specified Rating Condition

3.15.9 *Plenum Fan*. A fan assembly consisting of a single inlet impeller mounted perpendicular to airflow that pressurizes a plenum chamber in an air-distribution system.

3.16 *Variable Frequency Drive (VFD).* A power electronic device that regulates the speed of an alternating current (AC) motor by adjusting the frequency and the voltage of the electrical power supplied to the motor.

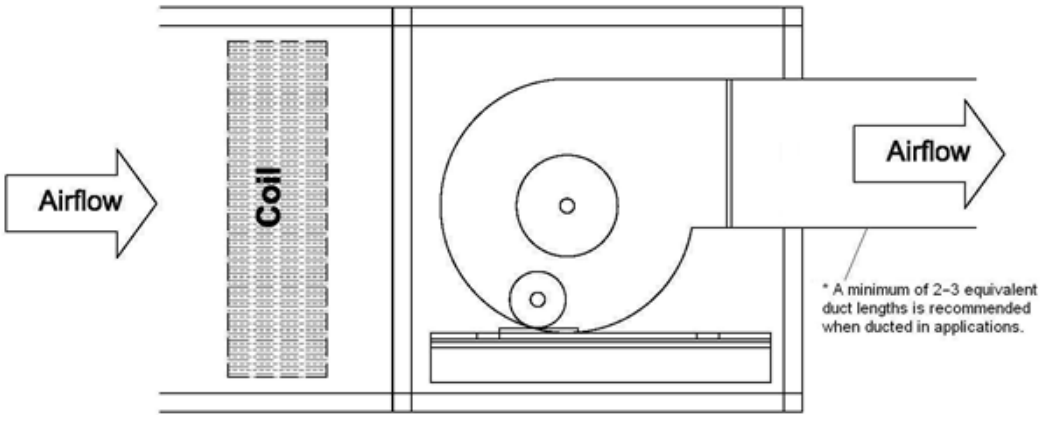


Figure 1. Ducted Fan Discharge – Horizontal Arrangement

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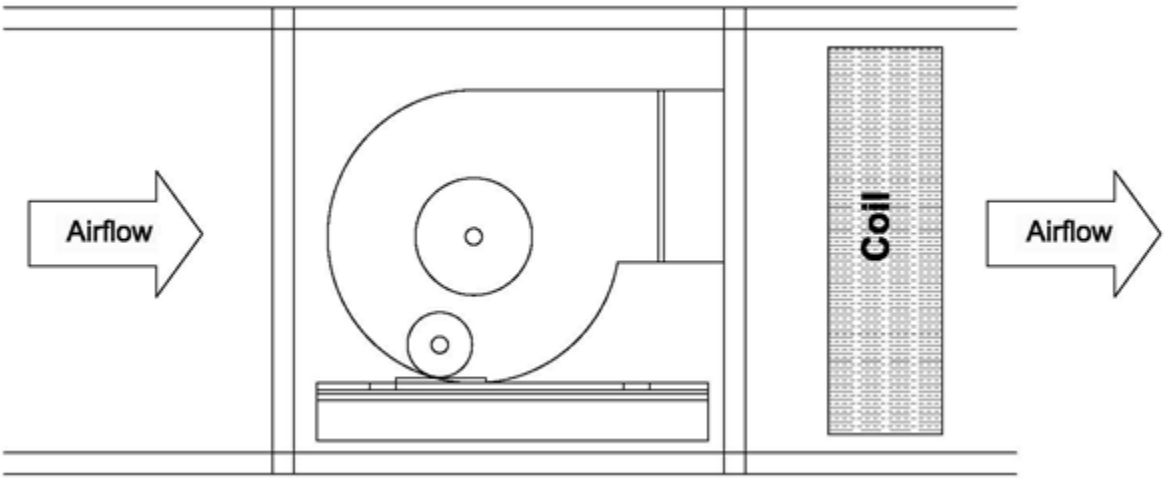


Figure 2. Unducted Fan Discharge – Horizontal Arrangement

Section 4. Classifications

4.1 *Methods of Classification.* Equipment covered within the scope of this standard shall be classified as shown:

