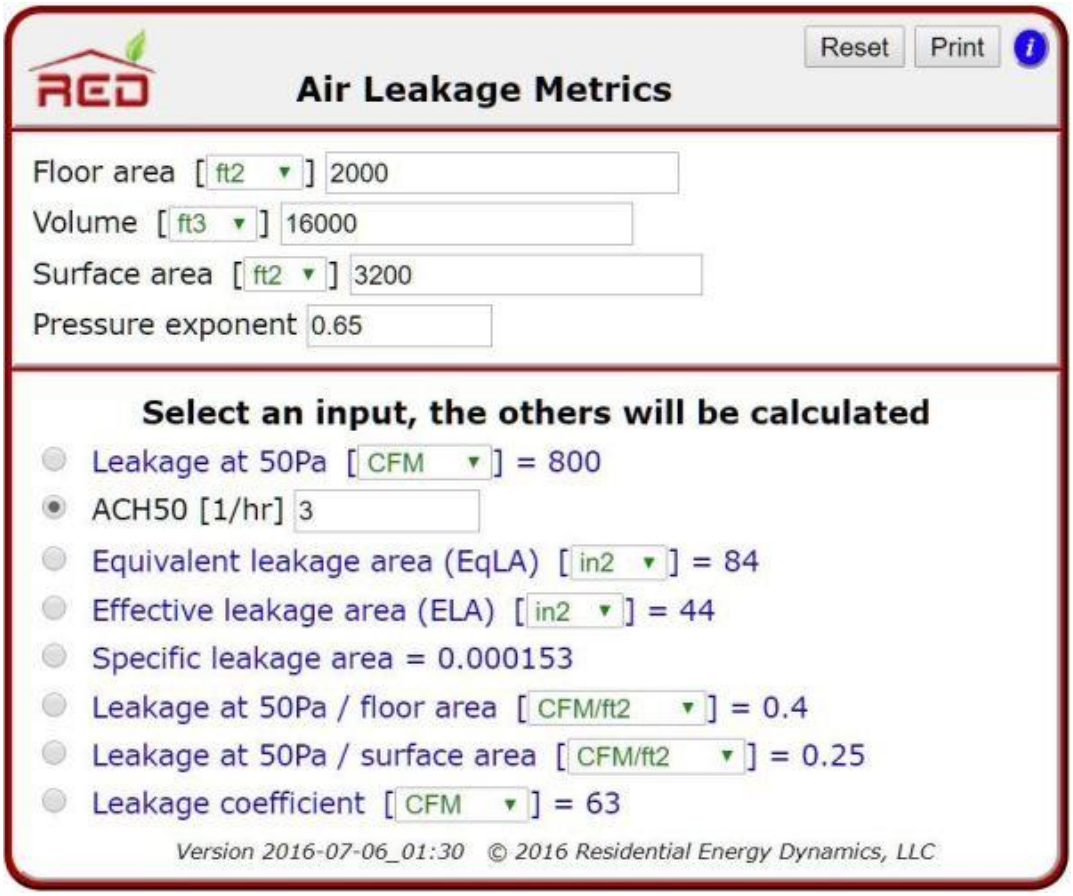
Air Leakage Metrics, a Rising Star



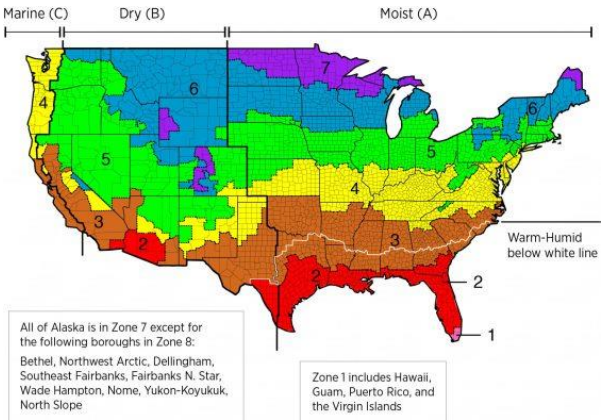
As new and existing buildings become tighter as a result of our attempts to save energy and slow global climate change, the ability to measure building tightness and convert the tightness to a useful metric becomes more important.

The RED Air Leakage Metrics tool allows you to calculate all the important air leakage metrics. Just check a radio button and fill in a handful of inputs in order to calculate seven building leakage metrics. Please see the tool screenshot below.

The standard method for measuring building tightness is with a blower door; this is familiar to most of us. The resulting CFM_{50} value (shown as `Leakage at 50Pa_ in the tool) is useful for many applications but is not a useful metric upon which to base an air sealing requirement or target. One reason for this shortcoming is because CFM_{50} does not take volume or envelope surface area into account, so it is not possible to compare the leakiness of a small building with that of a larger one. However, some of the other air leakage metrics do include building size. One is `$ACH_{50}$_ (Air Changes per Hour @ 50Pa), which includes building volume; and another is `Leakage at 50Pa / surface area_, which includes envelope area. More on both of these below.

International Energy Conservation Code (IECC) Favors ACH_{50}

The Air Leakage Metrics tool is very helpful for compliance with the tightness levels of the IECC for the last three versions, 2012, 2015, and 2018. Air leakage rates must be five ACH_{50} or less in climate zones 1 and 2 and three ACH_{50} or less in climate zones 3 through 8. Refer to the IECC climate zone map below to determine the climate zone within which you are working. How do we know if our blower door value for a residential building complies with the IECC? The RED Air Leakage Metrics tool does the work for you.



