

BY JIM BRADLEY AND CHRIS WEST

Tracing Air Leaks With a Blower Door



To begin a “smoke check,” the authors fill a home with dense fog produced by a high-volume theatrical fog machine (1).



With the blower-door fan blowing inwards, co-author Chris West starts to pressurize the home, pushing the fog to the exterior (2).

Part and parcel of being home-performance consultants based in northern Vermont is promoting the importance of a pre-drywall inspection for new homes. For us, the inspection includes establishing a home’s ACH rating (air changes per hour) as well as visually examining the primary air barrier for air leaks while the interior shell is still open. Although we still use an infrared camera to help locate air leaks, we find fogging homes or “smoke checking” to be the most effective method.

To perform smoke checks, we use a theatrical fog machine (1). We first fog a home’s interior, then set up a Minneapolis Blower Door to pressurize the home and push the fog to the exterior through any open seams or gaps (2). This pressure test helps locate what we refer to as “areas of opportunity”—a last chance to easily tighten up the home’s air barrier prior to drywalling and installing the exterior cladding. Putting the effort in to track these down can often add up to hundreds of cfm worth of leakage reduction.

In addition to reducing a home’s energy performance, air leaks can be a health and safety issue. Small rodents can easily squeeze through small gaps in an air barrier and decimate a home’s insulation package, causing IAQ problems, or gnaw on Romex wiring, causing a potential fire hazard—a common occurrence in the rural North Country where we work.

Immediate feedback. A key advantage fogging offers is that it immediately demonstrates to the builder, his or her crew, and the homeowner problem spots in need of remediation. Also, air exfiltration at large unsealed gaps in the air barrier can be visually compelling, with fog jetting out of the building envelope like a vape pen.

Using an IR camera to find air leaks is effective, but when the temperature differential is low between the home’s interior and outdoors, the smoke test offers better results. We often use the two in tandem, fogging a home to get a quick overall sense of where leaks are, and then fine-tuning the search with an IR camera.

Tightening up your game. We recommend familiarizing yourself with your state’s status regarding impending IECC rules and preparing accordingly. In Vermont, where we work, the new 2020 Residential Building Energy Standards (RBES) was implemented on September 1, 2020. As a result, blower door testing by a certified tester is now required for the RBES Base and Stretch codes. All newly-built



With the building pressurized, fog could be seen escaping from two doghouse dormers at their roof-to-wall junctures (3).



Co-author Jim Bradley points to smoke leaking from double-hung windows in living space above the garage (4). After checking the window openings and dormer framing, workers determined that the window units themselves were leaking (5).

homes are now required to be blower-door-tested for air leakage to certify a maximum airflow of 3 ACH50—it's no longer just a visual inspection. "Self-certifying" is allowed, but in Vermont, all testers must be certified through the Building Performance Institute (BPI) or Efficiency Vermont. Although Vermont is one of only 10 states that is currently implementing the IECC rules as is, other states will soon follow. It's important to stay informed on energy codes where you work, as energy standards tend to become more stringent over time, not less.

For us, the newly-enacted VT RBES mandate means the need for pre-drywall blower door testing—combined with a smoke check—will be all the more crucial, particularly on new homes built to code where air-sealing may be part of a builder's job scope but may not be applied to the nth degree. We expect to see more demand in the near future for pre-drywall testing on newly built code-compliant homes, in an effort to achieve better certified ACH numbers.

SMOKE CHECKING A HOME

Even well-sealed homes may be in need of tightening up. Earlier this year, we did a pre-drywall inspection and smoke check for an architect known for his high standards regarding energy efficiency. We discovered numerous problems with the air-sealing and insulation detailing that would have made his high-performance house project much leakier than it should have been, given the time and energy devoted to designing and building it. As a result of our findings, the builder was able to mitigate the leaks prior to drywalling, saving the energy-conscious architect the headaches he would have had if the mistakes had been covered up and the building had then underperformed.

Also, it's not out of the realm of possibility that building crews and subtrades who have bought into the concept of building well-sealed, high-performance homes but are rushing to meet a scheduling deadline can accidentally miss air-sealing penetrations or seams. Sometimes, crews have a bad day or "night before" and do not do the greatest air-sealing job on a particular day—these things happen.

Air-sealing is not always the problem. On another pre-drywall inspection we did last June, we were asked by a local home-building company to perform a blower door test and smoke check on a new custom house. At first glance, we could see that the builder's crew did a top-notch job air-sealing the interior side of the framing and the usual hard-to-seal spots.

Starting out, we set up the blower-door assembly with the fan oriented to blow inwards. We then filled the entire home with "smoke" using a high-volume theatrical fog machine (chauvetdj.com). The machine burns a special fluid to create the fog, which is innocuous but has a faint odor. It took about 20 minutes to fill the entire 4,500-square-foot

home. We then pressurized the house with the blower door to push the fog out through the home's primary air barrier and inspected the home's exterior perimeter for air leakage.

We could see smoke coming out a pair of second-floor doghouse dormers along the rake edges of their roofs (3). Dormers are somewhat notorious; because they are framed above the roofline, they are difficult to air-seal and small air leaks are common. More noticeable was the smoke emanating from the double-hung windows located at the second-floor living space above the garage (double-hungs are known to be less airtight than casements or European tilt-and-turns). The three windows were identical, but one of them was leaking more than the other two (4). The builder's crew broke out their ladders and determined the smoke was leaking from around the window's frame and not from its taped-off flanges (5). The window manufacturer was notified about the leaky unit.

Blower door test. With the smoke check completed, we can turn the fan around and depressurize the house to find our baseline ACH rating numbers for the client, which turned out to be 1 ACH50, well under the code maximum airflow of 3 ACH50, negating the need for another test (6).

As an aside, we now use a TEC DG-1000 Pressure and Flow Gauge manufactured by The Energy Conservatory to calculate a home's ACH rate. We've found its new DG-1000 manometer much more intuitive than its old workhorse DG 700 model (7). A high-resolution touchscreen graphically shows you such items as what size rings you need on the blower door fan, and what pressure taps to hook the red and green diagnostic tubing to, depending on the airflow-measuring task (8). TEC also has an app available that enables you to sync your smartphone to the manometer, which allows you to operate the DG-1000 remotely—it's a big step up from the older model.

We've heard many builders say, "We foamed everything," and think that's it with respect to air-sealing, but it's not. There are usually air-sealing opportunities waiting to be fixed. That's why a pre-drywall inspection is so valuable. It's a great fail-safe that will show air leakage pathways that need to be considered, such as penetrations for dryer and whole-house vacuum-cleaner vents, security lights, and range hoods. Other hidden trouble spots include changes in house geometry, such as shed and doghouse dormers, and built-up framing, such as inside and outside corners, ganged jack studs and king studs, headers, and double top plates.

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With the smoke test completed, the authors depressurized the home and performed a blower door test (6).



The authors used a new TEC DG-1000 manometer—here compared with an older DG 700 manometer—for the blower door test (7). The DG 1000 is much more intuitive, graphically showing where to connect red and green diagnostic tubing (8).