MEASURING NET FREE AREA OF ROOF SYSTEMS

By William B. Rose

What is the net free area of a roof on an existing house? The answer to that question seems to come up maybe twice in the life of a building: It comes up at design time, and it comes up if someone notices a problem—lack of ventilation is often seen as the default culprit. The late Tony Woods showed his Canadian roofing contractors that they could make more money than their U.S. counterparts by providing ceiling air tightening and insulation as an add-on to a roofing job, rather than roof ventilation. And those attic assemblies delivered far better energy performance than the holes-in-the-roof approach common in the U.S.

I've never seen someone try to do that calculation by measuring all openings with calipers and applying resistance factors for screens and for hole shapes and sizes. Thanks to weatherization and energy retrofit contracting (ERC) of existing homes, the matter of attic assessment has taken on new life with new tools. ERC specializes in providing added airtightness to ceilings and adding insulation in attics. These two strategies, especially taken together, provide greatly improved energy performance of attics; improved ice-dam performance; and, judging from anecdotes, few or no complaints about moisture performance. This is good.

Thanks to the efforts of researchers like Michael Blasnik, Anthony Cox, and Collin Olson, we can actually measure the net free opening area of a roof and of a ceiling. The key is making effective use of the blower door, with zone pressure measurements. Here's how to do it:

1. Set up and run the blower door, creating pressurization or depressurization of a fixed amount—say, 50 pascals (Pa).
2. Do a zone pressure measurement in the attic to find the pressure difference, with the blower door running, between the attic space and the outdoors.
3. Add a hole in the ceiling, for example by opening the attic hatch, and get a second flow measurement and a second zone pressure measurement.
4. Calculate.

Figure 1 is a schematic showing the measurement sites and resistors to flow at the locations of the ceiling, the new hole, the

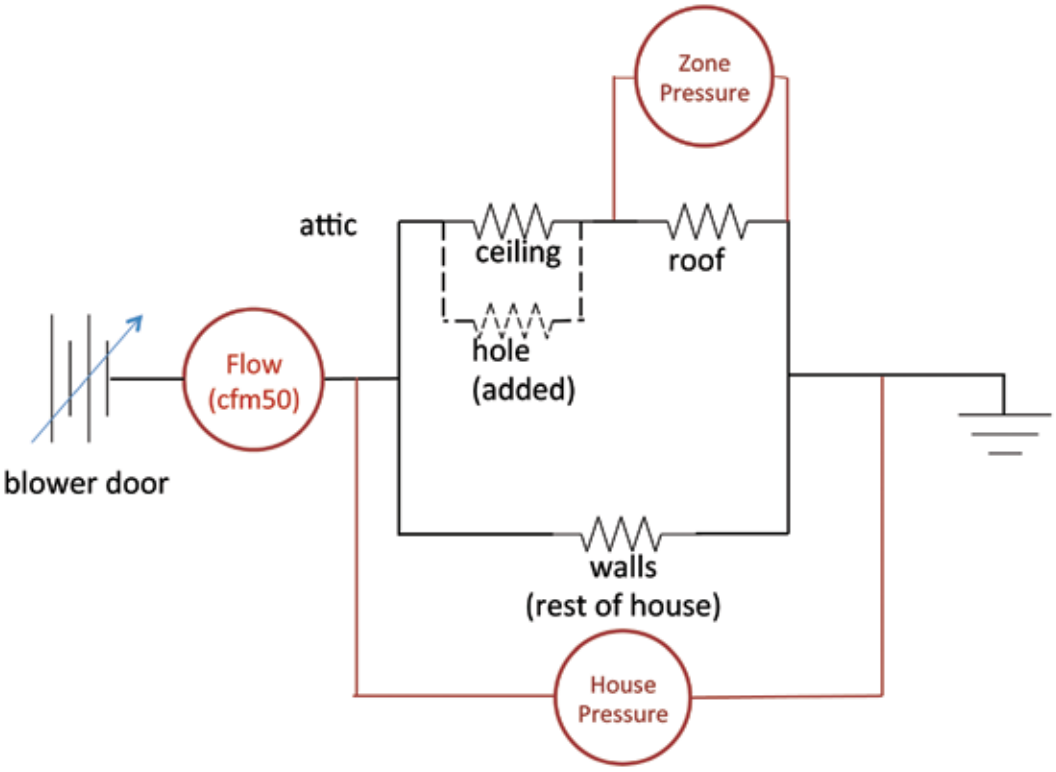

Figure 1 – Schematic showing a blower door test as an electric circuit analogy. Zone pressure in the attic is shown with reference to outdoors.

A Legacy Practice That Needs Revisitation?

