Building America Case Study Technology Solutions for New & Existing Homes

Measure: Complete and Fully Aligned Air Barrier

Portland, Oregon

PROJECT INFORMATION

Project Name:
Bryce Deep Energy Retrofit

Location: Portland, OR

Year Built: 1912

Building America Partner:
Pacific Northwest National Laboratory

Building Component:
Building Thermal Enclosure

Application: Single-Family Retrofit

Year Tested: 2011

Climate Zone(s): Marine

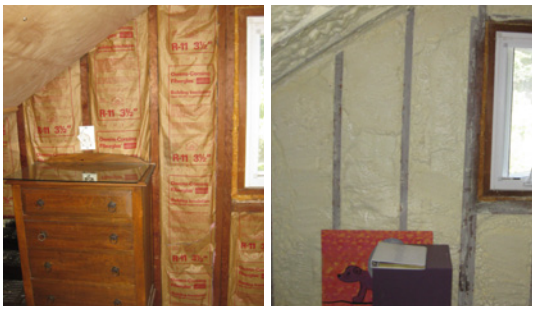
PERFORMANCE DATA

Cost of Energy-Efficiency Measure (including labor):
Total Retrofit: $19,636
Additional Attic Insulation: $4,970
HRV and Ventilation: $5,266

Projected Energy Savings:
Total Whole House: 21%
Additional Attic Insulation & HRV: 6%

Although an air barrier can dramatically reduce infiltration, it can also present problems in humid climates if not installed and ventilated properly. This project focused on eliminating excessive humidity in the attic of a multi-floor, single-family home that was causing condensation and water damage along the roof and eaves.

The top attic and part of the side attics in this historic four corner home had been insulated and air sealed with spray foam during a previous retrofit. However, other areas in the side attics had been insulated with fiberglass batt insulation, resulting in an incomplete air barrier. This made the insulation ineffective as a thermal barrier because the leaky side attics let large amounts of cool, outside air enter the attic in the winter. The spray foam and paper-faced batts, however, served as an excellent vapor barrier and condensing plane where warm, moist air from inside the home would rise into the cool, side attic from the floors below and condense. Such condensation can introduce moisture into the walls, eaves, and insulation materials, and may lead to staining, mold, and other moisture damage. Existing exhaust fans located in the two bathrooms were operated only for spot ventilation and were not alleviating the moisture problem.



The side attics had a mixture of insulation types, including faced and unfaced fiberglass batt insulation *(left)*. These were replaced with closed-cell spray foam on the exterior walls and roof deck to provide a complete and continuous air barrier *(right)*, fully aligned with the vapor barrier. This reduced infiltration, mitigating the stack effect, which was pulling warm, moist air up into the attic.

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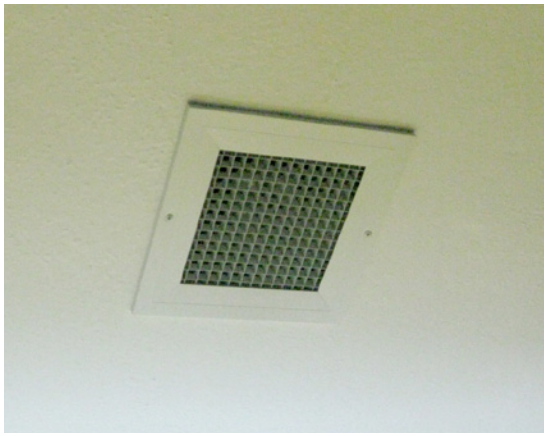

(top) Excessive humidity and condensation in the attic was causing unsightly staining and damage in the side attic spaces and on the eaves.

(bottom) The spray foam insulation in the top attic was trapping interior, warm air and moisture, significantly increasing the relative humidity levels. To relieve the excessive moisture build up and increase comfort on the second floor, passive transfer grilles were added between the second floor and the attic to increase air exchange between conditioned spaces, and an HRV was installed to increase overall ventilation in the home.

For more Information, see the Building America report available September 2012 at www.buildingamerica.gov

To alleviate these issues, the homeowners worked with the Building America team to provide a complete, continuous air barrier that is fully aligned with the existing thermal and vapor barriers (in this case, the spray foam serves as both) by applying R-30 spray foam to the roof deck and exterior walls in the side attics. Before renovation, the relative humidity in the attic was approximately 60%, about 20% greater than the average interior relative humidity levels in this house. After the retrofit, the home has felt much cooler and less stuffy, according to the homeowner. The building air leakage also decreased from 6.6 air changes per hour at 50 pascals of depressurization (ACH50) to 4.3 ACH50, which is below the minimum ventilation limit for this home. Thus, in addition to air sealing, vents were added between the top attic and the second floor to increase air exchange and further prevent condensation, and a heat recovery ventilator (HRV) was added to provide adequate ventilation in the home. This additional ventilation, combined with a complete and fully aligned air barrier, helped solve this home's moisture problems while making the home much more efficient and comfortable.

Lessons Learned

- The stack effect can trap moist air in attics, creating moisture problems.
- An incomplete air barrier that is not aligned with the vapor and thermal barriers in a home can cause significant condensation and moisture problems. Spray foam insulation is a very effective air sealer and insulator, but can lead to moisture problems if installed improperly.
- In this home, spray foam was added to the exterior walls in side attics and on the roof deck to complete and fully align the air, vapor, and thermal barriers.
- In addition to air sealing and insulation, additional ventilation and air exchange between the top attic and second floor of the home significantly decreased relative humidity levels in the attic and improved occupant comfort.

Other Measures

This home was part of a comprehensive energy retrofit, resulting in 21% whole house energy savings. Other measures included replacing a standard natural gas tank water heater with a condensing tankless natural gas water heater, and adding 3.24 kW of photovoltaic to the south-facing roof.

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