Building America Case Study Technology Solutions for New & Existing Homes

Measure: Properly Sized and Located Return Air Inlets

Richland, Washington

PROJECT INFORMATION

Project Name:
Canyon Home Energy Retrofit

Location: Richland, WA

Year Built: 1971

Building America Partner:
Pacific Northwest National Laboratory

Building Component: Ducts

Application: Single-Family Retrofit

Year Tested: 2011

Climate Zone(s): Cold/Very Cold

PERFORMANCE DATA

Cost of Energy-Efficiency Measure (including labor): $9,188

Projected Energy Savings: 38%

Projected Energy Cost Savings:
$57 per month or $685 per year

Air Handler Flow Rate:
Pre-retrofit: 660 cfm
Post-retrofit: 1,126 cfm

Duct Leakage:
Pre-retrofit: 400 cfm25
Post-retrofit: 276 cfm25

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A properly designed duct system is essential for keeping a home comfortable, managing indoor air quality, and maximizing the performance of heating and cooling equipment. Poorly designed or undersized duct systems can make homes uncomfortable and unhealthy. Misplaced air returns and leaky ducts can allow pollutants such as carbon monoxide and solvent fumes into occupied rooms, trapping them in the living space with the residents.

For this project, the homeowner of a single-family, multi-level home in Richland, WA, worked with the Pacific Northwest National Laboratory Building America team to resolve complaints about the home's poorly designed duct system. The original return duct was severely undersized and restricted the air supply to the 30-year-old electric furnace and seasonal energy efficiency ratio (SEER) 10 air conditioner by up to 50%. The homeowner was running the fan non-stop in an attempt to decrease the stratification and staleness of the air in the home. The duct system also included a return in the garage, which fortunately was not used by this homeowner to store vehicles because that could have resulted in carbon monoxide from automobile exhaust entering the home. Other potential pollutants from garages include gasoline, solvents, paints, and landscaping chemicals.

Building America researchers recommended removing the garage return duct, adding a return on the lower floor, and sealing and insulating the ducts. This increased the return air flow through the handler from 660 cubic feet per minute (cfm) to 1,126 cfm, and dramatically improved homeowner comfort by allowing the conditioning systems to deliver considerably more conditioned air and enabling better air mixing between floors. By sealing the ducts, the duct leakage to outside was also decreased from 400 cfm at 25 pascals of depressurization (cfm25) to 276 cfm25, almost a 50% reduction.

(top) Not only can faulty or poorly placed air returns (such as this one in the garage) allow air infiltration, they can also expose occupants to harmful pollutants.

(bottom left) The small return air duct created a bottleneck in the air distribution system, limiting its ability to provide adequate conditioning. The use of building cavities also caused the duct system to be very leaky and inefficient. The new return duct system was not only properly sized for the target air flow rate, but was also insulated and sealed to prevent heat loss and infiltration.

(bottom right) A new, high-efficiency (SEER 16/HSPF 9) heat pump was installed to replace the 30-year-old furnace and SEER 10 air conditioner when the ducts were being replaced.

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

More importantly, these measures avoided potential indoor air pollutants from the garage entering the living space. The original heating and cooling systems were replaced with a high-efficiency heat pump, further reducing the energy needed to condition the home.

Lessons Learned

- Undersized and leaky return ducts can make a home extremely uncomfortable because the air handler cannot effectively deliver conditioned air or provide mixing for temperature distribution.
- Ventilation air should come directly from the outdoors and not from garages, crawlspaces, or attics. Return air inlets in these areas can pose a health risk by drawing in airborne pollutants such as solvent fumes and carbon monoxide, in addition to increasing infiltration and duct leakage.
- In this home, redesigned ducts and a new SEER 16 heat pump are projected to reduce energy bills by 38%, saving approximately $685 per year. The new heat pump and ducts have also dramatically increased homeowner comfort by enabling the heating and cooling equipment to condition more effectively.
- The total cost of the project was $9,188, which is estimated to pay back within 9 years. For this project, the cost of sealing, insulating, and reconfiguring the ducts was included in the cost of heat pump replacement. However, the team estimates that just the duct work would cost approximately $1,000 and pay back in just 4 years.

Looking Ahead

Poorly designed duct systems can create discomfort, put health and safety at risk, and waste energy. Ducts should be sealed, insulated, and sized properly to ensure that heating and cooling systems are efficient and effective. It is important that ventilation and return air not be drawn from garages, crawlspaces, or attics. In new homes and comprehensive retrofits, ducts should be brought into the conditioned space to the extent possible, further minimizing duct leakage to the outdoors. In existing homes, if there is not sufficient room to bring the air handler and all duct work into the conditioned space, a closet can be built around the air handler to create conditioned space and further limit the possibility of garage pollutants being drawn into the living space.

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