



**Mark LaLiberte**

*President of Building Knowledge Inc., Mark LaLiberte is a highly regarded green building consultant who helps builders nationwide understand and apply proper building science construction principles to improve their homes.*  
[www.buildingknowledge.com](http://www.buildingknowledge.com);  
[www.laliberteonline.com](http://www.laliberteonline.com).

# Put It to the Test

Blower door, duct blaster, and other tests are essential for verifying and benchmarking the performance of your houses.

In my travels, I hear many construction myths. One of the most common is that new houses are “just too tight.” But can a house really be too tight? In my opinion, no. A tight house is a predictable house. It lets us determine indoor comfort and maintain structural integrity. A leaky house is unpredictable. It has its own peculiar personality, one that we can never fully understand or control.

I’ll cast my vote for a tight house every time—the tighter the better—but with one condition: Builders must understand and respect the rules of building science. That means installing distributed ventilation, selecting sealed combustion equipment for all systems using gas, oil, or wood, and managing the effects of weather on the enclosure.

Testing homes lets us define and quantify the level of tightness in a home. Diagnostic and testing professionals now have specialized equipment, such as blower doors, duct blasters, infrared imaging, and flow hoods, that provide reliable, verifiable measurements of how well a given home performs.

There are several reasons you need to test the tightness of your homes. One is to satisfy the guidelines for the energy-efficiency programs in which you may take part. Another is to give your trade contractors a benchmark used to design HVAC systems to that is often undervalued. Each person who works on your project needs clear, definable standards that will result in a level of satisfaction for the trade contractor as well as for you and your client. Using a combination of testing measures, performance standards, mockups, and even photos will help everyone succeed and keep your project goals clearly defined.

Testing is also the best way to learn where your project’s strengths and weaknesses lie. Each home reveals its own unique areas of air leakage, which are typically the result of a complex framing detail that makes proper insulation and air sealing difficult. Learning the fundamentals of building science and coming to understand the forces of whole-house performance will protect your reputation, your profitability, and your pride in

craftsmanship. I have learned more about building science from watching and participating in diagnostic testing than through any other method.

At a minimum, there are two diagnostic tests that you should perform on every home you build: the blower door test and the duct blaster test.

