ANSI/RESNET/ICC 380-2016 with Addendum A-2017 incorporated

Standard for Testing Airtightness of Building Enclosures, Airtightness of Heating and Cooling Air Distribution Systems, and Airflow of Mechanical Ventilation Systems

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SPECIAL NOTE

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RESNET obtains consensus through participation of its national members, associated societies, and public review.

This Standard is under continuous maintenance. In accordance with Section 10.9 of the *RESNET Standards Development Policy and Procedures Manual,* continuous maintenance proposals should be submitted to the Manager of Standards.

The Manager of Standards should be contacted for:

a. Interpretation of the contents of this Standard
b. Participation in the next review of the Standard
c. Offering constructive criticism for improving the Standard
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Contents

ANSI/RESNET/ICC 380-2016

Standard for Testing Airtightness of Building Enclosures, Airtightness of Heating and Cooling Air Distribution Systems, and Airflow of Mechanical Ventilation Systems

Forward (Informative)

Standard 380 has been developed to provide a consensus national standard for consistent measurement of several air-flow related residential building metrics. It builds on existing American National Standards to provide standard procedures essential to the evaluation of the energy performance of residential buildings.

This Standard provides a consistent, uniform methodology for evaluating the airtightness of building envelopes and heating and cooling air ducts and the air flows of mechanical ventilation systems. These test procedures can be used as building diagnostics, in quality assurance and control, for determining compliance with codes and standards, and to determine inputs to energy simulations and ratings. The Standard recognizes that some test procedures are easier to perform depending on building and HVAC system characteristics and that different codes and standards have specific testing requirements. Therefore, the Standard presents several alternative approaches for each measurement to allow flexibility in application of the standard.

This Standard is under continuous maintenance pursuant to RESNET's ANSI-accredited *Standards Development Policy and Procedures Manual* (http://www.resnet.us/professional/standards/consensus). Users are encouraged to propose changes. Forms and procedures for submitting change proposals may be found on RESNET's Website at http://www.resnet.us/professional/standards/submitting_amendments. When proposed addenda are available for public review and when approved addenda are published, notices will be published on RESNET's Website.

This Standard contains both normative and informative material. Normative materials make up the body of the Standard and must be complied with to conform to the Standard. Informative materials are clearly marked as such, are not mandatory, and are limited to this forward, footnotes, references and annexes.

1. Purpose

1.1. The provisions of this document are intended to establish national standards for testing the airtightness of enclosures and heating and cooling air distribution systems, and the airflow of mechanical ventilation systems. This Standard is intended for use by parties evaluating the performance of residential buildings including home energy raters, energy auditors, or code officials.

2. Scope

2.1. This Standard defines procedures for measuring the airtightness of building enclosures, the airtightness of heating and cooling air distribution systems, and the airflow of mechanical ventilation systems.

This Standard is applicable to all single-family dwelling units.

The procedure for measuring the airtightness of building enclosures is also applicable to dwelling units in multifamily buildings.

The procedure for measuring the airtightness of heating and cooling air distribution systems is also applicable to dwelling units in multifamily buildings, where each dwelling unit has its own duct system separate from other dwelling units.

The procedure for measuring the airflow of mechanical ventilation systems is also applicable to dwelling units in multifamily buildings, where each dwelling unit has its own ventilation system separate from other dwelling units.

3. Procedure for Measuring Airtightness of Building Enclosure

3.1. Equipment

The Equipment listed in this section shall have their calibrations checked at the manufacturer's recommended interval, and at least annually if no time is specified.

3.1.1. Air-Moving Fan. A fan that is capable of moving air into or out of the building to achieve one or more target pressure differences between the dwelling unit and the exterior.

3.1.2. Manometer. A device that is capable of measuring pressure difference with a maximum error of 1 % of reading, or 0.25 Pa (0.001 in. H2O), whichever is greater.

3.1.3. Airflow Meter. A device to measure volumetric airflow with a maximum error of 5% of the measured flow.

3.1.4. Thermometer. An instrument to measure air temperature with an accuracy of ±1°C (2°F).

3.1.5. Blower Door. A device that combines an Air-Moving Fan as defined in Section 3.1.1, an Airflow Meter as defined in Section 3.1.3, and a covering to integrate the Air-Moving Fan into the building opening.

3.2. Procedure to Prepare the Building for Testing

3.2.1. Fenestration. Exterior doors and windows shall be closed and latched.

3.2.2. Attached garages. All exterior garage doors and windows shall be closed and latched unless the Blower Door is installed between the Conditioned Space Volume and the garage, in which case the garage shall be opened to outside by opening at least one exterior garage door.

3.2.3. Crawlspaces. Crawlspaces shall be configured as follows and the position of the crawlspace access doors and hatches shall be recorded. When the access doors and hatches between Conditioned Space Volume and the crawlspace are closed, due to requirements in 3.2.3.1, 3.2.3.2.1, or 3.2.3.2.2, the crawlspace shall be excluded from Infiltration Volume and Conditioned Space Volume.

3.2.3.1. If a crawlspace is vented to the exterior, interior access doors and hatches between the Conditioned Space Volume and the crawlspace shall be closed. Exterior crawlspace access doors, hatches, and vents shall be left in their as-found position.

3.2.3.2. If a crawlspace is not vented to the exterior, all access doors and hatches between the Conditioned Space Volume and crawlspace shall be opened. Exterior crawlspace access doors, hatches, and vents shall be closed to the extent possible.

3.2.3.2.1. Exception 1: If the floor above the crawlspace is air sealed and insulated, the access doors and hatches between the Conditioned Space Volume and crawlspace shall be closed. Exterior crawlspace access doors, hatches, and vents shall be left in their as-found position.

3.2.3.2.2. Exception 2: In multifamily buildings where the crawlspace volume is continuous below multiple adjacent dwelling units, interior access doors and hatches between the dwelling unit under test and the crawlspace shall be closed. Exterior crawlspace access doors, hatches, and vents shall be left in their as-found position.

3.2.4. Attics. Attics shall be configured as follows and the position of the attic access doors and hatches shall be recorded. When the access doors and hatches between the Conditioned Space Volume and the attic are closed, due to requirements in 3.2.4.1 or 3.2.4.2.1, the attic shall be excluded from Infiltration Volume and Conditioned Space Volume.

3.2.4.1. If an attic is not *both* air sealed and insulated at the roof deck, access doors and hatches between the Conditioned Space Volume and the attic shall be closed. Exterior attic access doors, hatches and vents shall be left in their as-found position.

3.2.4.2. If an attic is both air sealed and insulated at the roof deck, interior access doors and hatches between the Conditioned Space Volume and the attic shall be opened. Exterior attic access doors, vents, and hatches shall be closed to the extent possible.

3.2.4.2.1. Exception: In multifamily buildings where the attic volume is continuous above multiple adjacent dwelling units, interior access doors and hatches between the dwelling unit under test and the attic shall be closed. Exterior attic access doors, hatches and vents shall be left in their as-found position.

3.2.5. Basements. Basements shall be configured as follows and the position of the basement doors shall be recorded. When doors between the Conditioned Space Volume and the basement are closed, due to requirements in 3.2.5.1.1 or 3.2.5.1.2, the basement shall be excluded from Infiltration Volume and Conditioned Space Volume.

