DIAGNOSING AIR LEAKS IN BUILDING ENCLOSURES

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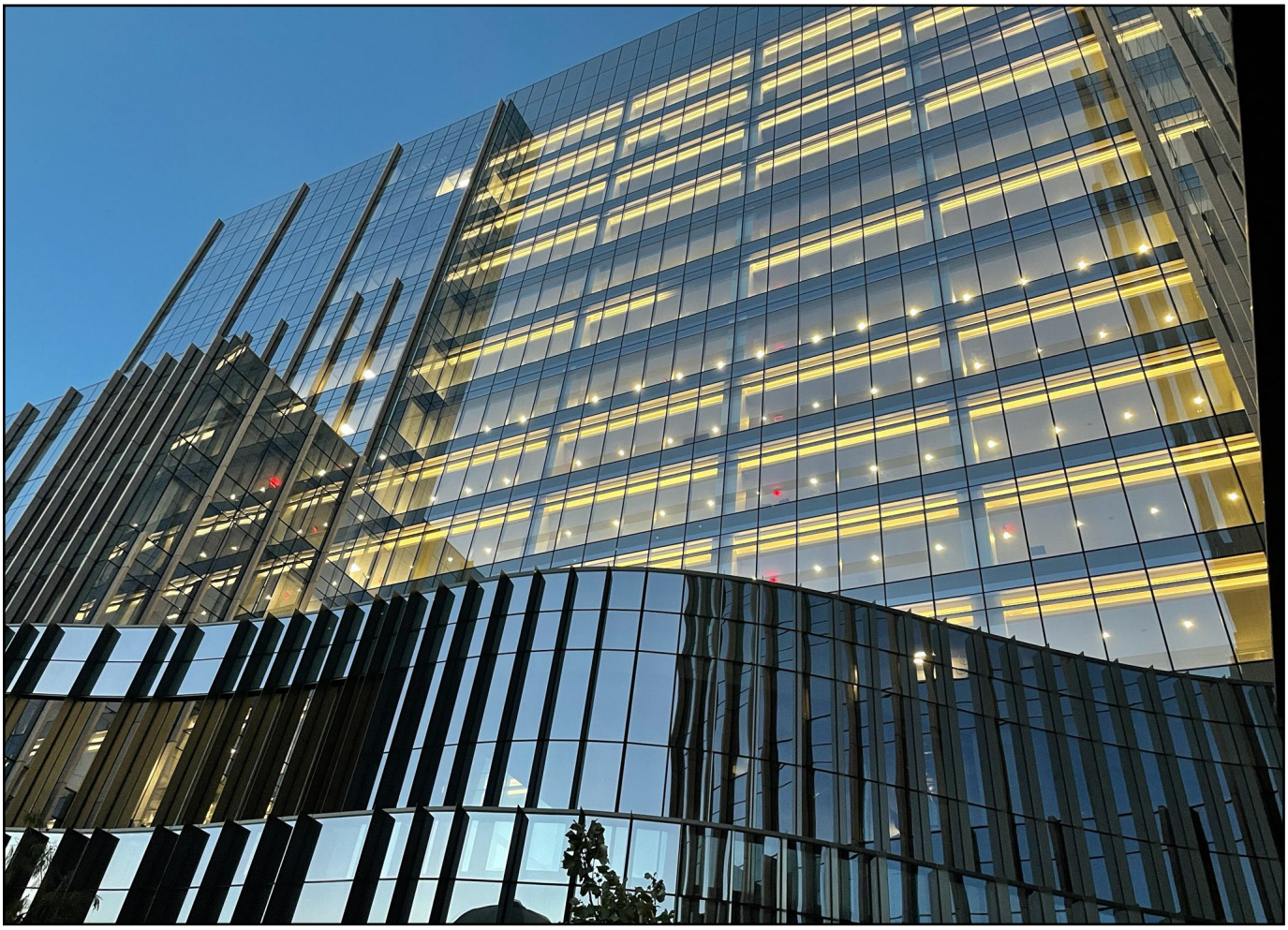


The need for new construction airtightness has been growing for decades, but has been booming in the last 10 years specifically. While airtightness testing is required in some jurisdictions by energy codes, other projects may have a specification requirement or an energy program requirement. In these cases, a whole-building, or partial-building test will occur.