When searching for articles to fill this month's issue on ventilation, I remembered a presentation by William Rose at a Region I meeting in 2000. His talk was called the "Early History of Attic Ventilation" (*docserver.nrca.net/technical/7877.pdf*) and came to the conclusion that the 1/300 ventilation ratio was apparently derived from a single data point in a single 1938 study by Rowley. It became an industry standard. Though venting was originally intended to be a means of "condensation control," it eventually became a requirement of shingle manufacturers to prevent premature degradation of their products. This article brings focus to sealing the building's conditioned space from the attic rather than relying on ventilation to remove moisture.

Since I have been conditioned to believe that venting the roof deck is necessary for the longevity of shingles, I raised this point in an e-mail exchange with Mr. Rose. He pointed out that the shingle industry didn't require deck ventilation "until the early 1980s, when the industry was adjusting to unfamiliar raw materials from new and different sources, such as Alaska."

In one e-mail, he wrote (and I paraphrase), "Ventilation industry says: Vent roofs with our shingles or they'll get too hot. Response: How hot is too hot? Ventilation industry: [silence]. It appears that vented black shingles in Phoenix are warrantable; unvented white shingles in Minneapolis are not. This stance cannot be taken seriously."

Well, *Interface* readers? I would be interested in other evidence and opinions on the subject. Mr. Rose believes that, as consultants and professionals, our underlying ethic should be to benefit our clients more than ourselves. By requiring attic ventilation to obtain shingle warranties when the ability of ventilation to affect shingle temperature is weak compared to, say, shingle color, we may be covering ourselves more than benefitting our clients. Precision (1/300) attic ventilation is a legacy practice outlook and one that is deserving of a new critical assessment.

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roof, and the rest of the house. The calculation is quite simple:

$$A_r = \left[\frac{(F_2 - F_1)}{10}\right] / \left[\left(\frac{ZP_2}{50}\right)^n - \left(\frac{ZP_1}{50}\right)^n\right]$$

Where:

- A_r is the net free area of the roof openings (in.^{2}).
- F_2 and F_1 are the measured blower door flows of tests 2 and 1 (cfm@ 50Pa).
- ZP_2 and ZP_1 are the measured zone pressures with respect to outdoors of tests 2 and 1 (Pa).
- n is the flow exponent, usually 0.65.

The assumptions in this relation are:

1. A change of 10 cfm50 flow occurs with a change of 1 in.^{2} of hole opening area.
2. Both blower door tests were conducted at 50 Pa.

So what do we do with this new-found ability?

The first thing we will note is that there are essentially no 1/300-vented and no unvented roof assemblies out there. That distinction is artificial and is not represented in the actual building stock. Every roof assembly, whatever we choose to call it, is partially vented and partially unvented. It has leaks from the house to the attic and leaks from the attic to outdoors. We can assign two leakage numbers to any attic assembly. This includes full attics, cathedral ceilings, and story-and-a-half knee wall areas. Different unconnected zones will have different leakage values. If shingle warranties strictly required 1/300 attic ventilation, I suspect we would find few complying attics.

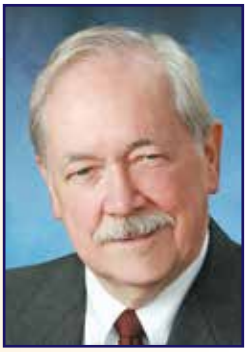
The second thing we may do as roof consultants is to build up a database of attic values and see what leakage numbers correspond to good performance and which ones correspond to bad performance. If your experience is like mine, leakage across the ceiling plays a much bigger role than opening area in the roof. Tony Woods was very much on the right path.

The third thing we may do is put these numbers to use. From experience and the use of our database, we can distinguish attics that are performing well, and we can make better predictions when designing or redesigning roofs.

Attic venting is a legacy practice, a leftover from the days when ceilings were simply leaky and remained leaky. Every roof consultant I know views the 1/300 rule skeptically, despite the fact that it appears in the code as a requirement. Compliance of course provides cover against legal exposure. We owe it to our clients to deliver performance, and we should not be delivering rule compliance solely for our own reduced-exposure purposes. Legacy practices become more questionable over time, as materials and processes change. If there is any ethical obligation in roof consulting, it is to assign greater importance to delivering performance to the client than complying blindly with legacy practices and values.

Weatherization and energy-retrofit contracting is becoming very skilled at adding tightness to the ceiling. The industry has the tools at hand to do zone pressure testing as part of blower door tests. These two skills by themselves—air tightening and diagnostics—should provide excellent overall performance of residential attics in existing buildings.

William B. Rose



William B. Rose is senior research architect at the Prairie Research Institute, part of the University of Illinois at Urbana-Champaign. His research is in building performance, particularly the heat and moisture performance of building envelopes. For 12 years he was the handbook chair for the *ASHRAE Handbook* chapters on building envelopes. In 2005, he authored *Water in Buildings*, published by Wiley & Sons. His current research is with the U.S. Department of Housing and Urban Development, to determine concentrations of common air compounds in homes that are weatherized and mechanically ventilated. Mr. Rose was recently named an ASHRAE Fellow.