4.1.1 *Unit Type.*

4.1.1.1 Ducted Discharge
4.1.1.2 Unducted Discharge

4.1.2 *Fan Type.*

4.1.2.1 Housed Centrifugal

4.1.2.1.1 Airfoil/Backward Inclined/Backward Curved
4.1.2.1.2 Forward Curved

4.1.2.2 Axial

4.1.2.3 Plenum

4.1.2.3.1 Single Plenum Fan
4.1.2.3.2 Plenum Fan Array

4.1.3 *Fan Drive Type.*

4.1.3.1 Belt Drive
4.1.3.2 Direct Drive

4.1.4 *Test Methods.*

4.1.4.1 Wire-to-Air Method. per Section 5.1.1
4.1.4.2 Fan Shaft Power (H_{act}) and Calculation of FEP per Section 5.1.2

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Section 5. Test Requirements

5.1 *Test Methods.* Acceptable test methods are described in Sections 5.1.1 and 5.1.2.

5.1.1 *Electrical power Measurement Wire-to-Air Method.* All Published Ratings shall be from testing conducted in accordance with AMCA Standard 210 and ASHRAE Standard 51. Electrical power shall either be measured by one of the two following methods:

5.1.1.1 Electrical power shall be measured at all airflows and pressures at which the CSAHU will be offered for sale.

5.1.1.2 Interpolations shall be performed per the requirements of Appendix G of this standard for calculation of electrical power measurement ratings at non-tested speeds and conditions.

5.1.2 *Fan Shaft Power and Calculation of FEP by AMCA Standard 207 Method.* For CSAHUs that include motors, transmissions, and optional Motor Controllers that meet the requirements of AMCA Standard 207, all Published Ratings shall be from fan shaft power testing conducted in accordance with AMCA Standard 210 and ASHRAE Standard 51 with FEP calculated per the requirements of AMCA Standard 207.

5.2 *Duct Arrangement*

5.2.1 *Single Outlet Ducted Fan Discharge CSAHUs.* Single outlet Ducted Fan Discharge CSAHUs shall be tested in accordance with AMCA Standard 210 and ASHRAE Standard 51.

5.2.2 *Multiple Outlet Ducted Fan Discharge CSAHUs.* Multiple outlet Ducted Fan Discharge CSAHUs shall be tested as described in Section 5.2.1 with each fan outlet ducted as shown in Figure 3 to the airflow measuring test setup. No corrections for individual fan outlet duct friction losses shall be made.