When airtightness testing results in a passing grade, diagnostic testing is typically not performed because the specified criteria has been met. There are some exceptions; for instance the US Army Corps of Engineers criteria which requires infrared scanning of the building at the same time as the test. In most cases, diagnostic testing to determine the major air leakage locations is only triggered in the event of a failed test result. This paper will help identify how these diagnostic tests are performed along with their pros and cons.

Why perform air leakage diagnostic testing?

Whether included in project requirements or not, finding air barrier breaches makes repairs and sealing efforts effective, thus increasing building enclosure performance.

Diagnostic testing to identify air leaks in building enclosures is described in ASTM E1186 by the following methods.

- Infrared scanning
- Smoke tracers
- Airflow measuring devices
- Sound detection
- Chamber pressure combined with smoke
- Leak detection liquids

Not all of these methods are needed for diagnostic testing, but they are effective options, each with their own unique characteristics. Let's explore the benefits of the most common diagnostic tools and how they apply in the real world.

Infrared Scanning

Infrared (IR) scanning employs the use of a thermal camera which displays the difference in surface temperatures of different parts of the building's enclosure. When using IR to assist in finding air leaks in enclosures, we're not necessarily interested in the exact temperature of an object, we're more interested in the difference in temperature between adjacent objects. The building needs to be under pressure when utilizing IR diagnostics.

IR does not find air leaks since IR cameras do not see air. IR shows surface temperatures that may change by heating or cooling a surface adjacent to an air leak and appear as streaky patterns as shown in the two images on this page.

Infrared imaging is effective with assisting a technician with diagnosing air leaks in a building's enclosure, but it has limitations. For IR to be useful, a temperature difference between interior and exterior is necessary; ten degrees or more is ideal. A lack of temperature difference may deem IR scanning inaccurate and air leaks may not be apparent. IR images can be confusing to the untrained eye, so having an experienced or certified technician is important. Factors such as thermal bridging, water leaks, shiny or reflective objects in the image, improper camera settings, and other temperature patterns can trick the eye and lead to conclusions other than air leakage.

IR should be used to assist a technician with air leakage but not be solely relied upon as the only diagnostic tool in the tool box. If an air leak is apparent on the IR scan, the technician should confirm that apparent leak using other methods.

IR shows surface temperatures that may change by heating or cooling a surface adjacent to an air leak.

The above image displays cool exterior air leaking to the building's warm interior from pan deck roofing at curtain wall detail. This color array displays presence of an air leak.

The below image displays cool exterior air leaking into the warm school gym at the head of an overhead door.

Smoke Tracers

Employing the use of smoke or fog can make most air leaks visible. This is a scaleable method of diagnostics and can be as small as a smoke pencil, or as large as a commercial grade smoke machine which can fill several rooms or one large room with smoke. The introduction of smoke tracers with building pressure differentials can make air leaks visible to the naked eye. The building needs to be under pressure when utilizing smoke for diagnostics.

A benefit of smoke tracers over infrared scanning is that a temperature difference is not necessary. Also, smoke machines are inexpensive and require almost no training as compared to infrared cameras.

Smoke does have its limitations though. Wind can whisk smoke away prior to ever seeing the problem area, making documentation of the air leak difficult, as well as the visual characteristics of the leak difficult to analyze.

Small devices such as smoke pencils are popular for small areas, like joints around windows and doors, wall penetrations, and other single-detail areas.

Smoke machines are popular for whole rooms or multiple rooms of a building, and other larger areas where many details and planes are present.

Feel Test

Experiencing an air leak by feeling its effects makes for a very quick understanding on severity of the leak. This method does not require tools, equipment, or extensive training. It's as simple as putting your hand up to an air leak and feeling the airflow leaking out. The building must be under pressure to utilize the feel test. This is often coupled with a different temperature of air, making the air leak a bit more obvious.

