Building America Case Study

Air Leakage and Air Transfer Between Garage and Living Space

Waldorf, Maryland

PROJECT INFORMATION

Project Name: Ventilation Effectiveness

Location: Waldorf, MD

Partners:

Building Science Corporation, *buildingscience.com*

K. Hovnanian Homes, *khov.com*

Building Component: Building and garage ventilation

Application: New and retrofit; single and multifamily

Year Tested: 2013

Applicable Climate Zone(s): All

PERFORMANCE DATA

Cost of energy efficiency measure (including labor): $0 if no garage ventilation needed to comply with EPA Indoor airPLUS requirements; $250 if garage ventilation needed

Projected energy savings: 1% if no garage ventilation needed

Projected energy cost savings: $30/year

Building AMERICA SM U.S. Department of Energy

This project focused on the source of outside air as it pertains to "ventilation" air that may come from polluted air in the garage. Garage air can enter the living space, especially when the living space is at a negative pressure with respect to the garage because of natural forces or the use of mechanical exhaust ventilation in the living space. This project builds on previous work by Rudd and Bergey (2013) to further examine and evaluate the problem of unwanted air transfer from garage to living space and the effectiveness of garage exhaust ventilation or house supply ventilation to provide a solution to that. The effectiveness of garage exhaust requirements in the U.S. Environmental Protection Agency (EPA) Indoor airPLUS program were examined to consider the most effective methods of meeting the DOE Zero Energy Ready Home criterion, which requires meeting the EPA Indoor airPLUS criteria.

The U.S. Department of Energy Building America team Building Science Corporation worked with production homebuilder K. Hovnanian to conduct testing at a single-family home in Waldorf, Maryland, constructed in accordance with the 2009 International Residential Code. The team used automated fan pressurization and pressure monitoring techniques to conduct a series of 25 tests that characterized the garage and house air leakage and pressure relationships and the garage-to-house air leakage. Six tracer gas tests were conducted to determine the fraction of house air that came from the garage under different ventilation operating conditions.

The EPA Indoor airPLUS program requires a one-step test for garage-to-house pressure differential when the whole-building ventilation system is exhaust-only. The intent is to ensure little air leakage through the constructed garage-to-house interface. To pass the test, the garage-to-house pressure differential must be greater than 45 Pa while a house-to-outside CFM50 test is being conducted with all operable garage openings closed. Testing in this project showed that a

Tracer Gas Testing Results

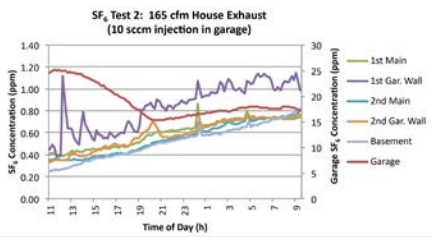


Figure 1. SF6 Test 2, 165 cfm house exhaust ventilation tracer gas test showing that, by the end of the 24-hour test, about 4.6% of the air in the house came from the garage (0.078/17 = 0.046)

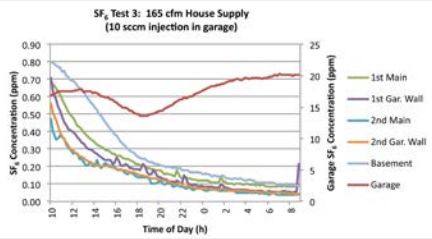


Figure 2. SF6 Test 3, 165 cfm house supply ventilation tracer gas test showing that, by the end of the 24-hour test, supply ventilation had suppressed essentially all air transfer from the garage to the house (0.06/20 = 0.003)

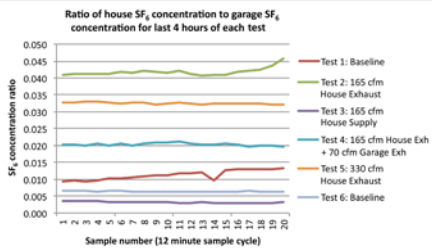
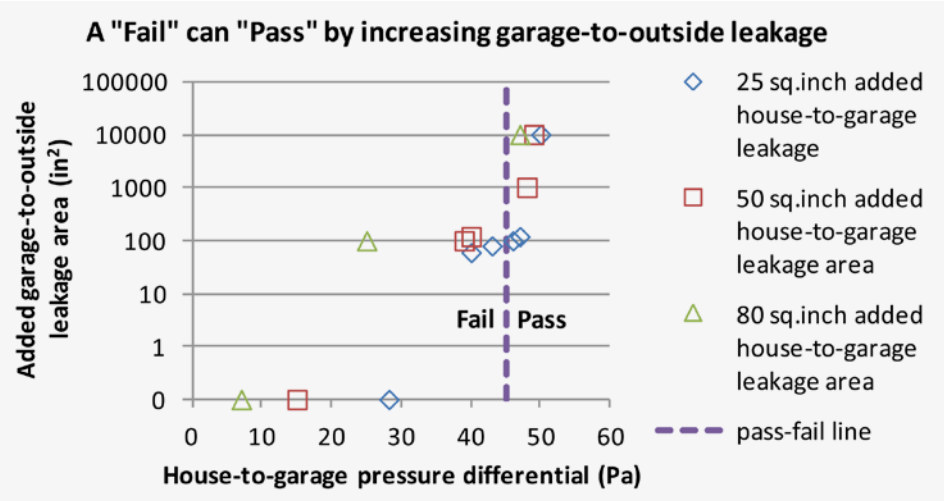


Figure 3. The operation of different ventilation systems showed a consistent and steady difference in the fraction of house air that came from the garage. From high to low fraction, the order was: house exhaust, baseline, house exhaust + garage exhaust, and supply.

For more information, see the Building America Technical Report, *Air Leakage and Air Transfer Between Garage and Living Space,* at: *buildingamerica.gov*

Image credit: All images were created by the BSC team.

leaky garage-to-house interface could be made to pass the test depending on the amount of garage-to-outside air leakage. It was found that a new second step in the testing process would eliminate that problem. The second step required an additional measurement of house-to-outside CFM50 with the overhead garage door open and verifying that the CFM50 with the garage door open was not more than 6% greater than the CFM50 with the garage door closed.



Test results showing the inadequacy of house-to-garage pressure differential as a single criterion for house-to-garage airtightness.

The averaging two baseline tracer gas tests revealed that about 1% of the air in the house came from the garage when no mechanical ventilation system was operating. That was close to one-fifth the volume when operating 165 cfm of house exhaust ventilation.

The tracer gas test with 165 cfm house supply ventilation test showed that the supply ventilation suppressed essentially all air transfer from the garage to the house. The house pressure maintained about 1.5 Pa positive with respect to the garage.

Lessons Learned

Based on the results of this project, the two-step garage-to-house air leakage test protocol described above would improve the EPA Indoor airPLUS testing requirements where whole-house exhaust ventilation is employed. For houses employing whole-house supply ventilation (positive pressure) or balanced ventilation (same pressure effect as the baseline condition), adherence to the EPA Indoor airPLUS house-to-garage air sealing requirements should be sufficient to expect little to no garage-to-house air transfer.

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