

Table RA3.1-2 – Duct Leakage Verification and Diagnostic Test Protocols and Compliance Criteria

Case	User Application	Leakage Compliance Criteria (% of Air Handler Airflow)	Procedure(s)
Sealed and tested new duct systems in single family homes and townhomes	Installer Testing at Final HERS Rater Testing	<del>-6%</del> <b>5%</b>	RA3.1.4.3.1
Sealed and tested new duct systems in single family homes and townhomes	Installer Testing at Rough-in, Air Handling Unit Installed	<del>-6%</del> <b>5%</b> Installer Inspection at Final	RA3.1.4.3.2 RA3.1.4.3.2.1 RA3.1.4.3.3
Sealed and tested new duct systems in single family homes and townhomes	Installer Testing at Rough-in, Air Handling Unit Not Installed	4% Installer Inspection at Final	RA3.1.4.3.2 RA3.1.4.3.2.2 RA3.1.4.3.3
Sealed and tested new duct systems in multi-family homes regardless of duct system location.	Installer Testing at Final HERS Rater Testing	12% Total Duct Leakage	RA3.1.4.3.1
Sealed and tested new duct systems in multi-family homes regardless of duct system location.	Installer Testing at Final HERS Rater Testing	6% Leakage to Outside	RA3.1.4.3.4
Verification of Low Leakage Air Handler with Sealed and Tested Duct System Compliance Credit	Installer Testing at Final HERS Rater Testing	compliance target values 6% or less as specified on the Certificate of Compliance	RA3.1.4.3.1 and RA3.1.4.3.9
Verification of low leakage ducts located entirely in conditioned space	Installed Testing HERS Rater Testing	25 CFM Leakage to Outside	RA3.1.4.3.8
Sealed and tested altered existing duct systems	Installer Testing HERS Rater Testing	15% Total Duct Leakage	RA3.1.4.3.1
Sealed and tested altered existing duct systems	Installer Testing HERS Rater Testing	10% Leakage to Outside	RA3.1.4.3.4
Sealed and tested altered existing duct systems	Installer Testing and Inspection HERS Rater Testing and Verification	Fails Leakage Tests but All Accessible Ducts are Sealed Inspection and Smoke Test with 100% Verification	RA3.1.4.3.5 RA3.1.4.3.6 RA3.1.4.3.7

#### RA3.1.4.3.1 Diagnostic Duct Leakage from Fan Pressurization of Ducts

The objective of this procedure is for an installer to determine or a rater to verify the total leakage of a new or altered duct system. The total duct leakage shall be determined by pressurizing the entire duct system to a positive pressure of 25 Pa (0.1 inches water) with respect to outside. The following procedure shall be used for the fan pressurization tests:

- (a) Verify that the air handler, supply and return plenums and all the connectors, transition pieces, duct boots and registers are installed and sealed. The entire duct system shall be included in the total leakage test.
- (b) For newly installed or altered ducts, verify that cloth backed rubber adhesive duct tape has not been used and if a platform or other building cavity used to house the air distribution system has been newly installed or altered, it contains a duct or is ducted with duct board or sheet metal.
- (c) Seal all the supply registers and return grilles except for one large centrally located return grille or the air handler cabinet access panel.
- (d) Attach the fan flowmeter device to the duct system at the unsealed return grille or the air handler cabinet access panel. Ensure that the air filter has been removed.
- (e) Install a static pressure probe at a supply register located close to the air handler, or at the supply plenum.
- (f) Adjust the fan flowmeter to produce a positive 25 Pa (0.1 inches water) pressure at the supply register or the supply plenum with respect to the outside or with respect to the building space with the entry door open to the outside.
- (g) Record the flow through the flowmeter; this is the leakage flow at 25 Pa (0.1 inches water).

- (h) Divide the leakage flow by the total air handler airflow determined by the procedure in Section RA3.1.4.2 and convert to a percentage. If the leakage flow percentage is equal to or less than the compliance criterion from Table RA3.1-2 the system passes.

