

# Effectiveness of Air Sealing techniques.

Richard Kadulski

Air sealing or draft-proofing is important to reduce energy consumption as uncontrolled air leakage can account for well over 1/3 of a home's total heat loss. That is why air sealing is stressed in retrofit programs.

## How tight is tight?

How do you know you're getting your money's worth? North East Utilities, a Connecticut based utility is typical of many that have started retrofit programs to assist residential customers in reducing their heating bills.

The Wrap-Up/Seal-Up (WUSU) program offers weatherization and conservation services at cost. The Wrap-up portion of the program addresses domestic hot water conservation; the Seal-up portion of the program is designed to save the heating and cooling energy costs by reducing infiltration. There are two approaches offered for air sealing, one is a low cost prescriptive approach (seal-up), the other is a more elaborate performance based approach (using the air sealing specialist).

To determine just how effective each approach is, they undertook a study of both approaches. The questions they tried to answer were:

- \* How well does a basic prescriptive program reduce infiltration?
- \* Is the air-sealing specialist's approach a more effective way to reduce infiltration?
- \* Which method will save the homeowner the most money per dollar of investment?
- \* Will air-sealing a home increase its concentration of indoor air pollutants, particularly Radon?

WUSU offers twelve energy conservation "measures". The customer selects the measures he feels are useful for his home.

The Wrap up program for domestic water conservation includes: a water heater insulation blanket; turning down

water heater thermostat; low-flow shower heads; low-flow faucet aerators; wrap pipes with insulation; insulate forced-air ducts; put thermal coverings on basement windows

The Seal-up measures save energy by reducing infiltration. These include: caulking window and door frames; weatherstripping window and door frames; installing door sweeps to block air flow under doors; insulate the attic entrance hatchway, door or pull-down ladder; insulation gaskets behind electric switch and outlet cover-plates; insulate the gap between siding and foundation.

## Air sealing approaches

Operation Wrap-up/Seal-up is a low-cost approach to weatherization; but its effectiveness is also low. Seal-



up usually achieves small but measurable infiltration reductions, but sometimes no measurable reductions are achieved.

WUSU relies on the occupants of the house to identify the major points of infiltration in the structure. It is assumed that the homeowner will be aware of the areas to improve. It could be the winter wind blowing under the front door, or the drafty window next to the bed or easy chair. The infiltration control measures are selected by the occupants from a limited menu, and all measures (except sill plate sealing) are performed within the living space.

The alternative approach is using an "Air Sealing Specialist", who uses special tools to locate drafts and air leaks into the house. The specialist eliminates those air leaks with caulks, sealants and other materials. The work normally takes longer and is more expensive than that done by WUSU.

The air-sealing specialist's work is more expensive, but tests have shown that it is also very effective at reducing infiltration.

The Specialist uses a blower door (and possibly other specialized tools) to discover where air is leaking into the house. From experience he knows that the leakiest parts of a house are often hidden and the homeowner will not be aware of them. He looks for air leaks that are "buried" within the details of construction, often found mainly in attics and basements.

The method looks at the house as a whole system, and searches for both infiltration and conduction losses. An infrared camera to scan walls and ceilings may be used to look for missing insulation and places where cold air is flowing through hidden paths.

A Quick Seal Approach assumes that the typical house has a few major leaks which account for more than half of its leakage. The Quick Seal Approach aims to locate and plug these leaks in a short period of time (typically a half-day visit by a two-person crew) and achieve substantial energy savings at about half

the cost of a more comprehensive house doctoring job.

## The test

100 single family detached homes were studied, 50 were treated using the basic seal up techniques, 50 used the specialist techniques.

The basic seal up group was further subdivided: Group 1 received only the specific measures requested by the homeowner; Group 2 received every WUSU measure that could be done to the house. Every window and door was caulked and weatherstripped. A sweep was installed on every exterior door. The foundation sill was sealed when it was accessible. Outlet gaskets were installed on exterior walls. This was to determine the maximum savings to be gained.

Group 3 consisted of the 50 homes treated by the Specialist.

### Airtightness Before:

Before retrofit, the average infiltration rate was 11.4 to 13.5 ACH at a pressure difference of 50 Pascals. (The R-2000 standard is 1.5 ACH at 50 Pascals).

The homes with electric heating were found to have a 38% lower leakage rate than those with gas heating. (Part, but not all, of the difference is likely due to the presence of a flue.) Houses with ductwork had 15% more leakage than those without.