3.2.5.1. All doors between the Conditioned Space Volume and basement shall be opened. Exterior basement access doors, vents, and hatches shall be closed to the extent possible.

3.2.5.1.1. Exception 1: When the floor above the basement is air sealed and insulated, doors between the basement and Conditioned Space Volume shall be closed. Exterior basement access doors, hatches and vents shall be left in their as-found position.

3.2.5.1.2. Exception 2: In multifamily buildings where the basement volume is continuous below multiple adjacent dwelling units, interior doors between the dwelling unit under test and the basement shall be closed. Exterior basement access doors, hatches and vents shall be left in their as-found position.

3.2.6. Interior doors. All doors between rooms inside the Conditioned Space Volume shall be opened.

3.2.7. Chimney dampers and combustion-air inlets on solid fuel appliances. Chimney dampers and combustion-air inlets on solid fuel appliances shall be closed. Precautions shall be taken to prevent ashes or soot from entering the dwelling unit during testing.

3.2.8. Combustion appliance flue vents. Combustion appliance flue vents shall be left in their as-found position.

3.2.9. Fans. Any fan or appliance capable of inducing airflow across the building enclosure shall be turned off including, but not limited to, clothes dryers, attic fans, kitchen and bathroom exhaust fans, air handlers, ventilation fans used in a whole-building mechanical ventilation system[1], and crawlspace and attic ventilation fans. This requirement to turn fans off includes accessible fans in adjacent attached dwelling units.

3.2.10. Dampers

3.2.10.1. Non-motorized dampers[2] that connect the Conditioned Space Volume to the exterior or to Unconditioned Space Volumes shall be left in their as-found positions.[3]

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[1] (Informative Note) For example, a system intended to meet ASHRAE Standard 62.2.
[2] (Informative Note) For example, pressure-activated operable dampers and fixed dampers.
[3] (Informative Note) For example, a fixed damper in a duct supplying outdoor air for an intermittent ventilation system that utilizes the HVAC fan shall be left in its as-found position.

3.2.10.2. Motorized dampers that connect the Conditioned Space Volume to the exterior or to Unconditioned Space Volume shall be placed in their closed positions and shall not be further sealed.

3.2.11. Non-dampered openings for ventilation, combustion air and make-up air

3.2.11.1. Non-dampered ventilation openings of intermittently operating local exhaust ventilation systems[4] that connect the Conditioned Space Volume to the exterior or to Unconditioned Space Volume shall be left open.

3.2.11.2. Non-dampered ventilation openings of intermittently operating whole-building ventilation systems, including HVAC fan-integrated outdoor air inlets, that connect the Conditioned Space Volume to the exterior or to Unconditioned Space Volume shall not be sealed.

3.2.11.3. Non-dampered ventilation openings of continuously operating local exhaust ventilation systems[5] that connect the Conditioned Space Volume to the exterior or to Unconditioned Space Volume shall be sealed at the exterior of the enclosure where conditions allow.

3.2.11.4. Non-dampered ventilation openings of continuously operating whole-building ventilation systems that connect the Conditioned Space Volume to the exterior or to Unconditioned Space Volume shall be sealed at the exterior of the enclosure where conditions allow.

3.2.11.5. All other non-dampered intentional openings between Conditioned Space Volume and the exterior or Unconditioned Space Volume shall be left open.[6]

3.2.12. Whole-building fan louvers/shutters. Whole-building fan louvers and shutters shall be closed. In addition, if there is a seasonal cover present, it shall be installed.

3.2.13. Evaporative coolers. The opening to the exterior of evaporative coolers shall be placed in its off position. In addition, if there is a seasonal cover present, it shall be installed.

3.2.14. Operable window trickle-vents and through-the-wall vents. Operable window trickle-vents and through-the-wall vents shall be closed.

3.2.15. Supply registers and return grilles. Supply registers and return grilles shall be left in their as-found position and left uncovered.

3.2.16. Plumbing drains with p-traps. Plumbing drains with empty p-traps shall be sealed or filled with water.

3.2.17. Vented combustion appliances. Vented combustion appliances shall remain off or in "pilot only" mode for the duration of the test.

3.3. Procedure to Install the Test Apparatus and Prepare for Airtightness Test

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[4] (Informative Note) For example, bath fan and kitchen range fan.
[5] (Informative Note) For example, bathroom or kitchen exhaust.
[6] (Informative Note) For example, un-dampered combustion air or make-up air openings shall be left in their open position.

3.3.1. The Blower Door shall be installed in an exterior doorway or window that has an unrestricted air pathway into the building and no obstructions to airflow within 5 feet of the fan inlet and 2 feet of the fan outlet. The opening that is chosen shall be noted on the test report. The system shall not be installed in a doorway or window exposed to wind, where conditions allow. It is permissible to use a doorway or window between the Conditioned Space Volume and an Unconditioned Space Volume as long as the Unconditioned Space Volume has an unrestricted air pathway to the outdoors and all operable exterior windows and doors of the Unconditioned Space Volume are opened to the outdoors. For multifamily dwelling units, if the main entry door is in an interior hallway then the hallway shall be well connected to outside through open windows or doors, or an exterior window or door[7] shall be used.

3.3.2. Tubing shall be installed to measure the difference in pressure between the enclosure and the outdoors in accordance with manufacturer's instructions. The tubing, especially vertical sections, shall be positioned out of direct sunlight.

3.3.3. The indoor and outdoor temperatures shall be measured using the Thermometer and recorded. Observations of general weather conditions shall be recorded.

3.3.4. The altitude of the building site above sea level shall be recorded with an accuracy of 500 feet (150 m).

3.3.5. The model and serial number(s) of all measurement equipment shall be recorded.

3.3.6. If the results of the test will be reported as Air Changes Per Hour at 50 Pa (0.2 in. H_2O) (ACH50), the Infiltration Volume of the dwelling unit shall be recorded.

3.3.7. If the results of the test will be reported as Specific Leakage Area (SLA), the Conditioned Floor Area of the dwelling unit shall be recorded.

3.4. Procedure to Conduct Airtightness Test. The leakage of the enclosure shall be measured using either the One-Point Airtightness Test in Section 3.4.1 or the Multi-Point Airtightness Test in Section 3.4.2**.**

3.4.1. One-Point Airtightness Test

3.4.1.1. With the Air-Moving Fan turned off and sealed, the pressure difference across the enclosure shall be recorded using the Manometer, with the outside as the reference. The measurement shall represent the average value over at least a 10-second period and shall be defined as the Pre-Test Baseline Building Pressure.

3.4.1.2. The Air-Moving Fan shall be unsealed, turned on, and adjusted to create an induced enclosure pressure difference of 50 ±3 Pa (0.2 in. ±0.012 H_2O), defined as the induced enclosure pressure minus the Pre-Test Baseline Building Pressure. Note that this value is permitted to be positive or negative, which will be dependent upon whether the enclosure is pressurized or depressurized. An

[7] (Informative Note) For example, leading to a deck or patio.

indication of whether the Air-Moving Fan pressurized or depressurized the dwelling unit shall be recorded.

If a 50 Pa (0.2 in. H_2O) induced enclosure pressure difference is achieved, then the average value of the induced enclosure pressure difference and the airflow at 50 Pa (0.2 in. H_2O), measured over at least a 10-second period, shall be recorded.

