Supplement B

Taking Credit for Reduced Air Leakage in Residential Buildings

In recent years, a growing number of Washington State Energy code (WSEC) submittals have attempted to take credit for energy savings that result from air sealing of homes. In many cases these submittals do not include accurate energy simulations and are not performing tests to confirm that they meet the proposed infiltration levels. This supplement will discuss the code language, documentation, and field inspection as it applies to air leakage control in residential buildings.

Chapter 4 of the WSEC allows applicants to take credit for building practices that reduce energy using the systems analysis approach. This approach allows applicants to take credit for improved heating system efficiency, impacts of glazing type and orientation, and other features not covered by the component trade off or prescriptive compliance methods. Software capable of evaluating building performance is used to demonstrate compliance with the code.

Systems analysis is by far the most complex code compliance approach, and both the applicant and code official need to know how to handle these complexities. When evaluating a systems analysis submittal, code enforcement personnel need to establish early on if the software is capable performing needed calculations and whether the proposed measures can be verified during inspection.

What Does the Code Say About Air Leakage Control Credits?

WSEC language is very specific when it comes to the air leakage rate to be used in systems analysis calculations:

[402.1.5] Infiltration levels used shall be set at 0.35 air changes per hour for thermal calculation purposes only.

As written, the code does not implement a method for taking credit for reduced air leakage in homes. The Code requires that 0.35 ACH be used for both the proposed and target building calculations. In addition, the code does not specify how to calculate the energy impacts of required mechanical ventilation.

The history of this code language dates back to the original adoption of the WSEC in 1990. The code enforcement community did not want to administer additional inspections needed to verify reduced air leakage in homes.

Because of the limitations placed in the code, credit for reduced infiltration must be submitted as an alternative method. The applicant must submit documentation that includes the proper methodology for calculating and inspecting a home with reduced air leakage. Because this is an alternative method, the building department has the latitude to accept or reject the proposed alternative for technical or administrated reasons as stated in WSEC Section 103.

What About Mechanical Ventilation?

In a home with average air leakage area, mechanical ventilation will add about 50% of the fan flow to the natural air change rate. In a home with very little air leakage area, mechanical ventilation will add nearly 100% of the fan flow to the natural air change rate. This occurs because it is more difficult for the fan to overcome the natural stack effect in homes with more air leakage area. Balanced mechanical ventilation systems with equivalent supply and exhaust flows will always add 100% of the fan flow to the natural air change rate. Given the code requirements

for mechanical ventilation, the net annual air change rate in homes will rarely drop below 0.25 per hour.[1]

Also at issue is the size of the ventilation fan. Some heat recovery ventilators have a much higher capacity than the minimum ventilation rate specified in the code. If the code requires a 100 CFM exhaust fan and the builder installs a 300 CFM HRV, there won't be any energy savings. As noted below, the software chosen to document savings from reduced air leakage needs to include the capability of analyzing the impacts of the mechanical ventilation system.

What are the Software Capabilities?

The two most popular programs used for energy analysis in Washington, WATTSUN and SUNDAY, are capable documenting the energy savings achieved through reduced air leakage in homes. However, they don't account for required mechanical ventilation. Without including mechanical ventilation in the analysis, the simulation will overestimate the savings of reduced air leakage.

A DOE-2 based program called Energy Gauge does a acceptable job of analyzing this variable.

What are the Recommended Inspections and Tests?

Systems analysis is a whole building approach. Air leakage involves all of the systems in the building. A builder might do a fine job of air sealing the building envelope, but if the back-draft dampers aren't in place on the kitchen exhaust, the building won't perform to the levels promised in the submittal. A blower door test is needed to confirm that the proposed air leakage rate has been achieved as part of the inspections process. There are a number of methods for testing and calculating the results. For simplicity, we recommend a single point blower door test (see next page for details.)

[1] *John Heller, Residential Construction Demonstration Project: Cycle III. Analysis of Innovative Ventilation Systems in Multifamily Buildings, Bonneville Power Administration, Portland, 1998, p. 4.*

What are the qualifications for blower door test professionals? Should code enforcement personal observe the test? This is not established in the code. The applicant and the jurisdiction will have to agree on qualifications and procedure as part of the permit application. We strongly recommend an independent third party testing agency.

What Happens if the Applicant Fails the Blower Door Test?

This is a sticky issue. Because the test occurs at or near the completion of the home, failure puts both the applicant and code enforcement personnel in a difficult position. If there is one large hole in the building, it is fairly easy to identify the air leakage path and plug it. In most cases, the additional leakage is the result of a series of very small failures in air sealing. Finding and fixing these failures can be difficult – particularly in very tight homes.

The best approach is to avoid failure during submittal by limiting proposed air leakage rates to reasonable levels. For example, if compliance requires passing a blower door test with results of 0.25 ACH, don't submit documentation that places the target at 0.10 ACH.

Summary

1. WSEC Chapter 4 does not allow credit for reduced air leakage in the home. Proposals must be submitted as an alternative method. The code officials can reject proposals for technical or administrative reasons.
2. The target value for home air leakage in the WSEC is 0.35 ACH.
3. Software selected needs to be capable of performing the needed calculations to account for building air sealing and mechanical ventilation.
4. Blower door tests should be used to document compliance.

Single Point Blower Door Test

Figure B-1

The blower door test does not measure air leakage. It is a measurement of the size of all the holes in the home. This is converted to an estimate of average annual air leakage by applying some math to the blower door test results. The final result is called ACH Natural.

To determine the air leakage rate of a home, a blower door test is performed. A specialized fan is placed in an exterior door of the home. The fan exhausts air from the home, creating a negative pressure in the home with respect to outdoors. The target test pressure used for single point test is 50 Pascals (0.205 inches of water). The blower door fan speed is adjusted until the target test pressure is achieved; then the flow through the fan is recorded. The fan flow is noted on the report as CFM50 (cubic feet per minute at 50 Pascals pressure difference). Set up for the test is important. The following notes should be used:

- Testing shall occur after everything is roughed-in/ installed that will penetrate the building envelope (plumbing, electrical, HVAC, ventilation, combustion appliances, etc.) and the air barrier has been

installed. Testing should NOT be conducted when wind gusts exceed 15 mph.

- All windows and doors shall be properly closed, including pass-through wood-box doors and pet doors. All interior doors shall be left open.
- All exhaust fan openings, vent openings, and intake-air vents with backdraft dampers (e.g., dryer vents and kitchen, bathroom, utility room, whole-house, range vents, etc.) shall ***NOT*** be sealed. Exterior vent openings without backdraft dampers (e.g., some continuous ventilation systems) shall be temporarily sealed for the test. Heat recovery ventilator supply openings shall be sealed. Heat recovery ventilator exhaust openings should have backdraft dampers and shall not be sealed.

Single Point Blower Door Test Math

Step 1:
Convert the blower door test value from CFM50 to ACH50 (air change per hour at 50 Pascals pressure difference)

ACH50 = CFM50 x 60/ Building Volume (cubic feet)

Step 2:
Convert the ACH50 to ACH Natural
ACH natural = ACH50/20

Example:
House Volume = 15000 cubic feet
Blower door test results = 1600 CFM50

Step 1: ACH50 = (1600 x 60) / 15000 = 6.4

Step 2: ACH natural = 6.4 / 20 = 0.32 ACH