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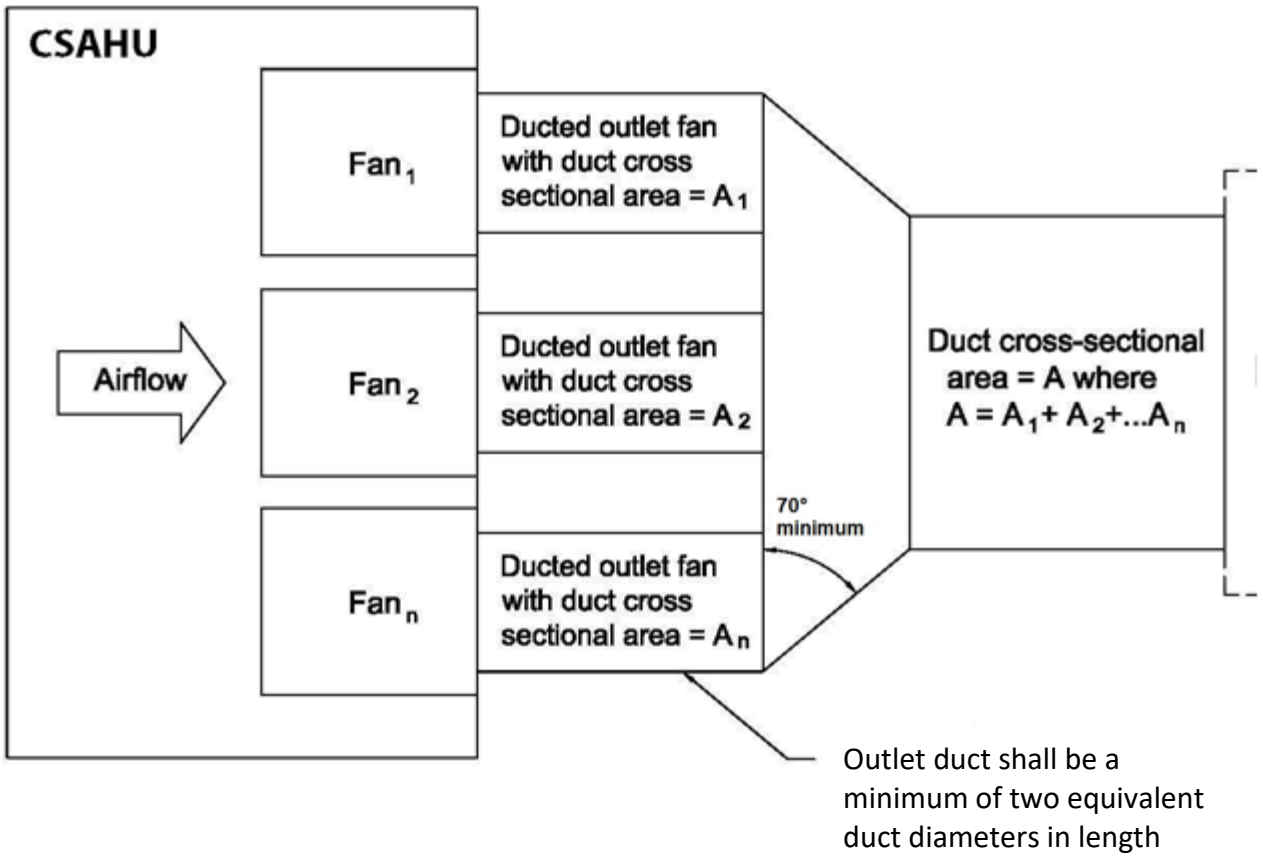


Figure 3. Outlet Test Unit Configuration for Multiple Parallel Housed Fans in CSAHUs with Individual Ducted Discharges

5.2.3 *Unducted Fan Discharge CSAHUs.* Unducted Fan Discharge CSAHUs shall be tested in accordance with AMCA Standard 210 and ASHRAE Standard 51, except when an outlet chamber with multiple nozzles within the chamber is used. If an outlet chamber with multiple nozzles within the chamber is used, the test chamber cross-sectional area shall be sized so that the maximum air velocity does not exceed 400 fpm. The test chamber height and width shall be at least 5% greater than the respective height and width of the duct connection at the test chamber. Discharge area cannot exceed the test chamber area. For an example, see Figure 4. Corrections for static pressure losses created by the test apparatus (e.g. the addition of ductwork) shall be made according to Appendix E and the ASHRAE Duct Fitting Database.

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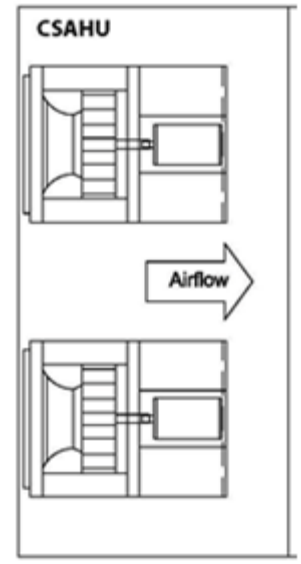


Figure 4. Single Outlet Test Unit Configuration for Single or Multiple Parallel Plenum Fans in CSAHUs with Full Face Opening Axial Discharge