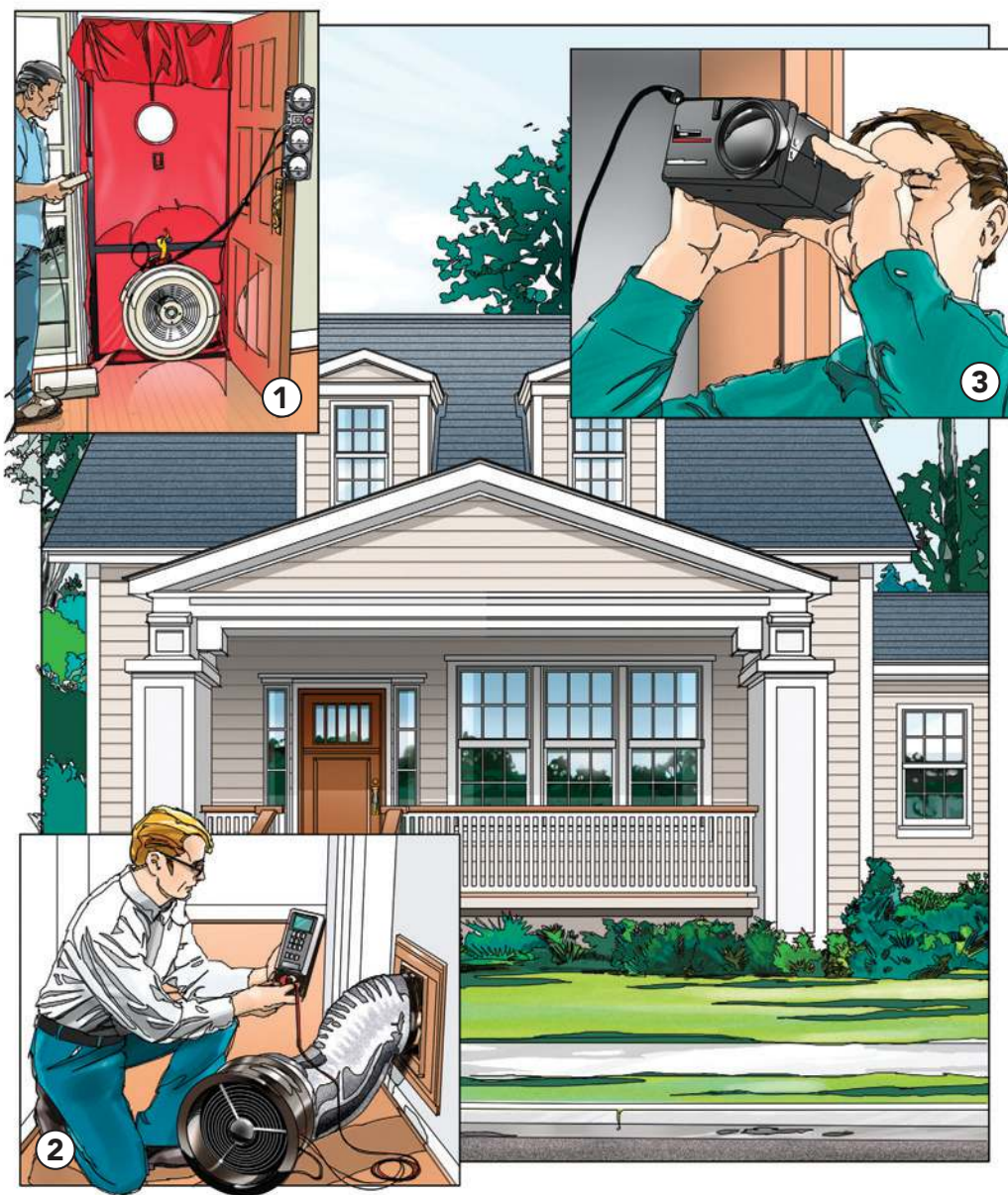
## **BLOWER DOOR TEST**

A blower door test measures air infiltration. It estimates the amount of air that is leaking into or out of the house under average weather conditions. It also measures the cumulative size of all the holes, cracks, and crevices in the house. The size of this opening may be comparable to a small window left open year-round, or it may be the size of a patio door.

Here’s how a blower door test works: After tightly closing every window and door in the house, the technician places a device called a “blower door” into the front door of the home. This device contains a large fan that’s attached to a portable computer. During the test, the computer takes the fan through a specific range of speeds designed to simulate a 20-mph wind pressing against all sides of the structure. As the house tries to equalize this pressure from outside, air infiltrates through various leaks in the building envelope. The leakage rate is calculated, and a test report is generated.

A blower door test typically takes about an hour. Have an experienced professional technician, like a certified home energy rater, conduct the test to ensure the data is acquired correctly. This person or a third-party professional from one of the energy certification programs, such as Energy Star, can be a valuable resource.

Ask your rater to generate a test report listing the home’s natural infiltration rate in air changes per hour (ACHnat). Have your mechanical contractor enter this infiltration rate into his Manual J load calculation software. Does it change the size of the HVAC system you are installing? Yes, with better information, you will find right-sizing these systems often results in smaller equipment and lower cost. A correctly sized HVAC system can



**FIGURE 1: PERFORMANCE TESTS**

**1. Blower Door Test.** A large fan connected to a computer simulates wind pressure against the exterior of a home and measures rate of air infiltration into the building shell.

**2. Duct Blaster Test.** A computer-connected fan pulls air from a sealed duct system, including sealed-off supplies and returns, and measures the pressure difference in the ducts to measure air leakage. You should conduct a separate test on ducts running outside of conditioned space.

**3. Infrared Imaging.** Infrared scanners “read” heat loss through walls and roof to identify problem areas where insulation has not been properly installed.

for heating, we can and should be using one for cooling, ventilation, whole-house air filtration, humidification, dehumidification, and to circulate air that would otherwise be stratified or stagnant.

Many energy efficiency and green building programs have performance standards for duct system tightness, and now require a duct blaster test as well as blower door testing. Some HVAC contractors also conduct their own duct testing upon a job’s completion. The test should be done after the rough-in of your duct systems and before insulation and drywall, so you can locate and seal any leaks in the system before they become hidden.