### Airtightness After:

After the retrofit work, the air leakage rate was reduced by: 3.9% for the Group 1 houses (owner requested items only); 10% for Group 2 houses (maximum prescriptive items); and 23% for Group 3 houses (the specialists' work).

### Cost:

The average WUSU participant in this test requested \$25 worth of measures. The effectiveness of the measures varied considerably; some were effective and others did not show any infiltration reduction. Attic ladder covers were ineffective at reducing infiltration (but they appear to be effective as insulation, and could reduce infiltration with some design changes). Sill seal was found not to be effective in the three homes where it was tested.

Installing all possible WUSU measures in a house had a greater effect reducing infiltration. If the homeowner had paid for this work, he would have paid, on average, \$230. (costs ranged from \$53 to \$408 per site).

While the savings achieved by the WUSU work are low (averaging \$22/-house), the payback to the homeowner is quick. Spending nine times as much yielded a 3-times increase in leakage reduction. Doing intensive WUSU appears to have a diminishing return. When "maximum WUSU" work is done a lot of it will be ineffective.

The Air-Sealing Specialist's work was, as expected, the most effective method for reducing infiltration (by an average 23%). Significant differences were found in the degree of reduction that could be achieved in gas heated vs. electrically heated houses (the electric houses were tightened more).

As the electric houses in the test were older it was difficult to determine if the Air-Sealing can tighten the typical electrically heated house more than it could the gas heated house.

The Specialist's tools and measurement techniques enabled him to locate many previously unknown leaks in the houses. Many infiltration points were located and sealed, most of which could not be treated using the tools available to WUSU crews.

The cost of the Specialist's work in a full-scale program is ill-defined as standard specifications have not been established. If one assumes that the Specialist's work were to cost about \$300 to \$400 per house, it would be 12 to 16 times as expensive to the customer as the basic work done in this test. Infiltration is reduced by 7 to 8 times as much as was done with the simpler approach, so the specialists' work is about 7 times as expensive but has the same payback rate.

The Air-Sealing work done in this test was performed by trained crews, much done within the living space, less in attics and basements. (Some firms claim that 90% of their tightening work is done in attics and basements). More training (possibly with other tools such as an infrared camera) might increase the effectiveness, yielding up to a 30 to 40% infiltration reduction as a practical upper limit.

If the lifetime of the sealing work is more than ten years, all approaches tested here were shown to be worthwhile.

### Air Quality Measurements

Three pollutants were measured in each home before and after sealing: Radon, formaldehyde and nitrogen dioxide (NO<sub>2</sub>). In all houses and for all three pollutants, nearly as many houses showed a decrease in pollutant concentration as showed an increase after sealing.

Air quality measurements indicated that sealing a home does not cause a decrease in its indoor air quality.

*"A comparison of Two Weatherization Techniques: NU Seal-up vs The Air Sealing Specialist". Study Conducted by Enercom Inc. Marketing Services Department, North East Utilities, Hartford CT.*

## No. BS Centre

*There are strange things done in the midnight sun  
By the men who moil for gold;  
The Arctic trails have their secret tales  
That would make your blood cold;  
The Northern Lights have seen queer sights,  
But the queerest they ever did see .....*

On September 22, 1990 in Whitehorse, Yukon, far away in the north-western corner of Canada the Northern Building Science Centre (the No BS Centre) is officially opening.

Guests from other arctic regions in the USSR, USA and Finland, and even Ottawa, are expected for the opening.

The north faces some of the harshest climate conditions in the world. This means that special design and construction practices must be taken into account to deal with northern realities.

Up to now there has been no focal point to deal with northern building issues. Most activity has been coordinated from the South at the NRC in Ottawa and the former Prairie regional station in Saskatoon.

This is about to change as the Northern Building Science Centre located on the campus of the Yukon College opens. It will facilitate building trades training programs, be an information source to the industry and public as well, and help coordinate research and development into northern building issues.

The centre was initiated by northerners themselves. Wayne Sippola, the R-2000 program manager for the Yukon and Yukon Homebuilder's Association executive officer has been a key driving force for the project. It will also house the Yukon Home Builder's Association.

The structure itself is innovative: It uses a rigid monocoque frame developed by the Council of Forest Industries of B.C. The frame is supported on 4 footings rather than a perimeter foundation wall. This allows for foundation movement without damaging the building - an important consideration for buildings built on permafrost.

The structure is "stick built" and uses spruce plywood, spruce dimension lumber, 20 gauge galvanized sheet steel and a large number of power driven nails.