



INNOVATIONS CATEGORY:
Advanced Technologies and Practices
Building Science Solutions
Optimized Comfort Solutions

INNOVATOR:
LBNL and PARR

HVAC Cabinet Air Leakage Test Method

If air-tight HVAC air handlers become a minimum standard in 2015, then by 2030, the cumulative savings will be 10 billion therms of natural gas and 300 billion kWh of electricity. This corresponds to approximately \$20 billion of utility savings for American homeowners while also reducing peak energy demand for utilities by 5%.

Building America-funded research by teams and national laboratories resulted in the development of an ASHRAE standard and a standardized testing method for testing the air leakage of HVAC air handlers and furnace cabinets and has spurred equipment manufacturers to tighten the cabinets they use for residential HVAC systems.

While HVAC installers have improved their air sealing practices to reduce the amount of air leaking at ducts and duct boots, testing showed that distribution systems still leaked at air handlers and furnace cabinets. This has hampered the ability of HVAC installers to meet air leakage limits and raised concerns about indoor air quality.



BUILDING AMERICA TOP INNOVATIONS

Recognizing Top Innovations in Building Science – The U.S. Department of Energy’s Building America program was started in 1995 to provide research and development to the residential new construction and remodeling industry. As a national center for world-class research, Building America funds integrated research in market-ready technology solutions through collaborative partnerships between building and remodeling industry leaders, nationally recognized building scientists, and the national laboratories. Building America Top Innovation Awards recognize those projects that have had a profound or transforming impact on the new and retrofit housing industries on the road to high-performance homes.

Research sponsored by the U.S. Department of Energy’s Building America program found that air leakage in furnace cabinets and air handlers is a significant contributor to thermal distribution system air leakage. In typical installations, losses were up to 60 cubic feet per minute (cfm) or about 5% of total air flow (Walker et al. 2010b). Not only does this air leakage waste energy and impact HVAC system performance, it is a cause for indoor air quality concerns. This is because the HVAC cabinet can pull unhealthy air into the living space of the home if it is located in a crawlspace, basement, or garage.

Building America-sponsored research by Lawrence Berkeley National Laboratory (LBNL) and industry research teams first began addressing this issue in the late 1990s. In 1998 LBNL measured six furnaces in a field study and found furnace outlet and blower compartment air leakage averaged 23 cfm at 25 Pascals (Pa) (0.1 in. water) or 34 cfm at operating pressures, representing 24% to 76% of total system air leakage. In a study of 69 Florida houses, the Florida Solar Energy Center (FSEC) found air leakage from the air handler and furnace cabinets averaged 70 cfm at estimated operating pressure.

Building Science Corporation (BSC), working with Las Vegas production home builders to reduce forced air system leakage in 1999, found that the air handlers leaked 45 to 60 cfm at 25 Pa, with about half at the furnace and the remainder in the coil boxes and plenums. Using smoke tests, BSC found the most significant leaks occurred at the partition between the blower compartment and the wiring compartment (especially at corners) and around the blower compartment door (Walker et al. 2010a).

The State of Florida added a furnace leakage limit to its building code in 2003. The California Building Energy code provided a credit for having a tight air handler. Both states set the leakage limit at less than 2% of blower air flow at 250 Pa (1 in. water column); for example, a furnace or air handler with a nominal air flow of 1,000 cfm must have less than 20 cfm of air leakage. However, no specific test procedure was provided and there was no consistency among manufacturers for ratings of different pieces of equipment (Walker et al. 2010b).