Here’s how the duct blaster test works: The technician starts by sealing off all the return and supply boots, typically with special duct masking tape, but anything that seals the opening will work. Cardboard works, and I also have seen a test done with friction-fit rigid foam pads. Once the boots are sealed, your rater will attach a fan to the blower compartment of your furnace or air handler, and will remove any filters in the return plenum. At this point, the only intentional opening in your duct system should be through the duct blaster. The rater will attach the same pressure gauge used for the blower door test to measure the pressure difference in the ducts. The more airflow it takes to create a certain pressure difference in the duct, the more holes there are in your duct system.

Ask your rater to correlate the duct leakage at 25 pascals as a percentage of the total design flow of the system (percent of flow at 25 pascal). The designed flow rate is typically 400 CFM per ton of cooling, i.e. a 3-ton A/C unit will need to move about 1,200 CFM across the A-coil. That said,

have a significant effect on energy load, indoor air quality, and home durability.

Make sure your rater also calculates the air leakage rate for the total surface area of the home (CFM50 per square foot of surface). This is the cumulative surface area of all the floors, walls, and ceilings exposed to unconditioned areas. Depending on the program, this target is usually 0.25 CFM50/square foot or less. Builders in Minnesota routinely air-seal to levels between 0.10 and 0.15 CFM50/square foot of surface area.

### DUCT BLASTER TEST

I often hear people say they don’t like forced air. This is sort of like saying you don’t like plumbing. Whether or not we use an air-distribution system

## Other Tests and Tools Available

**Infrared Imaging:** Finds hot spots and cold spots on exterior walls, ceilings, and floors caused by air leakage or missing or inadequate insulation levels

**Flow Hood:** Measures air flow from exhaust fans, supply registers, and return registers. Ensures you are getting the designed flow rates from your HVAC systems

## Who Conducts These Tests?

**Energy Raters:** Find a local energy rater at [www.resnet.org](http://www.resnet.org) or [www.energystar.gov](http://www.energystar.gov). Work with them to create a strategy to tighten up your homes and ducts.

**Trade Partners:** A number of insulation and HVAC contractors already test their work. Check with your trade contractor to see if he provides this service. Programs like Environments for Living or LEED for Homes also can help you find the people you need.

**Do It Yourself:** Find a used blower door and duct blaster or buy a new one from The Energy Conservatory ([www.energyconservatory.com](http://www.energyconservatory.com)). It can help you learn what you need to do to test correctly.

you'll want to work with your mechanical contractor to establish the actual designed flow rate. Divide the measured duct blaster flow at 25 Pa by the air handler's designed flow rate and multiply by 100. So, if the test shows a leakage rate of 60 CFM at 25 pascal on a 3-ton air handler, this leakage is 5% of the rated flow. (60 CFM / 1,200 CFM) x 100 = 5% of air handler flow at 25 pascal.) The lower this percentage, the tighter your duct system. Typical energy program total duct leakage targets range from 3% to 10%.

Ducts that leak into unconditioned space, like attics and crawlspaces, have more severe energy and durability penalties (think supply trunks leaking warm, moist air into a cold attic). So you also want to know what percentage of your duct leakage occurs outside of conditioned space. This is called a "duct leakage to outside" test, and it differs slightly from the total duct leakage test in that your rater measures only that leakage into or out of the ducts from outside the conditioned space. Ask your rater or program representative about your program's requirements. You will want

this number to be as small as possible; aim for less than 3% of air handler flow.

### LIVE AND LEARN

Remember that both of these tests are often conducted after the fact. They reveal how effectively—or ineffectively—you achieved the standard. Use the tests as learning tools. Be present when your homes are tested and ask a lot of questions. Invite your trade partners to participate as well.

Once you use diagnostic testing, you'll be surprised how quickly you're able to identify and correct areas of potential failure in the design phase as well as in the framing stage. When you address these issues early on, your blower door and duct blaster tests become routine. Every house you build will be a tight house that's durable, energy efficient, safer, healthier, and a pleasure to live in.

*Pat O'Malley, director of operations at Building Knowledge, contributed to this article.  
[pato@buildingknowledge.com](mailto:pato@buildingknowledge.com).*