5.3 *Fan Types*

5.3.1 *Plenum Fan Units.* The rating configuration for Plenum Fan units shall be Full Face Opening Axial Discharge with the minimum spacing allowed per the manufacturer's specifications between the coil and the fan. If Full Face Opening Axial Discharge is not possible due to the size of the unit compared to the test chamber, the unit shall be provided with an inlet or discharge plenum and the duct length shall be specified by the manufacturer but not exceed 3 duct diameters. Corrections for static pressure losses created by the test apparatus (e.g. the addition of ductwork) shall be made according to Appendix E and the ASHRAE Duct Fitting Database. The discharge or inlet plenum shall be considered as an Appurtenance to the CSAHU for the purpose of testing. The figure in AMCA 210 titled "Inlet Chamber Setup – Multiple Nozzles in Chamber" shall be used for the test set-up of Belt Drive Plenum Fan units (see Figure 5). Figures 5 or 6 shall be used for the test set-up of Direct Drive Plenum Fan units.

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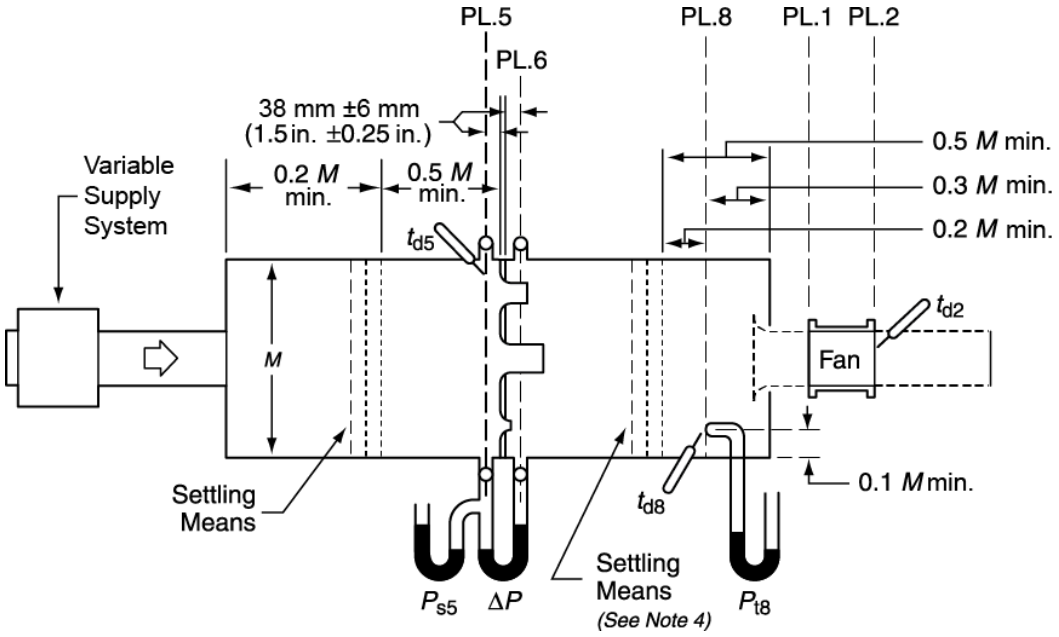


Figure 5. Inlet Chamber Setup – Multiple Nozzles in Chamber

(Figure 5 source: ANSI/AMCA 210-16; Copyright AMCA 2016. Reproduced by permission.)

