Energy Program
WASHINGTON STATE UNIVERSITY

Building Air Leakage Testing

The 2018 Washington State Energy Code (WSEC) section R402.4.1.2 requires air leakage testing for all new houses and additions (see code text below). The requirement is met if the structure has a leakage rate of 5 air changes per hour when depressurized with a blower door to 50 Pascals or less (5ACH$_{50}$). A Pascal is a measurement of pressure. 249 Pascals are equal to a 1-inch column of water. The test must be performed using a blower door device consisting of a large fan, frame and panel. A manometer (pressure gauge) is used to read house and fan pressures.

WSEC states that the test may be performed at any time after rough in. All penetrations in the building envelope must be sealed including those for utilities, plumbing, electrical, ventilation and combustion appliances. The code also states that the test shall be conducted by an approved third party when required by the building official.

To conduct the test:

1. Close all windows, doors and fireplace and stove doors.
2. Close all dampers including exhaust, intake, make-up air, backdraft and flue dampers. Since you will be depressurizing the house, dampers in bath fans, etc. will be sucked closed during the test and will therefore not negatively affect the results.
3. Make sure plumbing traps are filled with water.
4. Leave doors between heated areas open.
5. Open access hatches to conditioned attics and/or conditioned crawl spaces. Leave hatches closed if these are unconditioned areas.
6. Seal exterior openings for continuously operating ventilation systems and heat recovery ventilators.
7. Turn off heating and cooling systems but do not seal supply or return registers.
8. Adjust all combustion appliances so that they do not turn on during the test.
9. Install the blower door in an exterior door opening and connect hoses from the manometer to the blower door fan and the exterior pressure tap. See manufacturer's instructions for correct set-up.
10. Depressurize the house to -50 Pascals.
11. Record the flow rate (with simple manometers, the fan pressure (Pa) is converted to CFM$_{50}$ using a flow table. Many digital manometers sold with blower doors can automatically perform this conversion, and display CFM$_{50}$ directly. Consult blower door and manometer manuals.

You must now convert the flow rate (CFM$_{50}$) to ACH$_{50}$. Use the following formula:

ACH$_{50}$ = (CFM50 X 60) / Volume

Where: ACH$_{50}$ = air changes per hour at -50 Pascals
CFM$_{50}$ x 60 = converts cubic feet per minute to cubic feet per hour
Volume = conditioned floor area of housing unit multiplied by ceiling height of 8.5 feet (per 402.4.1.2 Testing)

Building Air Leakage Testing

Example: A blower door test on a 2,000 sf house and fan flow (CFM_{50}) rate of 1,100 CFM:

$ACH_{50} = (CFM_{50} \times 60) / \text{volume}$ $ACH_{50} = (1{,}100 \times 60) / (2{,}000 \times 8)$ $ACH_{50} = 66{,}000/16{,}000$

$ACH_{50} = 4.1$

Because the code requires that the ACH_{50} be less than 5, this house complies with an ACH_{50} of 4.1. Record the ACH_{50} on the compliance certificate posted on or near the electrical panel.

Energy Credit: If additional energy credits are selected from Air Leakage Control and Efficient Ventilation Options 2.1 to 2.4 in Table 406.3 (below), the requirements for the blower door testing leakage rates are more stringent (lower).

Corridor and non-corridor low-rise multifamily (R2)
If the building **has a conditioned corridor**, test the whole building all at once and use 5 ACH@50PA for compliance, per R402.4.1 for maximum leakage rates.

If the building **does not have a conditioned corridor** (garden style), a different test is used where envelope leakage rates measure no greater than 0.4 CFM@50PA per sf of apartment surface area. This area term includes all adjacent units and area to outside exterior walls, floor and ceilings. Each unit shall be tested per R402.4.1.2. All tests results shall be documented per R401.3 Certificate.

Floor area weighted whole building tested leakage rate for each unit can be used to document on certificate in each unit, or as approved by the authority having jurisdiction (AHJ).

R401.3 Certificate. A permanent certificate shall be completed by the builder or other approved party and posted on a wall in the space where the furnace is located, a utility room, or an approved location inside the building. When located on an electrical panel, the certificate shall not cover or obstruct the visibility of the circuit directory label, service disconnect label, or other required labels. The certificate shall list the predominant *R*-values of insulation installed in or on ceiling/roof, walls, foundation (slab, *below-grade wall*, and/or floor) and ducts outside conditioned spaces; *U*-factors for fenestration and the solar heat gain coefficient (SHGC) of fenestration; the results from any required duct system and building envelope air leakage testing done on the building; and the results from the whole-house mechanical ventilation system flow rate test. Where there is more than one value for each component, the certificate shall list the value covering the largest area. The certificate shall list the types and efficiencies of heating, cooling, whole-house mechanical ventilation, and service water heating appliances. Where a gas-fired unvented room heater, electric furnace, or baseboard electric heater is installed in the residence, the certificate shall list "gas-fired unvented room heater," "electric furnace" or "baseboard electric heater," as appropriate. An efficiency shall not be *listed* for gas-fired unvented room heaters, electric furnaces or electric baseboard heaters.

The *code official* may require that documentation for any required test results include an electronic record of the time, date and location of the test. A date-stamped smart phone photo or air leakage testing software may be used to satisfy this requirement.