If a 50 Pa (0.2 in. H_2O) induced enclosure pressure difference is not achieved, then additional Air-Moving Fans shall be used or the highest induced enclosure pressure difference ($dP_{measured}$) and airflow ($Q_{measured}$) that was achieved with the equipment available, measured over at least a 10-second period, shall be recorded. A minimum of 15 Pa (0.06 in. H_2O) must be induced across the enclosure for the test to be valid.

3.4.1.3. The Air-Moving Fan shall be turned off and the dwelling unit returned to its as-found condition.

3.4.1.4. If an induced enclosure pressure difference of 50 Pa (0.2 in. H_2O) was not achieved in Section 3.4.1.2, then the recorded airflow ($Q_{measured}$) shall be converted to a nominal airflow at 50 Pa (0.2 in. H_2O) using Equation 1. Alternately, a Manometer that is equipped to automatically make the conversion to CFM50 or CMS50 is permitted to be used.

$$CFM50\ \left(\frac{ft^3}{min}\right) = Q_{measured}\left(\frac{ft^3}{min}\right)\left(\frac{50}{dP_{measured}}\right)^{0.65} \quad (1a)$$

$$CMS50\ \left(\frac{m^3}{s}\right) = Q_{measured}\left(\frac{m^3}{s}\right)\left(\frac{50}{dP_{measured}}\right)^{0.65} \quad (1b)$$

3.4.1.5. Corrected CFM50 (corrected CMS50) shall be calculated by making the adjustments due to density and viscosity using Equation 4 in Section 9 and annex A1 of ASTM E779-10 [8], by substituting CFM50 (CMS50) for C and Corrected CFM50 (corrected CMS50) for C_0.

3.4.1.6. The Effective Leakage Area (ELA) shall be calculated using Equation 2:

$$ELA(in^2) = \frac{Corrected\ CFM50}{18.2} \quad (2a)$$

$$ELA(m^2) = \frac{Corrected\ CMS50}{13.6} \quad (2b)$$

3.4.2. Multi-Point Airtightness Test

3.4.2.1. With the Air-Moving Fan turned off and sealed, the pressure difference across the enclosure shall be recorded using the Manometer, with the outside as the reference. The measurement shall represent the average value over at least a

[8] Software provided by manufacturers of test equipment is permitted to be used to perform these calculations if the manufacturer certifies that the calculations are performed in accordance with ASTM E779-10.

10-second period and shall be defined as the Pre-Test Baseline Building Pressure.

3.4.2.2. The Air-Moving Fan shall be unsealed, turned on, and adjusted to create at least five induced enclosure pressure differences at approximately equally-spaced pressure stations between 10 Pa (0.04 in. H_2O) and either 60 Pa (0.24 in. H_2O) or the highest achievable pressure difference up to 60 Pa. The induced enclosure pressure difference is defined as the measured enclosure pressure at the pressure station, with reference to the exterior, minus the Pre-Test Baseline Building Pressure. If a manometer is used that has automatic baseline adjustments[9] then the Pre-Test Baseline Building Pressure shall not be subtracted from the adjusted value. The induced enclosure pressure difference is positive for pressurization and negative for depressurization. An indication of whether the Air-Moving Fan pressurized or depressurized the dwelling unit shall be recorded.

At each pressure station, the average value of the induced enclosure pressure difference, the airflow, and the temperature, measured over at least a 10-second period, shall be recorded. The highest induced enclosure pressure difference shall be at least 25 Pa (0.1 in. H_2O). If 25 Pa (0.1 in. H_2O) is not achieved, the One-Point Airtightness Test in Section 3.4.1 shall be used.

3.4.2.3. The Air-Moving Fan shall be turned off and the dwelling unit returned to its as-found condition.

3.4.2.4. The airflow at each pressure station shall be corrected for altitude and temperature to determine the corrected airflow using the calculations in Section 9 of ASTM E779-10[10].

3.4.2.5. The corrected airflow (Q) and the induced enclosure pressure difference measured at each pressure station (dP) shall be used in a log-linearized regression of the form $Q = C(dP)^n$ to calculate[11,12] C and n.

3.4.2.6. The Effective Leakage Area (ELA) shall be calculated using Equation 3:

$$ELA(in^2) = C\left(\frac{ft^3}{minPa^n}\right) \times 0.567 \times 4^{(n-0.5)} \quad (3a)$$

$$ELA(m^2) = C\left(\frac{m^3}{sPa^n}\right) \times 0.775 \times 4^{(n-0.5)} \quad (3b)$$

Where C and n are the values determined in Section 3.4.2.5.

[9] Informative note: for example, a "baseline" or "extrapolation" feature that automatically subtracts a previously-measured baseline from the measured value before displaying the measurement.
[10] Software provided by manufacturers of test equipment is permitted to be used to perform these calculations if the manufacturer certifies that the calculations are performed in accordance with ASTM E779-10.
[11] (Informative Note) For example, using the procedures in ASTM E779-10, Section 9 and Annex A.1.
[12] Software provided by the test equipment manufacturer that automatically calculates C and n shall not be used unless the manufacturer certifies that the calculations are performed in accordance with ASTM E779-10.

3.4.2.7. The flow through the building envelope at 50 Pa (0.20 in. H_2O) (CFM50 or CMS50) shall be calculated using Equation 4:

$$CFM50 = C\left(\frac{ft^3}{minPa^n}\right)\times 50^{(n)} \quad (4a)$$

$$CMS50 = C\left(\frac{m^3}{sPa^n}\right)\times 50^{(n)} \quad (4b)$$

Where C and n are the values determined in Section 3.4.2.5.

3.5. Procedure to Apply Results of Enclosure Air Leakage Test

3.5.1. If the results of the building enclosure air leakage test are to be used for conducting an energy rating or assessing compliance with a building enclosure leakage limit[13], then the corrected airflow determined using a one-point test shall be adjusted using Equation 5a or 5b.

Adjusted CFM50 = 1.1 x Corrected CFM50 (5a)

Adjusted CMS50 = 1.1 x Corrected CMS50 (5b)

The ELA determined in Section 3.4.1.6 for a one-point air leakage test shall be adjusted using Equation 6.

Adjusted ELA = 1.1 x ELA (6)

Other applications of building enclosure air leakage testing and the results of multi-point testing do not require the corrections in this section.

3.5.2. If the results of the building enclosure leakage test are to be converted to Air Changes Per Hour at 50 Pa (0.2 in. H_2O) (ACH50), Specific Leakage Area (SLA), or Normalized Leakage Area (NLA), then Equations 7 through 9 shall be used.

ACH50 = Adjusted CFM50 x 60 / Infiltration Volume in cubic feet (7a)

ACH50 = Adjusted CMS50 x 3600 / Infiltration Volume in cubic meters (7b)

SLA = 0.00694 x ELA in in^2 / Conditioned Floor Area in square feet (8a)

SLA = 10.764 x ELA in m^2 / Conditioned Floor Area in square meters (8b)

NLA = SLA x $(S)^{0.4}$, where S is the number of stories above grade (9)

[13] (Informative Note) For example, defined by code or by an energy efficiency program.

4. Procedure for Measuring Airtightness of Duct Systems

In addition to the test procedures in this section, Test Method A from ASTM E1554-13 is approved for use provided that the building and duct system preparation procedures in Section 4.2 of this Standard are followed. The supply and return air leakage from Test Method A shall be added together and assumed equivalent to CFM25 or CMS25 to outside.

