



## Building America Case Study Technology Solutions for New and Existing Homes

# Predicting Envelope Leakage in Attached Dwellings

### PROJECT INFORMATION

**Project Name:** Predicting Envelope Leakage in Attached Dwellings

Consortium for Advanced Residential Buildings  
[www.carb-swa.com](http://www.carb-swa.com)

**Building Component:** Building Envelope

**Application:** New and retrofit; Multi-family

**Year Tested:** 2013

**Applicable Climate Zone(s):** All

### POTENTIAL BENEFITS

Requires substantially fewer resources in the field—equipment, personnel, and time

Does not require simultaneous access to multiple housing units—extremely difficult in occupied housing

Provides a more appropriate assessment of envelope leakage and the potential energy benefits of air sealing than the commonly used total leakage test

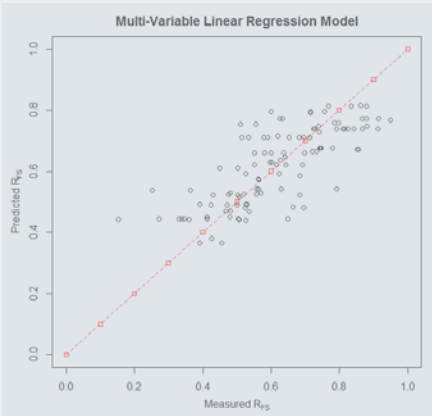
The most common method of measuring air leakage is to perform single (or solo) blower door pressurization and/or depressurization test. In detached housing, the single blower door test measures leakage to the outside. In attached housing, however, this “solo” test method measures both air leakage to the outside and air leakage between adjacent units through common surfaces. Although minimizing leakage to neighboring units is highly recommended to avoid indoor air quality issues between units, reduce pressure differentials between units, and control stack effect, the energy benefits of air sealing can be significantly overpredicted if the solo air leakage number is used in the energy analysis.

Guarded blower door testing is more appropriate for isolating and measuring leakage to the outside in attached housing. This method uses multiple blower doors to depressurize adjacent spaces to the same level as the unit being tested. Maintaining a neutral pressure across common walls, ceilings, and floors acts as a “guard” against air leakage between units. The resulting measured air leakage in the test unit is only air leakage to the outside. Although preferred for assessing energy impacts, the challenges of performing guarded testing can be daunting.

In an attempt to create a simplified tool for predicting leakage to the outside, U.S. Department of Energy Building America team Consortium for Advanced Residential Buildings (CARB) performed a preliminary statistical analysis on blower door test results from 112 attached dwelling units in four apartment complexes. The correlation between building specifications and the ratio of guarded and solo test results was investigated. Although the subject data set is limited in size and variety, the preliminary analyses suggest significant predictors are present and support the development of a predictive model. Further data collection is underway to create a more robust prediction tool for use across different construction types, climate zones, and unit configurations.



Guarded blower door setup: Conducting a guarded blower door test for these row houses required three blower doors working simultaneously and four people—three to operate the equipment and one to coordinate the effort. With other unit configurations like stacked apartments, a fully guarded test could easily require three times the equipment and labor.



Graph of preliminary model result showing predicted RFS against measured RFS. RFS is the ratio of guarded to solo blower door test values. This predicted ratio can then be multiplied by a solo test result to predict a guarded test result. The diagonal red line represents an accurate predictive model. The closer the data points are to the red line, the more accurate the model.

For more information, see the Building America report, *Predicting Envelope Leakage in Attached Dwellings*, at [www.buildingamerica.gov](http://www.buildingamerica.gov)

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

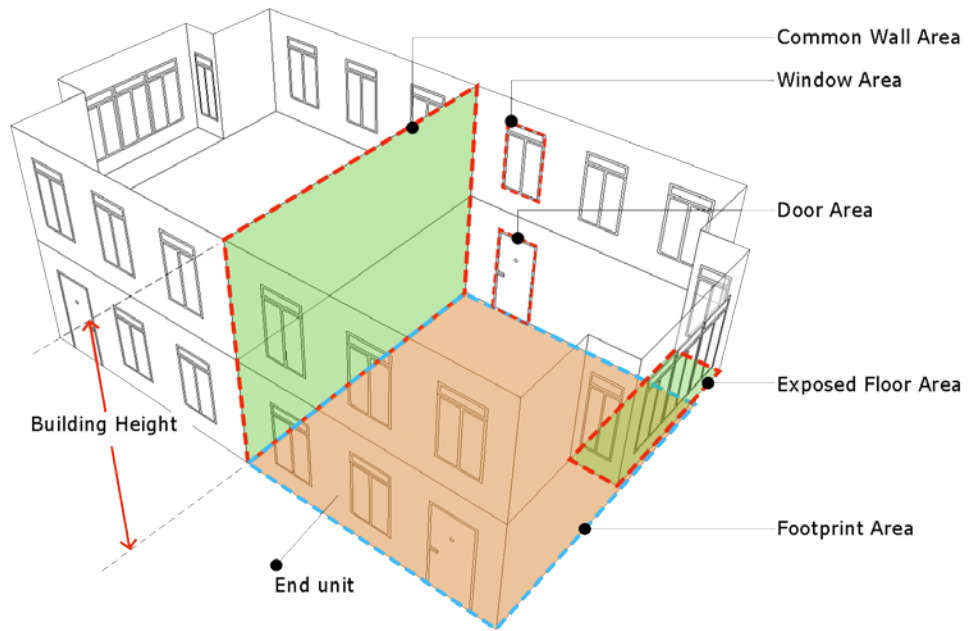


Illustration of typical building specifications evaluated in the model.

## Description of Model

A multivariable linear regression was selected as the form for the model. The intended result is a simple and reusable tool for builders, raters, engineers, and architects to predict air leakage to the outside based on a “solo” blower door test value and a few significant building specifications (predictor variables).

## Preliminary Significant Predictor Variables

- Ratio of common wall to total surface area
- Ratio of window area to total exposed area
- Unit location: indicates whether a unit is an end or interior unit
- Duct location: indicates whether the unit’s ductwork is in conditioned or unconditioned space
- Unit level: indicates whether a unit is on the top, bottom, or middle floor of an apartment building.

## Looking Ahead

The next step is to collect additional data for analysis and algorithm development so it may be more broadly applied with confidence. More data with more variations would help obtain a stronger and more reliable model. Also, the significance of current predictor variables could change and other significant variables could surface.