#### RA3.1.4.3.2 Diagnostic Duct Leakage at Rough-in Construction Stage

Installers may determine duct leakage in new construction by using diagnostic measurements at the rough-in building construction stage prior to installation of the interior finishing. When using this measurement technique, the installer shall complete additional inspection (as described in section RA3.1.4.3.3) of duct integrity after the finishing wall has been installed. In addition, after the finishing wall is installed, spaces between the register boots and the wallboard shall be sealed. Cloth backed rubber adhesive duct tapes shall not be used to seal the space between the register boot and the wall board.

The duct leakage measurement at rough-in construction stage shall be performed using a fan pressurization device. The duct leakage shall be determined by pressurizing both the supply and return ducts to 25 Pa (0.1 inches water). The following procedure (either RA3.1.4.3.2.1 or RA3.1.4.3.2.2) shall be used:

##### RA3.1.4.3.2.1 *Ducts with the Air Handling Unit Installed and Connected:*

For total leakage:

- (a) Verify that supply and return plenums and all the collars, connectors, transition pieces, duct boots, and return boxes have been installed. If a platform or other building cavity is used to house portions of the air distribution system, it shall contain a duct, be lined with duct board or sheet metal, and all duct connectors and transition parts shall be installed and sealed. The platform, ducts, and connectors shall be included in the total leakage test. All joints shall be inspected to ensure that no cloth backed rubber adhesive duct tape is used.
- (b) Seal all the supply duct boots and return boxes except for one return duct box.
- (c) Attach the fan flowmeter device at the unsealed return duct box.
- (d) Insert a static pressure probe at one of the sealed supply duct boots located close to the supply plenum or at the supply plenum.
- (e) Adjust the fan flowmeter to maintain a positive 25 Pa (0.1 inches water) pressure in the duct system with respect to the outside, or with respect to the building space with the entry door open to the outside.
- (f) Record the flow through the flowmeter; this is the leakage flow at 25 Pa (0.1 inches water).
- (g) Divide the leakage flow by the total air handler airflow determined by the procedure in Section RA3.1.4.2 and convert to a percentage. If the leakage flow percentage is less than or equal to the compliance criterion from Table RA3.1-2 the system passes.

##### RA3.1.4.3.2.2 *Ducts with Air Handling Unit Not Yet Installed:*

For total leakage:

- (a) Verify that supply and return plenums and all the collars, connectors, transition pieces, duct boots, and return boxes have been installed. If a platform or other building cavity is used to house portions of the air distribution system, it shall contain a duct, be lined with duct board or sheet metal, and all duct connectors and transition parts shall be installed and sealed. The platform, ducts and connectors shall be included in the total leakage test. All joints shall be inspected to ensure that no cloth backed rubber adhesive duct tape is used.
- (b) Supply and return leaks may be tested separately, or the supply and return plenums may be connected together using suitable temporary air-tight means to facilitate testing the total system. If the supply and return systems are to be tested separately, the opening to the supply or return plenums shall be sealed to prevent leakage unless used as the point of attachment for the fan flowmeter.

- (c) Seal all the supply duct boots and/or return duct boxes except for a location where the fan flowmeter device will be attached.
- (d) Attach the fan flowmeter device at the unsealed location..
- (e) Insert a static pressure probe at one of the sealed supply duct boots, or return duct boxes, located at a point in the system close to the fan flowmeter.
- (f) Adjust the fan flowmeter to produce a positive 25 Pa (0.1 inches water) pressure at the supply plenum with respect to the outside or with respect to the building space with the entry door open to the outside.
- (g) Record the airflow through the flowmeter; this is the leakage flow at 25 Pa (0.1 inches water).
- (h) If the supply and return ducts are tested separately, repeat items 4 through 6 with the flow meter attached to the unsealed return box and the static pressure probe in the return duct boxes, located at a point in the system close to the fan flowmeter, then add the two leakage rates together to get a total leakage flow.
- (i) Divide the leakage flow by the total air handler airflow determined by the procedure in Section RA3.1.4.2 and convert to a percentage. If the leakage flow percentage is less than or equal to the compliance criterion from Table RA3.1-2 the system passes.