The leakage to outside test shall be performed using a Blower Door in the main entry to the dwelling unit to pressurize or depressurize the individual unit with reference to outside. If the main entry door is in an interior hallway then the hallway shall be well connected to outside through open windows or doors, or an exterior window or door[14] shall be used. Only the ducts serving the dwelling unit being tested shall be included in the test.

4.1. Equipment Needed

The Equipment listed in this section shall have their calibrations checked at the manufacturer's recommended interval, and at least annually if no time is specified.

4.1.1. Air-Moving Fan. A fan that is capable of moving air into or out of the duct system to achieve a pressure difference of 25 Pa (0.10 in. H_2O).

4.1.2. Manometer. A device that is capable of measuring pressure difference with an accuracy of ± 1% of reading or 0.25 Pa (0.0010 in. H2O), whichever is greater.

4.1.3. Flow Meter. A device to measure volumetric airflow with a maximum error of 5% of the measured flow.

4.1.4. Thermometer. An instrument to measure air temperature with an accuracy of ±1°C (±2°F).

4.1.5. Duct Leakage Tester. A device that combines an Air-Moving Fan as defined in Section 4.1.1 and a Flow Meter as defined in Section 4.1.3.

4.2. Procedure to Prepare the Building and the Duct System for Testing

4.2.1. The presence of all components that are included in the HVAC design for the dwelling unit[15] and integrated with the duct system shall be verified. The leakage from these components must be captured when the test is conducted. If these components have not yet been installed[16], then the test shall not be conducted.

4.2.2. The HVAC system controls shall be adjusted so that the air handler fan does not turn on during the test.

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[14] (Informative Note) Such as windows and doors opening to decks or patios.
[15] (Informative Note) For example, heating, cooling, ventilation, dehumidification, humidification, and filtration components.
[16] (Informative Note) For example, an air handler has not yet been installed in new construction.

4.2.3. Any fans that could change the pressure in either the Conditioned Space Volume or any spaces containing ducts or air handlers[17] shall be turned off.

4.2.4. All vented combustion appliances shall be turned off if there is a possibility that the space containing the appliance will be depressurized during the test procedure.

4.2.5. All filters in the duct system and air handler cabinet shall be removed. If the Duct Leakage Tester is installed at a return grille, any filters present at that grille shall also be removed. If present, filter slot cover(s) shall be replaced after removing filters.

4.2.6. Dampers within the duct system shall be treated as follows:

4.2.6.1. Non-motorized dampers[18] that connect the Conditioned Space Volume[19] to the exterior or to Unconditioned Space Volume shall be left in their as-found positions.[20]

4.2.6.2. Motorized dampers that connect the Conditioned Space Volume[19] to the exterior or to Unconditioned Space Volume shall be placed in their closed positions and shall not be further sealed.

4.2.6.3. All zone and bypass dampers shall be set to their open position to allow uniform pressures throughout the duct system.

4.2.6.4. All balancing dampers shall be left in their as-found position.

4.2.7. Non-dampered ventilation openings within the duct system shall be treated as follows:

4.2.7.1. Non-dampered ventilation openings of intermittently operating whole-building ventilation systems, including HVAC fan-integrated outdoor air inlets, that connect the Conditioned Space Volume[19] to the exterior or to Unconditioned Space Volume shall not be sealed.

4.2.7.2. Non-dampered ventilation openings of continuously operating whole-building ventilation systems that connect the Conditioned Space Volume[19] to the exterior or to Unconditioned Space Volume shall be sealed at the exterior of the enclosure where conditions allow.

4.2.8. Supply registers and return grilles shall be temporarily sealed at both the face and the perimeter. Registers atop carpets are permitted to be removed and the face of the duct boot temporarily sealed during testing. For dwelling units without registers and grilles present[21], the face of the duct boots shall be sealed instead.

4.3. Procedure to Install the Test Apparatus and Prepare for Airtightness Test

There are two acceptable methods for attaching the Duct Leakage Tester to the duct system. Method 1 is permitted to be used for all duct systems. Method 2 is permitted only if:

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[17] (Informative Note) For example, bathroom fans, clothes dryers, kitchen vent hood, attic fan.
[18] (Informative Note) For example, pressure-activated operable dampers, fixed dampers.
[19] (Informative Note) This includes space conditioning duct systems.
[20] (Informative Note) For example, a fixed damper in a duct supplying outdoor air for an intermittent ventilation system that utilizes the HVAC fan shall be left in its as-found position.
[21] (Informative Note) For example, new construction.

i) the duct system has three or fewer return grilles, or

ii) the total duct leakage is less than 50 cfm (25 L/s) at 25 Pa, or

iii) local codes require licensing, that parties conducting the test have not obtained, in order to remove the blower access panel, or

iv) the air handler blower access is in an attic or crawlspace that has limited or restricted entry or exit[22]

- *Method 1 Installation*. The air handler blower access panel shall be removed and the Duct Leakage Tester attached to the blower compartment access.

- *Method 2 Installation*. The Duct Leakage Tester shall be attached to the largest return grille in the system. For systems with multiple returns of equal largest size, the return closest to the air handler shall be used. The remaining opening in the return grille and all other return grilles shall be temporarily sealed.

4.3.1. If the duct leakage to outside will be measured then a Blower Door shall be installed in the enclosure per Sections 3.3.1 and 3.3.2.

4.3.2. The static pressure probe(s) for the Duct Leakage Tester shall be installed using one of the following options.

When using Method 2 for a duct system with more than three returns (based on the exception in Section 4.3), then only Section 4.3.2.4 shall be used.

4.3.2.1. A single static pressure probe shall be located at the supply register closest to the air handler; or,

4.3.2.2. A single static pressure probe shall be located in the main supply trunk line, at least 5 feet from the air handler; or,

4.3.2.3. A single static pressure probe shall be located in the supply plenum; or,

4.3.2.4. A single static pressure probe shall be located according to Section 4.3.2.1, 4.3.2.2, or 4.3.2.3, and a second probe shall be located in the return plenum or in the closest return grill to the air handler, unless this is where the Duct Leakage Tester is installed, in which case the second closest return grille to the air handler shall be used. The return duct system pressure probe shall not be located in the airstream of the duct tester.

4.3.3. The Manometer and tubing for the Duct Leakage Tester shall be connected to the pressure probe(s) installed in Section 4.3.2, in accordance with the manufacturer's instructions, so that the duct system pressure is capable of being measured with reference to the inside of the building.

[22] (Informative Note) For example, ladders, and temporary, movable, spiral, or articulated stairs will usually be considered a limited or restricted means of entry or exit.

If Section 4.3.2.4 has been selected, then both the supply- and return-side duct system pressure probes shall be connected to a "tee" fitting, and the third leg of the "tee" shall then be connected to the Manometer in the position indicated by the manufacturer's instructions to measure the duct system pressure.

4.3.4. The locations where the Duct Leakage Tester and pressure probe(s) have been installed shall be recorded.

4.4. Procedure to Conduct Airtightness Test

The total leakage of the duct system shall be measured using the total duct leakage test in Section 4.4.1 or the leakage of the duct system to the outside shall be measured using the duct leakage to outside test in Section 4.4.2.