In 2007, with support from Building America and the California Energy Commission, LBNL conducted research to identify a testing procedure that could serve as a standard method for testing furnace and air handler cabinet tightness. LBNL evaluated five test methods. Three of the methods involved fixed pressure testing with a duct blower: pressurization of the whole system, depressurization of the whole system, and split pressurization where the blower was sealed and the upstream side of the blower was tested with negative pressures then the downstream side was tested with positive pressures. The other two leakage methods evaluated were a Delta Q method using the blower itself for test pressures as described in ASTM E1554 and tracer gas testing with a tracer gas injected into the system and concentrations measured at various locations. Three furnaces and a rooftop package unit were tested at the LBNL laboratory. Two additional furnaces were tested at the IBACOS test laboratory. Repeatability of the test methods was evaluated by performing tests multiple times (Walker et al. 2010a).

While the DeltaQ method was deemed too complicated and the tracer gas method too unreliable for use as standard test methods, LBNL found that pressurization testing was robust and repeatable. The specific procedure LBNL recommended was to depressurize the air handler and measure the air flow to maintain a static pressure of one inch of water (250 Pa) (Walker et al. 2010a).

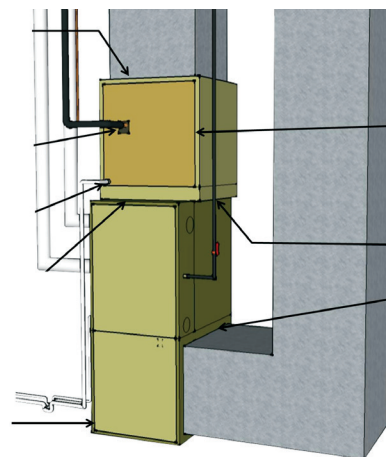
Building America’s research and support of standards development led to the creation of ASHRAE Standard 193, “Method of Test for Determining the Airtightness of HVAC Equipment,” which was ready for adoption in 2010. The standard can be used as a reference in building energy codes.

Lessons Learned

- The use of better cabinet materials (e.g., thicker gauge steel) and seals on access panels significantly reduces furnace cabinet air leakage.
- Other duct system components (wyes, VAV boxes, splitter boxes) have individual component leakage under 10 cfm; however, the use of multiple components in a duct system means that their contribution can be significant.
- Lowering cabinet air leakage from 5% to 1.5% of system air flow would result in an overall reduction in energy use for space conditioning of about 5% and a reduction of 5% or more in energy use for peak heating and cooling loads.
- Tighter cabinets will allow the smaller HVAC systems installed in energy-efficient homes to meet tightness specifications.

ASHRAE Standard 193

Several Building America researchers served on the committee to develop ASHRAE Standard 193, which specifies air leakage testing of furnace and air handler cabinets: Michael R. Lubliner, Chair, WSU Energy Office
Iain S. Walker, Vice-Chair, LBNL
James B. Cummings, FSEC
Armin Rudd, BSC



Standard 193 encourages manufacturers to install gaskets and take other steps to minimize air leaks in furnace cabinets. (Figure source: Calcs Plus 2014)

REFERENCES

ASHRAE Standard 193. 2010. “Method of Test for Determining the Airtightness of HVAC Equipment.” ASHRAE, shop.iccsafe.org/ashrae-193-2010-method-of-test-for-determining-the-airtightness-of-hvac-equipment-download.html.

Cummings, J., C. Withers, J. McIlvaine, J. Sonne, and M. Lombardi. 2003. *Air Handler Leakage: Field Testing Results in Residences*, FSEC-RR-138-03, Florida Solar Energy Center Research, www.fsec.ucf.edu/en/publications/html/FSEC-RR-138-03/.

Walker, I.S., M. Lubliner, D.J. Dickerhoff, and W.W. Delp. 2010a. Air Leakage of Furnaces and Air Handlers, LBNL-5553E, Lawrence Berkeley National Laboratory, buildings.lbl.gov/sites/all/files/Walker%20LBNL-5553E_1.pdf.

Walker, I.S., D.J. Dickerhoff, and W.W. Delp. 2010b. *Residential Forced Air System Cabinet Leakage and Blower Performance*. CEC-500-07-006, California Energy Commission, homes.lbl.gov/sites/all/files/lbnl-3383e_2.pdf.