# Air Tight Spray Foam home retrofit case study
# December 2006

Home Energy Solutions of Charleston, LLC was contracted to perform a case study of the Solar Reflection Inc office located at 1331 B Ashley River Road in Charleston, SC. The office is a converted residence built in 2000 currently being used as an office and a show room for the Solar Reflections and Air Tight Spray foam products.

## House details

The home is a 1550 square foot residence with 3 bedrooms and 2 baths on a single level. The house was built on a concrete slab with traditional 2 x 4 framed walls, R-13 fiberglass batt insulation and blown cellulose insulation on the ceiling with an estimated R – value of 30. The HVAC system consists of a 3 ton SEER 10 air conditioning condenser located outdoors with the air handler and ductwork located in the attic spaces. The heating system consists of an 80 AFUE gas fired furnace also located in the attic space.

The home retrofit consisted of removing the blown cellulose from the ceiling and installing 2 to 3 inches of spray foam insulation on the underside of the roof decking and the gable end walls. The insulation level in the roof was an average R – value of 19.

Since the roof system was insulated, the air handler and ductwork are now considered to be located inside conditioned space.

## Testing:

The home was tested before and after the retrofit using a blower door test. The blower door test measures the air leakage into the home through the use of a fan to de-pressurize the building. The air leakage is quantified using calibrated gauges. These figures are used to calculate the number of air changes per hour (ACH) that typically occur in the home. ACH provides a measurement of air infiltration which describes the percentage of air in a home that is replaced every hour.

The baseline testing using the blower door test measured an air leakage flow rate of 1350 cubic feet per minute ($cfm_{50}$). This equates to a .30 ACH or 30% of the air being replaced every hour due to air leakage in the home. During the testing, air leakage was found around doors, windows, both interior and exterior wall penetrations such as light switches, wall outlets, light fixtures and plumbing penetrations.

Following the spray foam installation in the attic space the air leakage flow rate was reduced to 700 $cfm_{50}$ or .16 ACH. This was a decrease in air leakage by 47%.

Duct blaster testing was also performed following the retrofit. The duct system measured a total air leakage of 98 $cfm_{25}$. When compared to the total square footage of the home, 6.3% of the air was leaking from the duct system. However, since the air handler and the ductwork are now considered inside conditioned space, there was no leakage outside of the conditioned area.

**REMRATE analysis:**

A REMRATE analysis was performed on the home using the before and after conditions. REMRATE is a software program used by Home Energy Rating Specialists to estimate the heating and cooling design loads and energy usage of the home. The REMRATE analysis provided the following summary:

**Estimated unit sizing requirement for heating and cooling.**

| Design Loads (kBTU/hr) | Before | After retrofit | Improvement |
|---|---|---|---|
| Heating | 30.6 | 18.5 | 12.1 |
| Cooling | 21.1 (2 tons) | 14.2 (1.5 tons) | 0.5 ton |

**Estimated electric or gas energy usage required for heating and cooling.**

| Energy Usage Loads (mmBTU/yr) | Before | After retrofit | Improvement |
|---|---|---|---|
| Heating | 18.7 | 17.4 | 7% * |
| Cooling | 35.0 | 25.7 | 27% |

* Improvements in the heating energy usage load is limited by the efficiency of the heating unit and the short duration of the heating season in Charleston.

**Summary:**

The application of spray foam insulation on the underside of the roofing system provided an effective seal to reduce air infiltration in the home. Air leakage in a home typically accounts for 40% of the total energy losses in a home. The air leakage in the test home was reduced by 47%. A number of additional benefits are achieved by reducing air leakage:

1. Reduced heating and cooling load on HVAC system.
2. Improved Indoor Air Quality by reducing the potential for mold, mildew and pollen to enter the home.
3. Improved humidity control in the home. By reducing hot and humid air from entering the home in the summertime, the Air Conditioner can more effectively reduce the indoor humidity level.
4. Improved home comfort. By reducing the indoor humidity levels, the occupants will be much more comfortable in their homes.

Insulating the roofline again has a number of benefits:

1. Reducing the attic temperatures also reduces the thermal losses from the duct systems providing more conditioned air to the living spaces.
2. The typical leakage found in all HVAC systems is now being used to condition the attic spaces.

All other benefits of the closed cell spray foam system apply here as well, such as:

1. Additional strength and rigidity of roofing system for storm and hurricane protection.
2. Sound proofing.
3. Insect and rodent control.
4. Vapor barrier for additional leak protection.

**Other considerations:**

Since this home was constructed on a concrete slab foundation, the majority of the electrical and water supply piping are routed through holes drilled in the top plate coming from the attic space. By sealing the attic space using spray foam, a significant reduction in air infiltration is expected. For homes built on crawl spaces, basements, or elevated homes the air infiltration will not be as dramatic. Consider at a minimum of sealing electrical, plumbing and duct penetrations under the home during a retrofit project to maximize the air leakage reduction.

Since the ACH is less than .25, (retrofit home measured at .16 ACH), it is highly recommended that a source of fresh air make up be supplied to the HVAC duct system to insure an adequate supply of oxygen for the occupants. Fresh air supply systems should be filtered with a manual damper or other means of controlling air flow. Make up air should supply a minimum rate of 10 cfm per person. Persons per home are usually calculated at the sum of the number of bedrooms plus 1. If there are any questions or concerns, consult with a local qualified HVAC contractor.

Consideration must be made concerning combustion air supply to gas fired heating systems located within a conditioned space. If a gas fired combustion source uses surrounding air for its combustion, should there be a lack of air supply to the unit, then the potential for back drafting could exist. This could result in carbon monoxide poisoning.

These units can quickly be identified by the metal vent exhaust pipe. There are several options to prevent the possibility of back drafting combustion appliances:

1. Upgrade the equipment to high efficiency units which utilize a double wall flue pipe pulling air directly from the outdoors.
2. Provide a source of make up air directly to the gas fired unit. This may include constructing a combustion closet around the unit.
3. Replace the gas fired equipment with electrical equipment.