#### RA3.1.4.3.3 Installer Visual Inspection at Final Construction Stage

After installing the interior finishing wall and verifying that one of the above rough-in tests was completed, the following procedure shall be used:

- (a) Remove at least one supply and one return register, and verify that the spaces between the register boot and the interior finishing wall are properly sealed.
- (b) If the house rough-in duct leakage test was conducted without an air handler installed, inspect the connection points between the air handler and the supply and return plenums to verify that the connection points are properly sealed.
- (c) Inspect all joints to ensure that no cloth backed rubber adhesive duct tape is used.

#### RA3.1.4.3.4 Duct Leakage to Outside from Fan Pressurization of Ducts

The objective of this test is to determine the amount of duct leakage to outside the air barrier for the conditioned space. This measurement is utilized to verify that duct systems are located entirely within conditioned space. The procedure is also utilized to provide an alternate leakage measurement for situations when it is likely that a portion of the total duct leakage is inside the air barrier for the conditioned space. The duct leakage to outside shall be determined by pressurizing the ducts and the conditioned space of the house to 25 Pa (0.1 inches water) with respect to outside. The following procedure shall be used for the fan pressurization test of leakage to outside:

- (a) Seal all the supply registers and return grilles except for one large centrally located return grille or the air handler cabinet access panel.
- (b) Attach the fan flowmeter device to the duct system at the unsealed return grille or the air handler cabinet access panel.
- (c) Install a static pressure probe at the supply plenum.
- (d) Attach a blower door to an external doorway.
- (e) If any ducts are located in an unconditioned basement, all doors or accesses between the conditioned space and the basement shall be closed, and at least one operable door or window (if it exists) between the basement and outside shall be open during the test.
- (f) If the ducts are located in a conditioned basement, any door between the basement and the remaining conditioned space shall be open, and any basement doors or windows to outside must be closed during the test.

- D. Joints and seams of duct systems and their components shall not be sealed with cloth back rubber adhesive duct tapes unless such tape is used in combination with mastic and drawbands.
  - E. Drawbands used with flexible duct.
    - i. Drawbands shall be either stainless-steel worm-drive hose clamps or UV-resistant nylon duct ties.
    - ii. Drawbands shall have a minimum tensile strength rating of 150 pounds.
    - iii. Drawbands shall be tightened as recommended by the manufacturer with an adjustable tensioning tool.
  - F. Aerosol-sealant closures.
    - i. Aerosol sealants shall meet the requirements of UL 723 and be applied according to manufacturer specifications.
    - ii. Tapes or mastics used in combination with aerosol sealing shall meet the requirements of this section.
4. **Duct Insulation R-value Ratings.** All duct insulation product R-values shall be based on insulation only (excluding air films, vapor retarder, or other duct components) and tested C-values at 75°F mean temperature at the installed thickness, in accordance with ASTM C518 or ASTM C177, incorporated herein by reference, and certified pursuant to Section 110.8.
5. **Duct Insulation Thickness.** The installed thickness of duct insulation used to determine its R-value shall be determined as follows:
- A. For duct board, duct liner, and factory-made rigid ducts not normally subjected to compression, the nominal insulation thickness shall be used.
  - B. For duct wrap, installed thickness shall be assumed to be 75 percent (25 percent compression) of nominal thickness.
  - C. For factory-made flexible air ducts, the installed thickness shall be determined by dividing the difference between the actual outside diameter and nominal inside diameter by two.
6. **Duct Labeling.** Insulated flexible duct products installed to meet this requirement shall include labels, in maximum intervals of 3 feet, showing the thermal performance R-value for the duct insulation itself (excluding air films, vapor retarder, or other duct components), based on the tests in Section 150.0(m)4 and the installed thickness determined by Section 150.0(m)5C.
7. **Backdraft Dampers.** All fan systems, regardless of volumetric capacity, that exchange air between the building conditioned space and the outside of the building shall be provided with backdraft or automatic dampers to prevent unintended air leakage through the fan system when the fan system is not operating.
8. **Gravity Ventilation Dampers.** All gravity ventilating systems that serve conditioned space shall be provided with either automatic or readily accessible, manually operated dampers in all openings to the outside except combustion inlet and outlet air openings and elevator shaft vents.
9. **Protection of Insulation.** Insulation shall be protected from damage, including that due to sunlight, moisture, equipment maintenance, and wind but not limited to the following: Insulation exposed to weather shall be suitable for outdoor service e.g., protected by aluminum, sheet metal, painted canvas, or plastic cover. Cellular foam insulation shall be protected as above or painted with a coating that is water retardant and provides shielding from solar radiation that can cause degradation of the material.
10. **Porous Inner Core Flex Duct.** Flexible ducts having porous inner cores shall not be used.
11. **Duct System Sealing and Leakage Testing.** When space conditioning systems utilize forced air duct systems to supply conditioned air to an occupiable space, the ducts shall be sealed, as confirmed through field verification and diagnostic testing, in accordance with all applicable procedures specified in Reference Residential Appendix RA3.1, and the leakage compliance criteria specified in Reference Residential Appendix TABLE RA3.1-2, and conforming to one of the following Subsections A, B, or C as applicable:
- A. For single family dwellings and townhouses with the air-handling unit installed and the ducts connected directly to the air handler, the total leakage of the duct system shall not exceed 5 percent of the nominal

