

Eyeballing It: What Visual Air Sealing Inspection Misses

March 2018

Introduction

As part of the Kentucky Residential Energy Code Study (Study) an opportunity arose to begin to answer a long-standing question – what is the actual envelope tightness of a home that was visually inspected for air sealing compliance? As part of the Study's Phase III data collection process, builders were asked if they would perform a visual inspection or blower door test to determine the envelope tightness of their homes. Since blower door tests were going to be performed on all homes included in the Study (regardless of the compliance option chosen by the builders), homes that were going to be visually inspected would now have a tested, quantifiable result (blower door number) to associate with visual inspections. This report describes the results of those comparisons.

Visual Inspection & ACH50 Analysis

The Kentucky statewide mandatory energy code is modelled on the 2009 International Energy Conservation Code (2009 IECC). Because the 2009 IECC allows for visual inspections of air sealing to be used as a compliance path, it is important to understand, quantitatively, the envelope tightness associated with visual inspections. Building occupants may not be getting the fresh air intake necessary to disperse interior moisture and indoor air pollutants if the building is too tight. If the building envelope is leaky, they may be wasting money and energy unnecessarily heating and cooling too much outside air. There is simply no way to know the home's actual fresh air intake through the visual inspection process.

In Phase III of the Study, 23 homes were visited by data collectors where the builder planned to use the visual inspection compliance path. Per the data collection protocol, a blower door test was performed on each of these 23 homes. The blower door test showed that all homes met the code air leakage requirement of 7 air changes per hour at 50 pascals (7 ACH50) or less.

However, further analysis of these blower door tests showed test results ranging from nearly 2 ACH50 to just under 7 ACH50, with the average air leakage rate of 4.2 ACH50 (Table 1, Figure 1). In order for occupants and homes to be provided with adequate fresh air, the Kentucky Residential Code requires the installation of whole house ventilation systems for homes with envelope air leakage testing less than 5 ACH50. Seventy-four percent of tested homes had a leakage rate of less than 5 ACH50, yet only one of the 23 homes (1.99 ACH50) had a fresh air system integrated into the air handling unit. Unfortunately, all the other homes were provided with nothing more than bathroom fans for ventilation¹.

While homes appear to be easily meeting the envelope tightness standard of 7 ACH50, the vast majority of visually inspected new homes, critically, have an envelope tightness below 5 ACH50 where mechanical ventilation becomes required.

¹ Data collectors only noted that bath fans were installed. No sizing or operational information was collected.

Visual Inspection and ACH Comparison – Original Sample	
Median (ACH50)	4.3
Average (ACH50)	4.2
Range (ACH50)	5.0
Maximum (ACH50)	7.0
Minimum (ACH50)	2.0
Standard Deviation	1.6
Sample Size	23
Number of homes with < 5 ACH50	17
Percent of Sample Size <5 ACH50	74%

Table 1: Blower door test results of homes using visual inspection to comply with the energy code requirements.

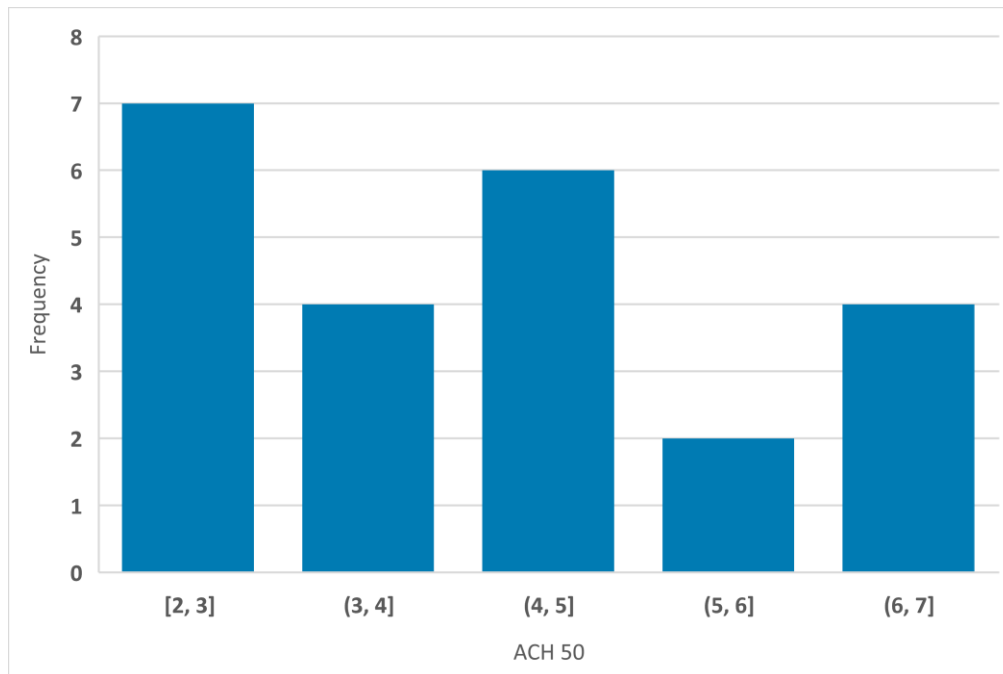


Figure 1: Histogram indicating the frequency of blower door test results of homes using visual inspection to comply with the energy code