4.4.1. Total Duct Leakage Test

4.4.1.1. If ducts run through Unconditioned Space Volume including attics, garages or crawlspaces, then any vents, access panels, doors, or windows between those spaces and the outside shall be opened. At least one door, window or comparable opening between the building and the outside shall be opened to prevent changes in building pressure when the Duct Leakage Tester is running.

4.4.1.2. The Duct Leakage Tester shall be turned on and adjusted to create an induced duct system pressure difference of 25 ± 3 Pa (0.1± 0.012 in. H2O) with reference to outside. Note that this value is permitted to be positive or negative, which will be dependent upon whether the duct system is pressurized or depressurized.

If a 25 Pa (0.1 in. H_2O) induced duct system pressure difference is achieved, then the average value of the duct system pressure difference and the airflow at 25 Pa (0.1 in. H_2O) (CFM25, CMS25), measured over at least a 10-second period, shall be recorded.

If a 25 Pa (0.1 in. H_2O) induced duct system pressure difference is not achieved, then the highest induced duct system pressure difference ($dP_{measured}$) and airflow ($CFM_{measured}$, $CMS_{measured}$) that was achieved with the equipment available, measured over at least a 10-second period, shall be recorded.

4.4.1.3. An indication of whether the Duct Leakage Tester is pressurizing or depressurizing the duct system shall be recorded.

4.4.1.4. The Duct Leakage Tester shall be turned off and the dwelling unit returned to its as-found condition.

4.4.1.5. If an induced duct system pressure difference of 25 Pa (0.1 in. H_2O) was not achieved in Section 4.4.1.2, then the recorded airflow ($CFM_{measured}$, $CMS_{measured}$) shall be converted to a nominal airflow at 25 Pa (0.1 in. H_2O) (CFM25, CMS25) using Equation 10. Alternately, a Manometer that is equipped to automatically make the conversion to CFM25 or CMS25 is permitted to be used.

$$CFM25 = CFM_{measured}\left(\frac{25}{dP}\right)^{0.6} \quad (10a)$$

$$CMS25 = CMS_{measured}\left(\frac{25}{dP}\right)^{0.6} \quad (10b)$$

4.4.2. Duct Leakage to Outside Test

4.4.2.1. If ducts run through Unconditioned Space Volume including attics, garages or crawlspaces, then any vents, access panels, doors, or windows between those spaces and the outside shall be opened. All exterior doors and windows between the Conditioned Space Volume and outside shall be closed, and other openings to the outside with potential to hinder the ability of the Air-Moving Fan to achieve an induced enclosure pressure difference of 25 Pa (0.1 in. H_2O) with reference to outside shall be closed or covered in some manner. Interior doors shall be opened.

4.4.2.2. With the Air-Moving Fan for the enclosure and the Duct Leakage Tester sealed and turned off, one measurement of the pressure difference across the enclosure shall be recorded, with the outside as the reference. The measurement shall represent the average value over at least a 10-second period and shall be defined as the Pre-Test Baseline Building Pressure.

4.4.2.3. The Air-Moving Fan for the enclosure shall be unsealed, turned on, and adjusted to create an induced enclosure pressure difference of 25 ± 3 Pa (0.1 ±0.012 in. H_2O), defined as the induced enclosure pressure minus the Pre-Test Baseline Building Pressure. Note that this value is permitted to be positive or negative, which will be dependent upon whether the enclosure is pressurized or depressurized.

If a 25 Pa (0.10 in. H_2O) induced enclosure pressure difference is not achieved, then the highest possible value up to 25 (0.10 in. H_2O) Pa shall be achieved with the equipment available.

4.4.2.4. The Duct Leakage Tester shall be unsealed, turned on, and adjusted to create an induced duct system pressure difference of 0.0 ± 0.5 Pa (0.0±0.002 in. H_2O), relative to the dwelling unit. If an induced duct system pressure difference of 0.0 Pa (0.0 in. H_2O) is not achieved, then the airflow of the Air-Moving Fan for the enclosure shall be reduced until an induced duct system pressure difference of 0.0 Pa (0.0 in. H_2O) is achieved.

4.4.2.5. The induced enclosure pressure difference shall be re-checked and the Air-Moving Fan for the enclosure shall be adjusted to maintain 25 Pa (0.10 in. H_2O) or the highest achievable value up to 25 (0.10 in. H_2O) Pa, per Section 4.4.2.3, or the airflow required to maintain an induced duct system pressure difference of 0.0 Pa (0.0 in. H_2O), per Section 4.4.2.4.

4.4.2.6. The induced duct system pressure difference shall be re-checked and the Duct Leakage Tester shall be adjusted to maintain 0.0 ± 0.5 Pa (0.0±0.002 in. H_2O), per Section 4.4.2.4.

4.4.2.7. Repeat 4.4.2.5 and 4.4.2.6 until the induced enclosure pressure difference is 25 Pa (0.10 in. H_2O) or the highest achievable value up to 25 Pa (0.10 in. H_2O) and the induced duct system pressure difference is 0.0 Pa (0.0 in. H_2O).

- If a 25 Pa (0.10 in. H_2O) induced enclosure pressure difference is achieved, then the average value of the induced enclosure pressure

difference, the induced duct system pressure difference, and the airflow at 25 Pa (0.10 in. H_2O) (CFM25, CMS25), measured over at least a 10-second period, shall be recorded.

- If a 25 Pa (0.10 in. H_2O) induced enclosure pressure difference is not achieved, then the average value of the highest induced enclosure pressure difference (dP_{high}), the induced duct system pressure difference, and the airflow (Q_{high}) that was achieved with the equipment available, measured over at least a 10-second period, shall be recorded.

4.4.2.8. An indication of whether the Air-Moving Fan for the enclosure is pressurizing or depressurizing the dwelling unit and whether the Duct Leakage Tester is pressurizing or depressurizing the duct system shall be recorded.

4.4.2.9. The Air-Moving Fan for the enclosure and the Duct Leakage Tester shall be turned off and the dwelling unit returned to its as-found condition.

4.4.2.10. If an induced enclosure pressure difference of 25 Pa (0.10 in. H_2O) was not achieved or a different value was used to achieve an induced duct system pressure difference of 0.0 Pa (0.0 in. H_2O), then the recorded airflow ($CFM_{measured}$, $CMS_{measured}$) shall be converted to a nominal airflow at 25 Pa (0.10 in. H_2O) (CFM25,CMS25) using Equation 10. Alternately, a Manometer that is equipped to automatically make the conversion to CFM25 or CMS25 is permitted to be used.

4.5. Procedure to Apply Results of Duct System Leakage Test

4.5.1. If the results of the duct system leakage test are to be used for assessing compliance with a limit on total duct system leakage[23], then the total duct leakage determined in Section 4.4.1.2 or 4.4.1.5 shall be used.

4.5.2. If the results of the duct system leakage test are to be used for assessing compliance with a limit on duct system leakage to the outside[24], then the duct system leakage to outside determined in Section 4.4.2.7 or 4.4.2.10 shall be used. Alternatively, the total duct leakage determined in Section 4.4.1.2 or 4.4.1.5 is permitted to be used as if it were the leakage to outside[25].

4.5.3. If the results of the duct system leakage test are to be used for conducting an energy audit or predicting savings from retrofits, then the duct system leakage to outside determined in Section 4.4.2.7 or 4.4.2.10 shall be used.