- system air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.1.
- B. For single family dwellings and townhouses at the rough-in stage of construction prior to installation of the dwelling's interior finishing:
- Air-handling unit installed.  
If the air-handling unit is installed and the ducts are connected directly to the air handler, the total leakage of the duct system shall not exceed 5 percent of the nominal system air handler airflow as determined utilizing the procedures in Reference Residential Appendix Sections RA3.1.4.3.2, RA3.1.4.3.2.1 and RA3.1.4.3.3.
  - Air-handling unit not yet installed.  
If the air-handling unit is not yet installed, the total leakage of the duct system shall not exceed 4 percent of the nominal system air handler airflow as determined utilizing the procedures in Reference Residential Appendix Sections RA3.1.4.3.2, RA3.1.4.3.2.2 and RA3.1.4.3.3.
- C. For multifamily dwellings with the air-handling unit installed and the ducts connected directly to the air handler, regardless of duct system location,
- The total leakage of the duct system shall not exceed 12 percent of the nominal system air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.1, or
  - The duct system leakage to outside shall not exceed 6 percent of the nominal system air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.4.
12. **Air Filtration.** Mechanical systems that supply air to an occupiable space through ductwork exceeding 10 ft (3 m) in length and through a thermal conditioning component, except evaporative coolers, shall be provided with air filter devices in accordance with the following:
- A. **System Design and Installation.**
- The system shall be designed to ensure that all recirculated air and all outdoor air supplied to the occupiable space is filtered before passing through the system's thermal conditioning components.
  - The system shall be designed to accommodate the clean-filter pressure drop imposed by the system air filter device(s). The design airflow rate and maximum allowable clean-filter pressure drop at the design airflow rate applicable to each air filter device shall be determined.
  - All system air filter devices shall be located and installed in such a manner as to allow access and regular service by the system owner.
  - All system air filter device locations shall be labeled to disclose the applicable design airflow rate and the maximum allowable clean-filter pressure drop as determined according to subsection ii above. The labels shall be permanently affixed to the air filter device readily legible, and visible to a person replacing the air filter media.
- B. **Air Filter Media Efficiency.** The system shall be provided with air filter media having a designated efficiency equal to or greater than MERV 6 when tested in accordance with ASHRAE Standard 52.2, or a particle size efficiency rating equal to or greater than 50percent in the 3.0–10 µm range when tested in accordance with AHRI Standard 680.
- C. **Air Filter Media Pressure Drop.** The system shall be provided with air filter media that conforms to the maximum allowable clean-filter pressure drop determined according to Section 150.0(m)12Aii, when tested using ASHRAE Standard 52.2, or as rated using AHRI Standard 680, for the applicable design airflow rate(s) for the system air filter device(s). If the alternative to 150.0(m)13B is utilized for compliance, the design clean-filter pressure drop for the system air filter media shall conform to the requirements given in TABLE 150.0-B or 150.0-C.
- D. **Air Filter Media Product Labeling.** The system shall be provided with air filter media that has been labeled by the manufacturer to disclose the efficiency and pressure drop ratings that demonstrate conformance with Sections 150.0(m)12B and 150.0(m)12C