Expanding the Sample

Prior to participating in the Study, all builders were asked about how they planned to comply with air sealing requirements. Many builders responded that they were not sure or chose not to answer the question. As a second method of investigating the visual inspection/ACH question, HERS rating data was used to determine the average percentage of homes getting a blower door test. It was assumed that blower door tests would only be performed if a HERS rating was being done. Analyzing statewide data regarding Kentucky HERS ratings, it was determined that 16% of homes built in Kentucky from 2014 to 2016 had a HERS rating done.^{2,3}

² RESNET, who administers the HERS program, provided complete data on all rated homes in Kentucky

³ A blower door test is required in order to provide a HERS rating

An additional 31 homes surveyed in the Study were identified as having no predetermined method of air sealing compliance. Based on the fact that 16% of homes statewide received HERS ratings in recent years, 16% of those 31 Study homes were randomly assigned as having had a blower door test and 84% were randomly assigned as having complied using a visual inspection. This added 26 more homes to the visual inspection compliance dataset.

With this increased sample size, the same statistical analysis was run to compare the blower door test results of all 49 homes (23 from the original data set and 26 from the expanded data set). Again, all the visually inspected homes met the air leakage requirement of 7 ACH50 or less. The detailed results of the expanded dataset were also strikingly similar to those from the smaller dataset, with blower door test results ranging from 1.9 ACH50 to 7.0 ACH50 and an average air leakage rate of 4.0 ACH50 (Table 2). The distribution of these results was also similar to that of the smaller sample size (Figure 2). Of the homes in the expanded data set, 68% had an air leakage rate of less than 5 ACH50. Only four of the homes in the expanded data set had a fresh air system integrated into the air handling unit, with the remainder of the homes just having bathroom fans.

Visual Inspection and ACH Comparison – Expanded Sample Size	
Median	3.9
Average	4.0
Range	5.1
Maximum	7.0
Minimum	1.9
Standard Deviation	1.5
Sample Size	49
Number of homes with < 5 ACH	32
Percent of Sample Size <5 ACH50	68%

Table 2: Blower door test results of expanded data set homes using visual inspections to comply with the energy codes.

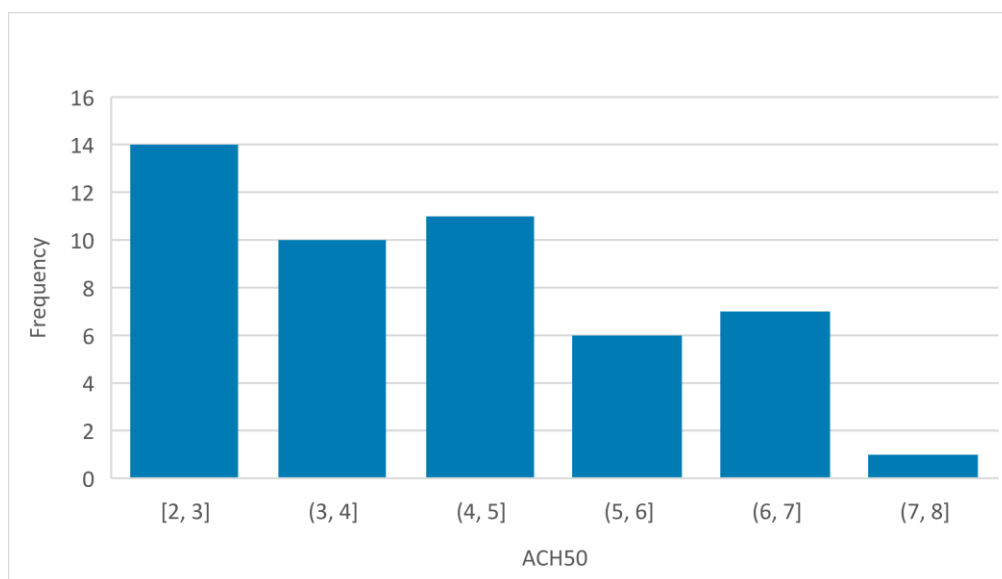


Figure 2: Histogram indicating the frequency of blower door test results of homes in the expanded data set using visual inspection to comply with the energy code.



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Conclusion

While the data sets used for this analysis were relatively small in terms of the number of homes included in the analysis, we do believe them to be representative of the conditions typically found across the state. The analysis finds that **while homes appear to be easily meeting the envelope tightness standard of 7 ACH50, the vast majority of visually inspected new homes, critically, have an envelope tightness below 5 ACH50 without sufficient ventilation.** This would imply that **most new homes are not getting the amount of fresh air recommended to maintain occupant health and safety.** This lack of fresh air would also suggest that these buildings are likely to have moisture-related problems down the road. Both of these conditions pose possible liability issues for builders and the state.

Given the potentially serious consequences of this demonstrated non-compliance with code requirements, we recommend that a statewide study be conducted to directly examine the home ventilation issue in detail and recommend mitigating measures. In the meantime, builders and code officials should be made aware of the results of this study, so that they may take whatever preventative measures they feel appropriate.