One of the best ways to feel an air leak is with the back side of your hand. even very small air leaks without a temperature difference can move the hairs on your hand and make the leak quite obvious.

Reaching out and feeling for air leaks is a quick and easy way of determining locations and severity of air barrier breaches.

Tissue or Ribbon

Another method for locating air leaks is to use a tissue or ribbon. The building needs to be under pressure to utilize a tissue or ribbon test.

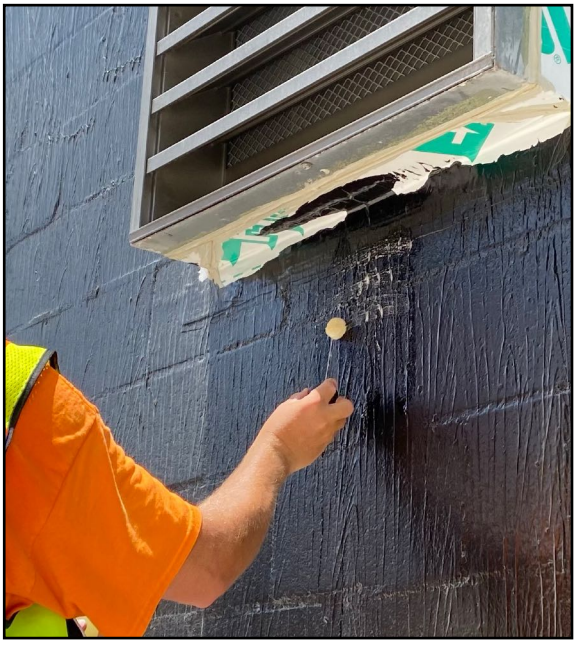
Holding a lightweight and flexible item next to an air leak will make the material move and the airflow direction and intensity will be obvious. Two benefits of this method is that it's inexpensive and it's simple. One drawback of this method is that you need direct access to the leakage zone, which can be difficult if equipment such as a swing stage or boom lift is needed. This process works best when using it on the lower pressure side of the air barrier, which will blow the tissue or ribbon away from the air leak.

Leak Detection Liquids

Use of leak detection liquids, or bubble solutions, can make small air leaks visible, especially when used in a clear vacuum chamber. This method is commonly used for small details like fastener penetrations, material laps, and other penetrations through an air barrier.

A bubble solution is swabbed on the zone to be tested and immediately followed by placing a clear dome, or "bubble", over the swabbed area and inducing a vacuum pressure, usually around 500 Pascals. If an air leak is present, the solution will show bubbles at the source, making the leak visible and able to be documented with videos or photos.

Making air leaks visible is an excellent aid for diagnosing and sealing efforts.



Other Methods

Many other methods of finding and measuring air leaks in building enclosures are out there and are useful in the right environment. It's typical to use several methods on one building during diagnostic testing and combining methods often results in more accurate information over any single method alone. With any testing method performed, you should always use a trained technician with accurate equipment.

Conclusion

Air leakage diagnostics seems challenging at first glance because air leaks are invisible and some large or complex buildings can be intimidating. With the use of special equipment, simple items, and some experience, we can locate air leaks through a pressure boundary with a high level of accuracy. This can help meet code requirements, specification requirements, improve indoor air quality, and reduce energy consumption.

Locating breaches in an air barrier system is so much more than walking around and feeling for leaks. It's a system which aids in whole building performance and energy efficiency. We must depend on our equipment, experience, and team members to accurately determine the location and severity of the breach.

About the Author

Mike Poirier is the Vice-President of QED LAB, Inc, an AAMA accredited testing laboratory and field testing agency headquartered in Troutdale, Oregon. QED LAB has tested over 900 buildings for airtightness in both commercial and residential configurations, equating to over 43 million square feet of air barrier and over 3,100 residential units.

Mike is a Level 2 certified infrared thermographer and a Level 3 certified blower door testing technician with over 20 years experience in the building science industry. He has tested projects across 12 states in the US, as well as in Mexico and Thailand (Nov 2023), including projects for the US Army Corps of Engineers. Mike was a presenter at the 2023 ABAA Building Enclosure Conference.

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