

# Duct Leakage to Outdoors

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## Scope



An energy rater uses a duct blower to test HVAC duct air leakage.

If the heating and cooling duct distribution system is located in unconditioned space (e.g., a vented attic or crawlspace), test the ducts for air leakage to the outdoors (i.e., into unconditioned space) in addition to testing total duct leakage.

Use a testing protocol approved by Residential Energy Services Network (RESNET) ([RESNET 2013](#)). This testing is typically done by a home energy rater certified by RESNET.

- Test duct leakage after all components of the system have been installed and air sealed, including the air handler, the ductwork, the duct boots, and the register grilles atop the finished surfaces (e.g., drywall, carpeting, flooring).
- If there is more than one system in the home, assess leakage on a per-system, rather than per-home, basis.
- Visually inspecting ducts prior to drywall installation allows for easier corrections.
- Either visually inspect or duct blower test ventilation ducts (e.g., ducts used for a separately ducted ERV or HRV system).
- Testing to outdoors is not required by ENERGY STAR or codes if the ducts are located completely within the conditioned space of the home and if certain other conditions exist, as described in the Compliance tab.

See the [Compliance Tab](#) for related codes and standards requirements, and criteria to meet national programs such as DOE's Zero Energy Ready Home program, ENERGY STAR Certified Homes, and Indoor airPLUS.

## Description

Duct leakage testing should be performed after all components of the system have been installed (including the air handler, ductwork, register boxes/boots, and all air devices such as diffusers, registers, or grills). Leakage limits should be assessed on a per-system, rather than per-home, basis. Duct leakage is determined and documented by a rater using a Residential Energy Services Network, Inc. (RESNET)-approved testing protocol. The accepted protocols are found in RESNET's *Mortgage Industry National Home Energy Rating Systems Standards*, Chapter 8, Section 803.3 ([RESNET 2006](#)).

Duct leakage testing per RESNET standards is performed using a duct tester such as the Minneapolis Duct Blaster or the Retrotec Duct Tester. The duct tester consists of three components: a calibrated fan that is used to either pressurize or depressurize the duct, a device to measure fan flow and building pressure, and supplies such as cardboard and tape or adhesive plastic sheeting to seal off the supply and return registers during the test. The fan is used to pressurize or depressurize the duct system to 25 pascals (0.10 inch water column [IN WC]) (RESNET Standards). Once at 25 pascals pressure, the air flow through the duct tester is read in cubic feet of air flow per minute at 25 pascals; this measurement is abbreviated as CFM25.

Two types of tests are performed: total duct leakage and leakage to the outdoors:

The "total" duct leakage test measures how much leakage there is for all of the ductwork connected to the HVAC system, including ducts located both outdoors and indoors. The ENERGY STAR Qualified Homes Version 3 HVAC Quality Installation Rater Checklist Note 4.1 requires that "total" duct leakage be < 8 CFM25 per 100 square feet (ft<sup>2</sup>) of conditioned floor area. For more on total duct leakage testing, see [Total Duct Leakage](#).

The "duct leakage to the outdoors" test measures only duct leakage outside of the home's air barrier, i.e., leakage to the outdoors, for example, into an unconditioned attic or crawlspace. The ENERGY STAR Qualified Homes Version 3 HVAC Quality Installation Rater Checklist Note 4.2 requires that duct leakage to the "outdoors" be <= 4 CFM25 per 100 ft<sup>2</sup> of conditioned floor area. For smaller homes (those with <= 1,200 ft<sup>2</sup> of conditioned floor area), measured duct leakage to outdoors shall be <= 5 CFM25 per 100 ft<sup>2</sup> of conditioned floor area.

For ducts in unconditioned spaces, both tests should be conducted, according to ENERGY STAR Version 3, Rev 6.

When ducts are located in conditioned spaces, only the "total" duct leakage test needs to be conducted if certain conditions apply according to ENERGY STAR Version 3, Rev 6. Testing of duct leakage to the outside can be waived if all ducts and air handling equipment are located within the home's pressure and thermal boundaries AND envelope leakage has been tested to be less than or equal to half of the Prescriptive Path infiltration limit for the Climate Zone where the home is to be built. Alternatively, testing of duct leakage to the outside can be waived if total duct leakage is <= 4 CFM25 per 100 ft<sup>2</sup> of conditioned floor area (or <= 5 CFM25 per 100 ft<sup>2</sup> of conditioned floor area for smaller homes that have less than 1,200 ft<sup>2</sup> of conditioned floor area).

