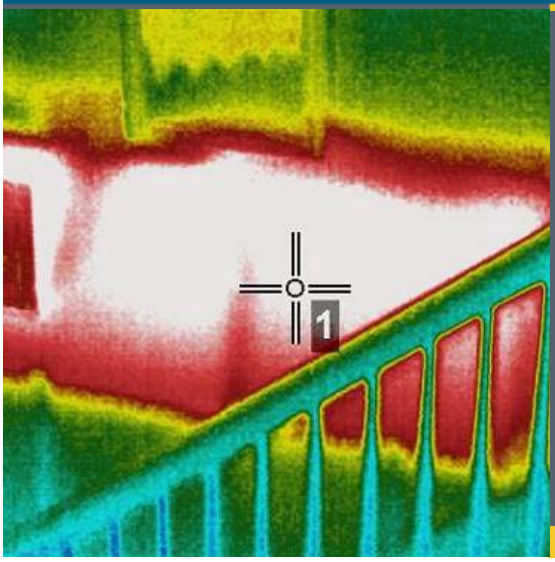


Building America Case Study
Technology Solutions for Existing Homes

Wind Washing in Two-Story Homes: Identifying the Problem and the Opportunity for Repair

Southeastern United States

PROJECT INFORMATION

Project Name: Opportunities for Energy Conservation and Improved Comfort from Wind Washing Retrofits in Two-Story Homes

Location: Central and North Florida

Partners: Florida Power & Light (FPL)

Building America Partnership for Improved Residential Construction
www.ba-pirc.org

Building Component: Attic/floor cavity intersections

Application: Retrofit; Single Family

Year Tested: 2011-2013

Applicable Climate Zone(s): All

PERFORMANCE ESTIMATES

Estimated Cost of Energy-Efficiency Measures: $200-$1200/house

Projected Annual Electricity Energy Savings: 4.2 million Btu/year per house [or 14 million Btu/year in source energy]

Projected Annual Energy Cost Savings: $140 per house

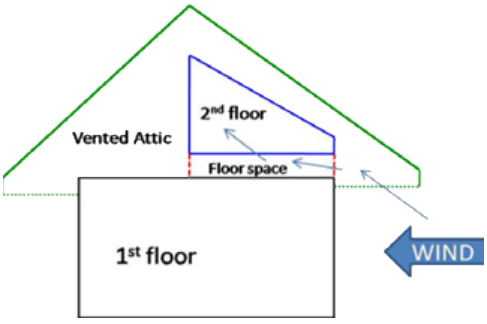
Residential construction is moving from simple one-story to architecturally complex two-story homes. Consequently, more homes have attic spaces that are horizontally adjacent to conditioned spaces. In some two-story homes, attic spaces over first-floor portions of the home that abut portions of the second-story conditioned space have been found to have breaches of the air and thermal boundaries, creating a phenomena known as “wind washing”:

1) Attic air above the first-floor space can be driven into the cavity between the first and second floors by wind, thermal buoyancy forces, or mechanical driving forces (duct leaks, unbalanced return air, unbalanced exhaust air, etc.).

2) Insulation batts installed on knee walls may have gaps between the batt and the gypsum wallboard that allow circulation of hot attic air against the wall board.

The Building America Partnership for Improved Residential Construction has investigated wind washing in 56 homes to identify the failure mechanisms that lead to wind washing, characterize the pathways for air and heat to enter the house, evaluate the seasonal energy savings and peak demand reduction that can result from repair of these wind washing problems, develop cost-effective retrofit solutions, and develop information that can help avoid these problems in new construction. The extent that wind washing will occur depends upon several factors: wind speed, direction, size of floor cavity openings, area of insulation exposed to air movement, and the presence of complimentary air leakage pathways. Air will move more readily though a floor cavity that has openings to outdoors on both sides compared to having just one pathway.

Figure 1 illustrates wind washing caused by air movement into the soffit, then into the attic, and finally into the floor space. Wind-driven attic air is pushed into the space between floors, bypassing house air and thermal boundaries.



WIND WASHING RESEARCH

This image shows a floor cavity that is open to a vented attic on one end, and has conditioned space above and below

IR scans show temperature variations, and reveal the operation of the wind washing phenomenon. As shown in the above images, thermal anomalies are occurring where hot attic air has penetrated into the floor cavity that lies behind the stairwell wall. The wall surface temperature was 83ºF compared to 78ºF room temperature.

For more information, see the Phase I report: http://fsec.ucf.edu/en/publications/pdf/fsec-cr-1842-09.pdf

Figure 2. Field tests can be conducted to characterize the existence of wind washing, the problems it causes, repair strategies, and the potential benefit of the repair. These tests include visual inspections (see left image), infrared (IR) scans of house surfaces (see sidebar), air/thermal boundary integrity, pressure mapping, air leakage assessment, and duct leakage assessment.

Lessons Learned

- Breaches of the air and thermal boundaries of the house can lead to significant sensible heat penetrating into the house and in some cases substantial latent heat (water vapor) penetrating into the structure. Consequently, second-story cooling loads increase.
- In some homes, significant levels of duct leakage are occurring within the floor cavity between the first and second floors of the house. Wind washing repair has the potential to eliminate a large portion of the duct leakage energy waste by containing much of that leakage within the newly created air and thermal boundaries of the floor cavity.

Looking Ahead

Wind washing has been identified as affecting energy, peak demand, comfort, moisture damage, and elevated humidity in some two-story homes in hot and humid climates. In colder climates, freezing of water pipes is an additional concern. Because wind washing retrofits also reduce peak electrical demand, it is likely that electric utilities will see the benefit of providing repair incentives to customers, which could further enhance retrofit cost-effectiveness from the customer perspective. Building codes should be examined and code enforcemei practices evaluated in order to eliminate this breach in residential construction efficiency.

Further research will explore the extent and magnitude of observed and monitored moisture impacts associated with thermal and air barrier failures. While some of the project findings will apply most directly to homes in hot/humid climates, the repair techniques and general principals of air-transported and conductive heat exchange will be applicable for colder climates as well.

U.S. DEPARTMENT OF ENERGY
Energy Efficiency & Renewable Energy

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The U.S. Department of Energy's Building America program is engineering the American home for energy performance, durability, quality, affordability, and comfort.