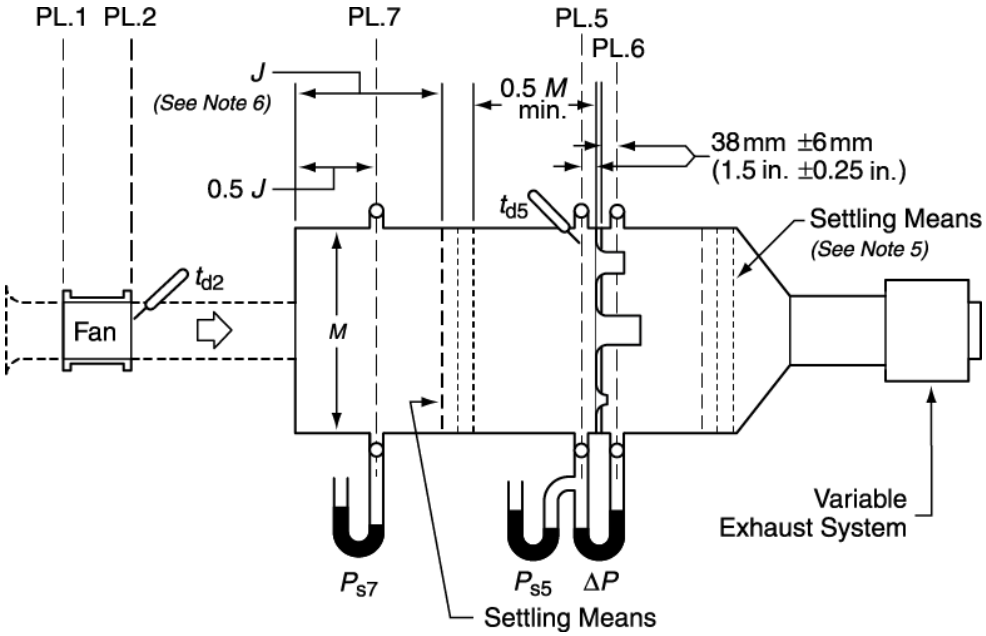


Figure 6. Outlet Chamber Setup – Multiple Nozzles in Chamber

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5.3.2 *Units with Direct Drive Fans*

5.3.2.1 The shaft power measurement for units with Direct Drive Supply Fans shall be either calibrated motor (as defined in the section of AMCA 210 titled "Calibrated Motor") or reaction dynamometer (as defined in the section of AMCA 210 titled "Reaction Dynamometers").

5.3.2.2 The electrical power measurement for units with Direct Drive Supply Fans shall be made using a power meter with an accuracy of ±0.5% of the indicated value.

5.3.3 *Units with Belt-drive Fans*

5.3.3.1 The shaft power measurement for units with Belt Drive Supply Fans shall be reaction dynamometer (as defined in the section of AMCA 210 titled "Reaction Dynamometers").

5.3.3.2 The electrical power measurement for units with Belt Drive Supply Fans shall be made using a power meter with an accuracy of ±0.5% of the indicated value.

5.3.4 *Units with Fan Arrays.* The rating configuration for units with Fan Arrays shall be Full Face Opening Axial Discharge with the minimum spacing allowed per the manufacturer's specifications between the coil and the fan. If Full Face Opening Axial Discharge is not possible due to the size of the unit, the unit shall be provided with an inlet or discharge plenum and a suitably sized duct shall extend from the plenum. Corrections for static pressure losses created by the test apparatus (e.g. the addition of ductwork) shall be made according to Appendix E and the ASHRAE Duct Fitting Database. The discharge or inlet plenum shall be considered as an Appurtenance to the CSAHU for the purpose of testing.

5.3.4.1 *Fan Shaft Power Method*. The shaft power determination for units with Fan Arrays shall use the calibrated motor method as defined in Section 4.4.3 of AMCA 210. (Optional)

5.3.4.1.1 The minimum number of motors to be calibrated shall be as specified in Table 1.

Table 1. Number of Motors to be Calibrated [1]

Number of Supply Fans in the Fan Array	Number of Motors to be Calibrated
2-4	2
5-8	3
9-12	4
13+	5

Notes:
1) An equal distribution of Contained and Uncontained Fans must be measured.

5.3.4.1.1.1 Refer to NEMA MG-1 for acceptable tolerances between motor calibrations. If the requirements in NEMA MG-1 are not met, then all motors shall be calibrated.

5.3.4.1.2 Motor calibrations shall be performed at the same frequency and voltage output as used during the test.

5.3.4.1.3 Average the calibrated motors to get the composite motor calibration.

5.3.4.1.3.1 To get the average composite motor calibration, create a scatterplot of the data and use simple linear regression to find the equation for the line fit in slope-intercept form.

5.3.4.1.3.1.1 Alternatively, a polynomial regression can be computed to improve accuracy instead of a linear regression.

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