Useful Links: [2018 WSEC Compliance Certificate]
[2018 Compliance Certificate - Instructions]
[The Energy Conservatory], [Retrotec], [Residential Energy Dynamics]
[Air Barrier Association of America]
[Home Energy Raters]

Building Air Leakage Testing

From 2018 WSEC-Residential text:

R402.4.1.2 Testing. The building or dwelling unit shall be tested and verified as having an air leakage rate of not exceeding 5 air changes per hour. Testing shall be conducted with a blower door at a pressure of 0.2 inches w.g. (50 Pascals). For this test only, the volume of the home shall be the conditioned floor area in ft^2 (m^2) multiplied by 8.5 feet (2.6 m). Where required by the *code official*, testing shall be conducted by an *approved* third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the *code official*. Testing shall be performed at any time after creation of all penetrations of the *building thermal envelope*. Once visual inspection has confirmed sealing (see Table R402.4.1.1), operable windows and doors manufactured by *small business* shall be permitted to be sealed off at the frame prior to the test.

Exception: For dwelling units that are accessed directly from the outdoors, other than detached one family dwellings and townhouses, an air leakage rate not exceeding 0.4 cfm per square foot of the dwelling unit enclosure area shall be an allowable alternative. Testing shall be conducted with a blower door at a pressure of 0.2 inches w.g. (50 Pascals) in accordance with RESNET/ICC 380, ASTM E779 or ASTM E1827. For the purpose of this test only, enclosure area to be calculated as the perimeter of the dwelling unit, measured to the outside face of the exterior walls, and the centerline of party walls, times 8.5 feet, plus the ceiling and floor area. Doors and windows of adjacent dwelling units (including top and bottom units) shall be open to the outside during the test. This exception is not permitted for dwelling units that are accessed from corridors or other enclosed common areas.

During testing:

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed, beyond the intended weatherstripping or other infiltration control measures.
2. Dampers including exhaust, intake, makeup air, backdraft and flue dampers shall be closed, but not sealed beyond intended infiltration control measures.
3. Interior doors, if installed at the time of the test, shall be open, access hatches to conditioned crawl spaces and conditioned attics shall be open.
4. Exterior or interior terminations for continuous ventilation systems and heat recovery ventilators shall be sealed.
5. Heating and cooling systems, if installed at the time of the test, shall be turned off.
6. Supply and return registers, if installed at the time of the test, shall be fully open.

Exceptions:

1. Additions less than 500 square feet of conditioned floor area.
2. Additions tested with the existing home having a combined maximum air leakage rate of 7 air changes per hour. To qualify for this exception, the date of construction of the existing house must be prior to the 2009 Washington State Energy Code.

TABLE 406.3 (continued) ENERGY CREDITS			
OPTION	DESCRIPTION	CREDIT(S)	
		All Other	Group R-2
2. AIR LEAKAGE CONTROL AND EFFICIENT VENTILATION OPTIONS Only one option from Items 2.1 through 2.4 may be selected in this category.			
2.1	Compliance based on R402.4.1.2: Reduce the tested air leakage to 3.0 air changes per hour maximum at 50 Pascals **or** For R-2 Occupancies, optional compliance based on Section R402.4.1.2: Reduce the tested air leakage to 0.3 cfm/ft^2 maximum at 50 Pascals **and** All whole house ventilation requirements as determined by Section M1507.3 of the *International Residential Code* or Section 403.8 of the *International Mechanical Code* shall be met with a high efficiency fan(s) (maximum 0.35 watts/cfm), not interlocked with the furnace fan (if present). Ventilation systems using a furnace including an ECM motor are allowed, provided that they are controlled to operate at low speed in ventilation only mode. To qualify to claim this credit, the building permit drawings shall specify the option being selected, the maximum tested building air leakage, and shall show the qualifying ventilation system and its control sequence of operation.	0.5	1.0
2.2	Compliance based on Section R402.4.1.2: Reduce the tested air leakage to 2.0 air changes per hour maximum at 50 Pascals **or** For R-2 Occupancies, optional compliance based on Section R402.4.1.2: Reduce the tested air leakage to 0.25 cfm/ft^2 maximum at 50 Pascals **and** All whole house ventilation requirements as determined by Section M1507.3 of the *International Residential Code* or Section 403.8 of the *International Mechanical Code* shall be met with a heat recovery ventilation system with minimum sensible heat recovery efficiency of 0.65. To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the maximum tested building air leakage and shall show the heat recovery ventilation system.	1.0	1.5
2.3	Compliance based on Section R402.4.1.2: Reduce the tested air leakage to 1.5 air changes per hour maximum at 50 Pascals **or** For R-2 Occupancies, optional compliance based on Section R402.4.1.2: Reduce the tested air leakage to 0.25 cfm/ft^2 maximum at 50 Pascals **and** All whole house ventilation requirements as determined by Section M1507.3 of the *International Residential Code* or Section 403.8 of the *International Mechanical Code* shall be met with a heat recovery ventilation system with minimum sensible heat recovery efficiency of 0.75. To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the maximum tested building air leakage and shall show the heat recovery ventilation system.	1.5	2.0

TABLE 406.3 (continued) ENERGY CREDITS			
OPTION	DESCRIPTION	CREDIT(S)	
		All Other	Group R-2
2.4	Compliance based on Section R402.4.1.2: Reduce the tested air leakage to 0.6 air changes per hour maximum at 50 Pascals **or** For R-2 Occupancies, optional compliance based on Section R402.4.1.2: Reduce the tested air leakage to 0.15 cfm/ft^2 maximum at 50 Pascals **and** All whole house ventilation requirements as determined by Section M1507.3 of the *International Residential Code* or Section 403.8 of the *International Mechanical Code* shall be met with a heat recovery ventilation system with minimum sensible heat recovery efficiency of 0.80. Duct installation shall comply with Section R403.3.7. To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the maximum tested building air leakage and shall show the heat recovery ventilation system.	2.0	2.5

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