[23] (Informative Note) For example, defined by code or by an energy efficiency program.
[24] (Informative Note) For example, defined by code, by an energy efficiency program, or for a home energy rating.
[25] (Informative Note) For example, the total leakage value is permitted to be used in software as if it were leakage to the outside.

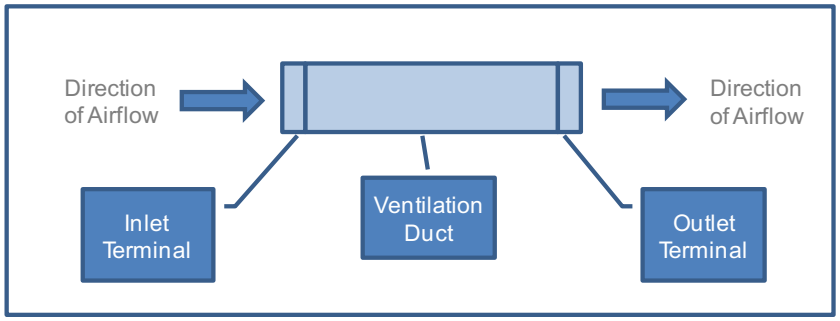
5. Procedure for Measuring Airflow of Mechanical Ventilation Systems

The purpose of this test procedure is to measure the volumetric airflow through a mechanical ventilation system including a whole-building ventilation system[26] or a local mechanical exhaust system[27, 28].

The airflow is permitted to be measured at the inlet terminal, per Section 5.1; or at the outlet terminal, per Section 5.2; or mid-stream in the ventilation duct, per Section 5.3.

The inlet terminal is defined as the location where the ventilation air enters the mechanical ventilation system and the outlet terminal is defined as the location where the ventilation air exits the mechanical ventilation system. A diagram of these locations for a generic mechanical ventilation system is shown in Figure 1.

Figure 1: Location of Terminals in Generic Mechanical Ventilation System



5.1. Procedure to Measure Airflow at Inlet Terminal

This Section defines procedures to measure the airflow of a mechanical ventilation system at an inlet terminal. The airflow is permitted to be measured using a Powered Flow Hood (Section 5.1.1); using an Airflow Resistance Device (Section 5.1.2); or using a Passive Flow Hood (Section 5.1.3).

5.1.1. Powered Flow Hood

5.1.1.1. Equipment Needed

[26] (Informative Note) For example, an outdoor air duct connected to the return trunk of an HVAC system, an in-line supply fan, an HRV, or an ERV.
[27] (Informative Note) For example, bathroom exhaust fan, kitchen exhaust fan.
[28] (Informative Note) Measuring the ventilation air supplied to corridors of multifamily buildings is beyond the scope of this Standard. However, measuring the flow rate of exhaust or supply systems used for mechanical ventilation in individual dwelling units is within the scope of this Standard.

The Equipment listed in this section shall have their calibrations checked at the manufacturer's recommended interval, and at least annually if no time is specified.

5.1.1.1.1. Powered Flow Hood. A device consisting of a flow capture element capable of creating an airtight perimeter seal around the inlet terminal; an Airflow Meter capable of measuring the volumetric airflow through the flow capture element with an a maximum error of 5 % or 5 cfm (2.5 L/s or 0.0025 m^3/s), whichever is greater; and a variable-speed Air-Moving Fan that is capable of moving air through the flow capture element and Airflow Meter.

5.1.1.1.2. Manometer. A device that is capable of measuring the static pressure inside the flow capture element relative to the room with a maximum error of 1% of reading or 0.25 Pa (0.0010 in. H2O), whichever is greater.

5.1.1.2. Procedure to Conduct Airflow Test

5.1.1.2.1. The flow capture element of the Powered Flow Hood shall be placed over the inlet terminal, ensuring that an airtight perimeter seal has been created.

5.1.1.2.2. The variable-speed Air-Moving Fan shall be turned on and the airflow adjusted until, using the Manometer, zero pressure difference (+/- 0.1 Pa (0.0004 in H_2O)) is measured between the flow capture element and the room.

5.1.1.2.3. The average volumetric airflow through the Airflow Meter, measured over at least a 10-second period, shall be recorded, and the variable-speed Air-Moving Fan shall be turned off.

5.1.2. Airflow Resistance Device

5.1.2.1. Equipment Needed

The Equipment listed in this section shall have their calibrations checked at the manufacturer's recommended interval, and at least annually if no time is specified.

5.1.2.1.1. Airflow Resistance Device. A device consisting of a flow capture element that has a known opening area and is capable of creating an airtight perimeter seal around the inlet terminal.

5.1.2.1.2. Manometer. A device that can measure pressure difference with a maximum error of 1% of reading or 0.25 Pa (0.0010 in. H2O), whichever is greater.

5.1.2.2. Procedure to Conduct Airflow Test

5.1.2.2.1. The flow capture element of the Airflow Resistance Device shall be placed over the inlet terminal, ensuring that an airtight perimeter seal has been created.

5.1.2.2.2. The opening area of the Airflow Resistance Device shall be adjusted until, using the Manometer, the pressure difference between the flow capture

element and the room meets the manufacturer's requirements. If no manufacturer's requirement exists then the pressure shall be between 1 and 8 Pa (0.004 and 0.032 in. water).

5.1.2.2.3. The average pressure difference (dP) between the flow capture element and the room, measured over at least a 10-second period, shall be recorded.

5.1.2.2.4. Using the average pressure difference, the airflow shall be calculated using the manufacturer's flow conversion table or, for devices without a flow conversion table, the following equations:

$$Airflow\ (CFM) = Opening\ Area\ x\ 1.07\ x\ (dP)^{0.5} \quad (11a)$$

$$Airflow\ (L/s) = Opening\ Area\ x\ 0.078\ x\ (dP)^{0.5} \quad (11b)$$

Where: For Eq. 11a, Opening Area is in in^2 and dP is in Pa
For Eq. 11b, Opening Area is in cm^2 and dP is in Pa

5.1.2.3. Limitations of Procedure. An Airflow Resistance Device is only permitted to be used on mechanical ventilation systems that do not have multiple duct branches.

5.1.3. Passive Flow Hood

5.1.3.1. Equipment Needed

The Equipment listed in this section shall have their calibrations checked at the manufacturer's recommended interval, and at least annually if no time is specified.

5.1.3.1.1. Passive Flow Hood. A device consisting of a flow capture element capable of creating an airtight perimeter seal around the inlet terminal; and an Airflow Meter capable of measuring the volumetric airflow through the flow capture element with a maximum error of 5 % or 5 cfm (2.5 L/s or 0.0025 m^3/s), whichever is greater.

5.1.3.1.2. Manometer. A device that is capable of measuring pressure difference with a maximum error of 1% of reading or 0.25 Pa (0.0010 in. H2O), whichever is greater.

5.1.3.2. Procedure to Conduct Airflow Test

5.1.3.2.1. The flow capture element of the Passive Flow Hood shall be placed over the inlet terminal, ensuring that an airtight perimeter seal has been created.

5.1.3.2.2. A tube shall be inserted inside the flow capture element between the Airflow Meter and inlet terminal to allow for measurement of the pressure difference between inside the Passive Flow Hood and the room. Devices that have a built-in pressure tube are acceptable.