**Figure 1** - A technician conducts a duct blaster test. 

The measured duct leakage can be compared to rated air handler flow to get a sense of the energy penalty that duct leaks are contributing in BTU/h. (This is not an ENERGY STAR requirement.) Cooling systems move 400 cubic feet of air per minute over the evaporator coil per ton of cooling. Each cubic foot of air moved will carry with it 30 BTU/h. A 2.5-ton cooling system moves 1,000 CFM of air and puts out 30,000 BTU/h. If that system has a measured duct leakage of 10% (100 CFM25), it is losing 3,000 BTU/h (1/4 ton) of cooling to outdoors.

Leakage limits are assessed on a per-system, rather than per-home, basis. So, for example, if a home has two furnaces, duct leakage must be measured in each system and compared to the square footage that the system conditions. Each system must meet the "total" and "outdoors" leakage requirements to qualify for the ENERGY STAR program.

**Figure 2** - The duct tester and blower door are set up to measure leakage to the outdoors. The blower door is set to depressurize the house to -25 pascals with respect to the outdoors. Then the duct tester is set to depressurize the duct system to 0 pascals with reference to the house. The flow reading on the right side of the manometer indicates duct leakage to the outside in CFM. In this case, duct leakage to the outdoors is 100 CFM at 25 pascals. Some raters prefer to do this test with the fans reversed so that they pressurize the house and ducts to 25 pascals rather than depressurizing the house to -25 pascals. 

## How to Test Duct Leakage to the Outdoors

1. Install a blower door in an exterior door that opens to a central location in the home. If the duct tester is set up to pressurize the duct system, then set up the blower door to pressurize the home. If the duct tester is set up to depressurize the duct system, set up the blower door to depressurize the home. Regarding pressurizing versus depressurizing, the test will work either way, the decision is up to the rater.
2. Close all exterior doors and windows between the building and the outside during the test.
3. Attach the duct that comes connected to the duct tester to the largest return duct grille using tape. Set up the duct tester per manufacturer's instructions to either pressurize or depressurize the duct system (whichever is preferred).
4. Temporarily seal shut all of the other supply and return duct registers using cardboard and tape or removable adhesive plastic.
5. Turn on the blower door fan and bring the building pressure to 25 pascals with reference to the outdoors.

6. Turn on the duct tester fan and increase the air flow until the pressure inside the duct system is 0.0 ( $\pm 0.1$  pascal) with reference to the home. When both the house and the ducts are pressurized to 25 pascals with respect to outdoors, there should be no air flowing through duct leaks into the house. During this time, the blower door fan speed may have to be adjusted to make sure the home stays at 25 pascals with reference to outdoors.
7. Note on the manometer connected to the duct tester the amount of air flow needed to maintain the duct pressure at 0 pascals with reference to the home. This number, in CFM, is the amount of duct leakage to the outside of the home's air barrier, i.e., leakage to the outdoors, for example into an unconditioned attic or crawlspace.
8. Take two measurements: the first measurement with the duct tester pressure probe in the return duct as shown in Figure 2 and the second with the duct tester pressure probe in a supply duct as far as possible from the return that the duct tester is connected to. Add both measurements together and divide by two. This will be the average measured duct leakage to the outdoors. Testing both the supply and return ducts can also show you where dominant sources of leakage are in the duct system, on the return side or on the supply side.

## Ensuring Success

After ducts are installed and before drywall is installed, the duct system should be visually inspected by a HERS rater to ensure that all duct connections are properly fastened and sealed, preferably with mastic. After all HVAC components, including registers and grilles, have been installed over finished surfaces (such as drywall or carpeting), the ducts should be tested for air leakage and proper air flow.

A HERS rater should confirm and document that duct leakage to the outdoors is  $\leq 4$  cubic feet of air flow per minute at 25 pascals (CFM25) per 100 ft<sup>2</sup> of conditioned floor area using a RESNET-approved testing protocol, such as a duct blaster test. An optional, additional duct blaster test can be conducted prior to drywall installation to measure duct leakage. If the leakage level is above 4 CFM25 per 100 ft<sup>2</sup> of conditioned floor area, the builder, rater, or HVAC contractor may use a smoke machine to determine exact locations of leakage so they can be sealed before drywalling. If the Prescriptive Path has been chosen, the rater should also visually inspect that ducts are fully insulated (to R-8 for supply ducts and R-6 for returns and other ducts) along the length, including all connections, and that the insulation is not compressed by tight strapping, by framing members, or by excessive bending.

# Climate

No climate specific information applies.

# Training

Right and Wrong Images

None Available

# CAD

None Available

# Compliance

The Compliance tab contains both program and code information. Exact code language is copyrighted and may require purchase from the publisher. While we continually update our database, links may have changed since posting. Please contact our webmaster if you find broken links.

