



Air leakage testing of large buildings...new and existing

New buildings

The main points

- USACE leads the way with over 400 new buildings tested to 0.25 CFM/sq ft
- Blower Doors and Infrared Thermography combine for effective measurement and location of building air leaks

Air tightness specifications for large buildings are becoming more commonplace. Much of this activity was pioneered by the US Army Corps of Engineers (USACE) Air Leakage Test Protocol which has been used on over 400 USACE buildings over the past 4 years. Washington State and Fort Collins, CO recently referenced USACE in their Energy Code effective January 2012. Other U.S. Federal Agencies and several States are looking at its adoption as well.

Blower doors are used with smoke and thermography to identify leaks in the air barrier before measuring the air leakage to see if they meet the air leakage specification. Consultants and designers are convincing some of their clients to go with these high performance specifications even though they have no legal requirement to do so.

Existing buildings

The main points

- Many valuable diagnostic procedures requiring Blower Doors, smoke and Infrared Thermography will identify performance problems
- HVAC must be addressed
- Audit procedures can effectively identify problems

New buildings can easily have their entire air barrier tested at one time to determine whether they pass or fail an airtightness specification, by subjecting the building envelope to a constant pressure with all interior doors open. Testing existing large buildings in this way is much more difficult because access to the entire air barrier at one time is difficult but there are still many valuable diagnostic procedures that require Blower Doors, smoke and Infrared Thermography. Locating leakage paths can determine cost effective air-sealing

measures, identify moisture movement pathways through walls that contribute to envelope failure, and connections between floors that increase stack flow which affects air leakage rates as well as allows pollutants to move through the building. These tests can be performed on one portion of the building at a time if access is limited, or on the whole building at once where complete access is possible, in cases such as institutional buildings.

For some more in-depth technical reading, the Retrotec *Multi-fan Testing Manual* is a useful guide.

Building as a system evaluation using air leakage testing is needed to make sure the HVAC can efficiently provide for occupant comfort while identifying efficiency problems. To make sense of the quantitative leakage results from the evaluation, the compartmentalization of the building must be understood and it can get complex. This work is best left up to engineers who ideally understand HVAC, air barriers and building auditing. They will typically identify a wide range of repair work including caulking, weather-stripping, window renovation, foaming, insulating, HVAC balancing, HVAC tuning, and exhaust fan maintenance.

Despite the complexity, what has been effective for many years is the performance of a Paper Audit or Prescriptive Audit. Such an audit generally goes through a list of typical areas to check that typically need work and produces a list of the remediation that must be done. Most buildings suffer from a similar series of problems that can be identified qualitatively and form a very reasonable basis for uncovering the most cost effective measures. Worthwhile prescriptive measures generally include:

- Locating and sealing the ground floor cracks to prevent vehicle exhaust from entering at the ground floor.
- Locating and sealing top floor leaks to prevent air leakage losses.
- Using test fans to locate and measure leakage from each suite to outdoors and to adjacent suites.
- Measuring hallway and floor to floor pressures.

In order to address the complexity of the large building system and provide quantitative results for the engineers to work with, a map of the ambient pressures in the building can also be completed. This map will say a lot about how the building performs and how the HVAC system should be balanced and may identify areas of leakage and moisture deposition. The process uses a pressure gauge to determine the pressure balance in the building. Readings should be taken in when wind velocities are below 5 MPH and temperature differences are less than 10 F between indoors and outdoors. Infrared analysis should be performed at the same time from inside and outside.

- Measure pressures between the outdoors and the top, bottom and middle of the building.
- Measure pressures between each floor from the stairwell.
- Measure pressures from each suite to the hallway.
- Photograph each side of the building, noting locations of open windows which can affect pressures.

Repeat these measurements at close to the highest and lowest outdoor temperature conditions (in low wind as before). Repeating them under high wind conditions will illuminate the building performance in another way and help in the understanding of the building's performance.

To get an idea what is going on in a building as far as leakage goes, a brief review of the results can be done by the building evaluator. Low pressure drops between floors indicate high levels of leakage. High pressures across the bottom of the building may indicate the top of the building is tight. Retrotec has a spreadsheet to help analyze the building pressures. If interested contact sales@retrotec.com.

Training

Air tightness for large buildings will become standard in time and these testing standards will provide opportunities for leading edge firms to meet the need as it develops. While there are clear training, certification and audit procedures for evaluating the performance of detached housing, there is no such clarity with large buildings. The Building Performance Institute (BPI) does have a [Technical committee](#) working on producing a guide: *Standard Practice for Multifamily Building Energy Auditing*.

Currently the USACE Air Leakage Test Protocol requires factory training for test fan and infra-red thermography procedures. Retrotec has put on several such training courses to provide test fan and in-depth large building training with as many as 75 attendees and has developed a comprehensive curriculum that teaches many of the facts and skills needed to handle the air leakage component of assessing these buildings. Large building air leakage testing is really a developing market. If you are interested in further education Retrotec can put together a course specific to your team needs. Contact sales@retrotec.com for further information.