5.1.3.2.3. The pressure difference between the flow capture element and the room shall be measured. The procedure shall be terminated and no results recorded if: (1) the pressure difference exceeds test equipment

manufacturer's recommendations, or (2) there is no manufacturer recommendation, and the pressure difference is more than 8 Pa.

5.1.3.2.4. The airflow through the Airflow Meter shall be averaged over at least a 10-second period.

5.2. Procedure to Measure Airflow at Outlet Terminal

This Section defines procedures to measure the airflow of a mechanical ventilation system at an outlet terminal. The airflow is permitted to be measured using a Powered Flow Hood (Section 5.2.1) or using a Bag Inflation Device (Section 5.2.2).

5.2.1. Powered Flow Hood. To measure airflow at an outlet terminal using a Powered Flow Hood, Section 5.1.1 shall be followed except with all occurrences of the phrase "inlet terminal" replaced with "outlet terminal".

5.2.2. Bag Inflation Device

5.2.2.1. Equipment Needed

5.2.2.1.1. Bag Inflation Device. A flow capture element capable of creating an airtight perimeter seal around the outlet terminal that is connected to a plastic bag of known volume and holds the bag open[29], and a shutter that controls airflow into the bag.

The plastic bag shall be selected such that three or more measurements of a single outlet terminal produce results that are within 20% of each other.

The volume of the plastic bag shall be selected such that the bag will completely fill with air from the outlet terminal in the range of 3 to 20 seconds.

5.2.2.1.2. Stopwatch. A stopwatch capable of recording elapsed time +/- 0.1 seconds.

5.2.2.2. Procedure to Conduct Airflow Test

5.2.2.2.1. The bag shall be completely emptied of air and the shutter closed to prevent airflow into the bag.

5.2.2.2.2. The Bag Inflation Device shall be placed over the outlet terminal.

5.2.2.2.3. The shutter shall be rapidly removed and the Stopwatch started.

5.2.2.2.4. The Stopwatch shall be stopped when the bag is completely filled with air from the outlet terminal and the elapsed time recorded.

5.2.2.2.5. The airflow shall be calculated using the following equations:

$$Airflow\ (CFM) = \frac{8 \times Volume}{Elapsed\ Time} \quad (12a)$$

[29] (Informative Note) For example, a lightweight frame made of wood, plastic or metal wire.

$$Airflow\ (L/s) = \frac{4 \times Volume}{Elapsed\ Time} \quad (12b)$$

Where: Volume = The volume of the plastic bag, in gallons
Elapsed Time = The time that elapsed until the bag was filled, in seconds.

5.3. Procedure to Measure Airflow Mid-Stream in the Ventilation Duct

This Section defines a procedure to measure the airflow of a mechanical ventilation system mid-stream in the ventilation duct. The airflow is permitted to be measured using an Airflow Measurement Station (Section 5.3.1) or using an Integrated Diagnostic Tool (Section 5.3.3).

5.3.1. Equipment Needed

5.3.1.1. Airflow Measurement Station. An Airflow Measurement Instrument capable of simultaneously measuring and averaging velocity pressure across a duct diameter with a maximum error of 10% or 5 CFM (2.5 L/s), whichever is greater, coupled with a section of permanently installed smooth-walled ductwork designed to facilitate accurate readings (i.e., the Station). The Airflow Measurement Instrument shall either be temporarily inserted into the Station for the duration of the procedure or be permanently installed as part of the Station.[30] The Airflow Measurement Instrument shall contain a port that allows it to be connected to a Manometer. Any temporary air flow station shall have its calibration checked at the manufacturer's recommended interval, and at least annually if no time is specified.

5.3.1.2. Manometer. A device that is capable of measuring pressure difference with a maximum error of 1% of reading or 0.25 Pa (0.0010 in. H2O), whichever is greater.

5.3.2. Procedure to Conduct Airflow Test

5.3.2.1. The Air Flow Measurement Station shall be installed in an accessible location, per manufacturer's instructions, or it shall be verified that such a device has been installed and is accessible. If the Airflow Measurement Instrument is not permanently installed, it shall be inserted into the measurement port of the Station.

5.3.2.2. The installation shall be visually verified to comply with the Airflow Measurement Instrument's specifications for minimum distance to both upstream and downstream duct fittings and fan outlets.[31]

5.3.2.3. The cross-sectional area of the duct at the Station shall be recorded in ft^2 or m^2.

5.3.2.4. The Manometer shall be connected to the Airflow Measurement Instrument, and the average velocity pressure, measured over at least a 10-second period, shall be recorded.

[30] (Informative Note) For example, as part of a manufacturer-assembled device consisting of the instrument factory-mounted in a housing.
[31] (Informative Note) To minimize turbulence and ensure an accurate reading.

5.3.2.5. If the Airflow Measurement Instrument is not permanently installed, then it shall be removed and the port sealed with a sheet metal plug or metallic tape.

5.3.2.6. Using the average velocity pressure, the average velocity in feet per minute (FPM) or meter per second (m/s) shall be calculated using the Airflow Measurement Instrument manufacturer's velocity conversion table or equation.

5.3.2.7. Equation 13 shall be used to convert the average velocity to airflow.

$$Airflow\ (CFM) = V\ x\ A \quad (13a)$$

$$Airflow\ (L/s) = 1000\ x\ V\ x\ A \quad (13b)$$

Where:

For Equation 13a, V = Velocity, in fpm, and A = Cross-Sectional Duct Area, in ft^2.

For Equation 13b, V = Velocity, in m/s, and A = Cross-Sectional Duct Area, in m^2.

5.3.3. Integrated Diagnostic Tool

5.3.3.1. Equipment

5.3.3.1.1. Integrated Diagnostic Tool. A tool that is integrated into the ventilation equipment[32] that permits assessment of airflow with a manufacturer-reported maximum error 15% of the measured flow at the highest speed setting of the ventilation equipment.

5.3.3.2. Procedure to Conduct Airflow Test. Follow the manufacturer-provided instructions for the Integrated Diagnostic Tool to determine the airflow.

6. Air Handler Flow

6.1. The air handler flow shall be measured in accordance with ASHRAE 152-2014 or ASTM E1554M-13.

7. Hazards

7.1. Equipment Guards - The air-moving equipment shall be UL, CSA or CE listed and include all proper guards or cages to house the fan or blower and to prevent accidental access to any moving parts of the equipment.

7.2. Personal Protective Equipment - Use of safety equipment appropriate for general fieldwork is required; all local or federal OSHA requirements shall be followed.

7.3. Debris and Fumes - The blower or fan forces a large volume of air into or out of a building while in operation. Caution shall be exercised against sucking debris or exhaust gases from fireplaces and flues into the interior of the building. Care shall be exercised to prevent damage

[32] (Informative Note) For example, pressure taps, a device that measures a parameter such as watt draw that can be translated to airflow.

to internal furnishings, plants or pets due to influx of cold, warm or humid air. If the building will not remain unoccupied, except for testing personnel during the test, care shall be exercised regarding the potential for the fans to introduce respiratory hazards to the breathing zone of the occupied space.

7.4. Access and Working Space - The testing procedures for ventilation flow measurements sometimes require the use of ladders and/or access to equipment rooms, unfinished attics, and other volumes containing air distribution ducting in the building that are not intended for occupancy. Caution must be exercised in these spaces to avoid injury and damage to the building.