## [ENERGY STAR Certified Homes](#)

ENERGY STAR Certified Homes (Version 3/3.1, Revision 08), Rater Field Checklist

### 6. Duct Quality Installation

6.5 Rater-measured duct leakage to outdoors the greater of ? 4 CFM25 per 100 sq. ft. of CFA or ? 40 CFM25.<sup>36, 38, 41</sup>

Footnotes:

(36) Items 6.4 and 6.5 only apply to heating, cooling, and balanced ventilation ducts. Duct leakage shall be determined and documented by a Rater using a RESNET-approved testing protocol. Leakage limits shall be assessed on a per-system, rather than per-home, basis. For balanced ventilation ducts that are not connected to space heating or cooling systems, a Rater is permitted to visually verify, in lieu of duct leakage testing, that all seams and connections are sealed with mastic or metal tape and all duct boots are sealed to floor, wall, or ceiling using caulk, foam, or mastic tape.

(38) For a home certified in the State of ID, MT, OR, or WA that is permitted before 01/01/2016, as an alternate to Rater-verified duct leakage, a PTCS® Duct Sealing Certification Form is permitted to be collected by the Home Energy Rater.

(41) Testing of duct leakage to the outside can be waived if all ducts & air handling equipment are located within the home's air and thermal barriers AND infiltration does not exceed the following: CZ 1-2: 3 ACH50; CZ 3-4: 2.5 ACH50; CZ 5-7: 2 ACH50; CZ 8: 1.5 ACH50. Alternatively, testing of duct leakage to the outside can be waived if total duct leakage is ? 4 CFM25 per 100 sq. ft. of conditioned floor area or 40 CFM, whichever is larger.

ENERGY STAR Revision 08 requirements are required for homes permitted starting 07/01/2016.

## [DOE Zero Energy Ready Home](#)

Exhibit 1: Mandatory Requirements. Certified under ENERGY STAR Qualified Homes Version 3.

### [2009 IECC](#)

Section R403.2.2 Sealing (Mandatory). Postconstruction leakage to outdoors test: Less than or equal to 8 cfm per 100 ft<sup>2</sup> of conditioned floor area.\*

### [2009 IRC](#)

Section N1103.2.2 Sealing. Postconstruction leakage to outdoors test: Less than or equal to 8 cfm per 100 ft<sup>2</sup> of conditioned floor area.\*

### [2012 IECC](#)

Section R403.2.2 Sealing (Mandatory). Duct tightness test has been performed and meets one of the following test criteria: (1) Postconstruction total leakage test (including air handler enclosure): Less than or equal to 4 cfm per 100 ft<sup>2</sup> of conditioned floor area. (2) Rough-in total leakage test with air handler installed: Less than or equal to 4 cfm per 100 ft<sup>2</sup> of conditioned floor area.\*

### [2012 IRC](#)

Section N1103.2.2 Sealing (Mandatory). Duct tightness test has been performed and meets one of the following test criteria: (1) Postconstruction total leakage test (including air handler enclosure): Less than or equal to 4 cfm per 100 ft<sup>2</sup> of conditioned floor area. (2) Rough-in total leakage test with air handler installed: Less than or equal to 4 cfm per 100 ft<sup>2</sup> of conditioned floor area.\*

\*Due to copyright restrictions, exact code text is not provided. For specific code text, refer to the applicable code.

### [2015 IECC](#)

### [2015 IRC](#)

## More Info.

Access to some references may require purchase from the publisher. While we continually update our database, links may have changed since posting. Please contact our webmaster if you find broken links.

### Case Studies

None Available

### References and Resources\*

1. [ACCA Manual D - Residential Duct Systems](#)  
**Author(s):** Air Conditioning Contractors of America  
**Organization(s):** Air Conditioning Contractors of America  
**Publication Date:** December, 2013  
*Standard outlining industry procedure for sizing residential duct systems.*
2. [DOE Zero Energy Ready Home National Program Requirements](#)  
**Author(s):** DOE  
**Organization(s):** DOE  
**Publication Date:** August, 2015  
*Standard requirements for DOE's Zero Energy Ready Home national program certification.*
3. [ENERGY STAR Certified Homes, Version 3 \(Rev. 08\) National Program Requirements](#)  
**Author(s):** EPA  
**Organization(s):** EPA  
**Publication Date:** September, 2015  
*Document outlining the program requirements for ENERGY STAR Certified Homes, Version 3 (Rev. 08).*
4. [Mortgage Industry National Home Energy Rating Systems Standards](#)  
**Author(s):** RESNET  
**Organization(s):** RESNET  
**Publication Date:** January, 2013  
*Standards aimed to ensure that accurate and consistent home energy ratings are performed by accredited home energy rating Providers through their Raters nationwide.*

\*Publication dates are shown for formal documents. Dates are not shown for non-dated media. Access dates for referenced, non-dated media, such as web sites, are shown in the measure guide text.

### Contributors to this Guide

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