8. Definitions

Blower Door – A device that combines an Air-Moving Fan as defined in Section 3.1.1, an Airflow Meter as defined in Section 3.1.3, and a covering to integrate the Air-Moving Fan into the building opening.

Conditioned Floor Area (CFA)[33] – The floor area of the Conditioned Space Volume within a building, not including the floor area of attics, crawlspaces, and basements below air sealed and insulated floors. The following specific spaces are addressed to ensure consistent application of this definition:

- The floor area of a wall cavity that is adjacent to Conditioned Space Volume shall be included.
- The floor area of a basement shall be included if the party conducting the evaluation has either:
    - Obtained an ACCA Manual J, S, and either B or D report and verified that both the heating and cooling equipment and distribution system are designed to offset the entire design load of the volume, or,
    - Verified through visual inspection that both the heating and cooling equipment and distribution system serve the volume and, in the judgement of the party conducting evaluations, are capable of maintaining the heating and cooling temperatures specified by the Thermostat section in Table 4.2.2(1) of ANSI/RESNET/ICC 301-2014.
- The floor area of a garage shall be excluded, even when it is conditioned.
- The floor area of a thermally isolated sunroom shall be excluded.
- The floor area of an attic shall be excluded, even when it is Conditioned Space Volume.
- The floor area of a crawlspace shall be excluded, even when it is Conditioned Space Volume.

Conditioned Space Volume[34] **-** The volume within a building serviced by a space heating or cooling system designed to maintain space conditions at 78 °F (26 °C) for cooling and 68 °F (20

[33] Informative Note: Informative Annex A contains a table that summarizes parts of a dwelling unit that are included in Conditioned Floor Area

[34] Informative Note: Informative Annex A has a table that summarizes parts of a dwelling unit that are included in Conditioned Space Volume.

°C) for heating. The following specific spaces are addressed to ensure consistent application of this definition:

- If the volume both above and below a floor cavity meets this definition, then the volume of the floor cavity shall also be included. Otherwise the volume of the floor cavity shall be excluded.
- If the volume of at least one of the spaces horizontally adjacent to a wall cavity meets this definition, then the volume of the wall cavity shall also be included. Otherwise, the volume of the wall cavity shall be excluded.
- The volume of an attic that is not both air sealed and insulated at the roof deck shall be excluded.
- The volume of a vented crawlspace shall be excluded.
- The volume of a garage shall be excluded, even when it is conditioned.
- The volume of a thermally isolated sunroom shall be excluded.
- The volume of an attic that is both air sealed and insulated at the roof deck, the volume of an unvented crawlspace, and the volume of a basement shall only be included if the party conducting evaluations has either:
    - Obtained an ACCA Manual J, S, and either B or D report and verified that both the heating and cooling equipment and distribution system are designed to offset the entire design load of the volume, or,
    - Verified through visual inspection that both the heating and cooling equipment and distribution system serve the volume and, in the judgement of the party conducting evaluations, are capable of maintaining the heating and cooling temperatures specified by the Thermostat section in Table 4.2.2(1) of ANSI/RESNET/ICC 301-2014.

Infiltration Volume[35] – The sum of the Conditioned Space Volume and additional adjacent volumes in the dwelling unit that meet the following criteria:

- Crawlspaces, when the access doors or hatches between the crawlspace and Conditioned Space Volume are open during the enclosure airtightness test (Section 3.2.3),
- Attics, when the access doors or access hatches between the attic and Conditioned Space Volume are open during the enclosure airtightness test (Section 3.2.4),
- Basements, where the doors between the basement and Conditioned Space Volume are open during the enclosure airtightness test (Section 3.2.5).

Unconditioned Space Volume[36] **-** The volume within a building that is not Conditioned Space Volume but which contains heat sources or sinks that influence the temperature of the area or room. The following specific spaces are addressed to ensure consistent application of this definition:

[35] Informative Note: Informative Annex A has a table that summarizes parts of a dwelling unit that are included in Infiltration Volume.
[36] Informative Note: Informative Annex A has a table that summarizes parts of a dwelling unit that are included in Unconditioned Space Volume.

- If either one or both of the volumes above and below a floor cavity is Unconditioned Space Volume, then the volume of the floor cavity shall be included.
- If the volume of both of the spaces horizontally adjacent to a wall cavity are Unconditioned Space Volume, then the volume of the wall cavity shall be included.
- The volume of an attic that is not both air sealed and insulated at the roof deck shall be included.
- The volume of a vented crawlspace shall be included.
- The volume of an attached garage shall be included, even when it is conditioned.
- The volume of a thermally isolated sunroom shall be included.
- The volume of an attic that is both air sealed and insulated at the roof deck, the volume of an unvented crawlspace, and the volume of a basement shall be included unless it meets the definition of Conditioned Space Volume.

9. References

ASHRAE Standard 62.2-2013 "Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings", ASHRAE, Atlanta, GA.

ASTM E1554-13 “Standard Test Methods for Determining Air Leakage of Air Distribution Systems by Fan Pressurization”, published by ASTM International, www.astm.org

ASTM E779-10 “Standard Test Method for Determining Air Leakage Rate by Fan Pressurization”, published by ASTM International, www.astm.org

Informative Annex A

Space Type	Included In the Following Categories?			
	Conditioned Space Volume	Un-Conditioned Space Volume	Conditioned Floor Area	Infiltration Volume
Space conditioned to 68/78F (excluding attics, basements, crawlspaces, garages, and sunrooms, which are addressed below)	Yes		Yes	Yes
Attic air sealed & insulated at roof deck, and conditioned [1]	Yes			Sometimes
Attic air sealed & insulated at roof deck, but not conditioned		Yes		Sometimes
Attic not air sealed & insulated at roof deck		Yes		
Wall cavity, with at least one horizontally-adjacent space conditioned	Yes		Yes	Yes
Wall cavity, with both horizontally-adjacent spaces unconditioned		Yes		
Floor cavity, with volume above & below conditioned	Yes			Yes
Floor cavity, with either volume above or below unconditioned		Yes		Yes
Floor cavity, with both volume above and below unconditioned		Yes		
Unvented crawlspace, conditioned [1]	Yes			Sometimes [3]
Unvented crawlspace, not conditioned		Yes		Sometimes [3]
Vented crawlspace		Yes		
Basement, conditioned [2]	Yes		Yes	Sometimes [3]
All other basements		Yes		Sometimes [3]
Garage, even if conditioned		Yes		
Thermally isolated sunroom		Yes		

1) *To be considered conditioned, the party conducting evaluations must obtain an ACCA Manual J, S, and either B or D report and verify that both the heating and cooling equipment and distribution system are designed to offset the entire design load of the volume.*
2) *To be considered conditioned, the party conducting evaluations must: obtain an ACCA Manual J, S, and either B or D report and verify that both the heating and cooling equipment and distribution system are designed to offset the entire design load of the volume; or verify through visual inspection that both the heating and cooling equipment and distribution system serve the volume and, in the judgement of the party conducting evaluations, are capable of maintaining the heating and cooling temperatures specified by the Thermostat section in Table 4.2.2(1) of ANSI/RESNET 301-2104.*
3) *Include attic, basement or crawl space in Infiltration Volume if the door(s) or hatch(es) between that space and Conditioned Space Volume are open during enclosure air leakage testing (Section 3.2.3, 3.2.4, and 3.2.5).*