Because the blower doors give a result in CFM_{50}, but the IECC requires compliance with the metric of ACH_{50}, it is necessary to calculate the equivalent ACH_{50} for the CFM_{50} result. The RED tool easily accomplishes this.

Notice in the screenshot of the RED Air Leakage Metrics tool above with detailed house values entered in the top input section of the tool: floor area of 2000ft^2, a volume of 16,000ft^3, a surface area of 3200ft^2, and pressure exponent of 0.65 (default value).

In the bottom and largest section of the tool screenshot, ACH_{50} is selected (notice the radio button) and a value of `3_ is entered in the input box. This means that the other seven metrics in the bottom tool section will be solved for a value equivalent to ACH_{50}=3, based on the house details entered in the top input section of the tool.

So if you are wondering what CFM_{50} tightness level corresponds with an IECC requirement of an ACH_{50} of three or less for the example house above, the answer is the CFM_{50} (`Leakage at 50Pa_ in the tool) must be 800 or less.

Passive House Institute U.S. Rejects ACH_{50}

The Air Leakage Metrics tool can also help determine if your project is in compliance with the Passive House Institute of the U.S. (PHIUS). In 2015 the PHIUS changed its tightness requirement from 0.6 ACH_{50} to 0.05 CFM_{50} per square foot of gross envelope area. Why did PHIUS change this requirement? They had a good reason. PHIUS states on its website:

> ". . . a larger building that met the 0.6 ACH50 requirement could in actuality be up to seven times more leaky in terms of air leakage per unit area through the walls than a small single family home that tested the same amount of volume air change rate."

In other words, the surface-to-volume ratio can significantly change with the ACH_{50} metric depending on the size of the building. However, it does not change with the `Leakage at 50Pa / surface area_ metric. This is the primary reason we prefer the `Leakage at 50Pa / surface area_ metric at RED.

Notice in the screenshot of the RED Air Leakage Metrics tool above, the equivalent `Leakage at 50Pa / surface area_, for an $ACH_{50}$=3 is 0.25 (five times leakier than the PHIUS requirement). In order to find the equivalent $CFM_{50}$ and $ACH_{50}$ for the current PHIUS requirement, on the working RED tool click the radio button to the left of `Leakage at 50Pa / floor area_ and enter `0.05 in the input box; this is the PHIUS requirement. The resulting CFM_{50} equals 160 and ACH_{50} equals 0.6. Very tight!

If you are interested, you can read the PHIUS *Climate-Specific Passive Building Standards*, July 2015.

The Winner for Visualizing Building Leakage Is EqLA

The Air Leakage Metrics tool includes EqLA, the Equivalent Leakage Area. The story behind this metric is complex, but the concept is very simple: it represents the square inches of leakage in the building envelope. Notice when you use the Air Leakage Metrics tool that EqLA is close to the CFM_{50} value divided by 10. In the screenshot above the CFM_{50} is 800 and the EqLA is 84, very close to 800 divided by 10!

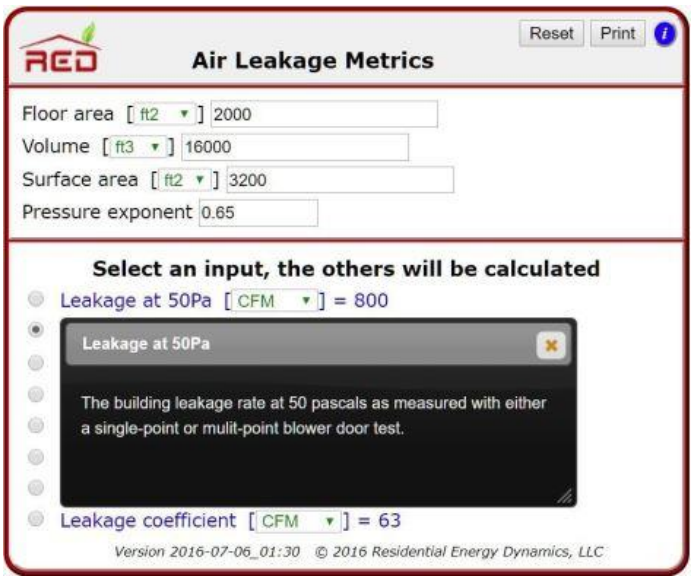
The simplicity of finding the EqLA metric allows us to approximate leakage area quickly and communicate it to homeowners routinely. When I am out in the field doing an energy audit and I get a blower door test result of 1400 CMF_{50}, for example, it helps the homeowner understand leakiness if I say: `If we were able to put all the leaks in your house in one spot, it would equal 140 square

inches. Then I open a window to 140in² to give them a visual. There is nothing like a simple visualization to communicate the complex idea of a blower door test!

If your reason for knowing the square inches of envelope leakage requires accuracy, use the RED Air Leakage Metrics tool. But if you just need a fast and effective way of communicating with a homeowner or crew member, just divide CFM_{50} by 10.

A Few Useful Tips

A. *Click on any input or result label in any RED tool to show the help dialogue for that item.* Notice the help dialogue for `Leakage at 50Pa_ in the screenshot to the right. These help dialogues explain what you need to know about each of the eight air leakage metrics.



B. *Click on the blue circle with an "i" inside (upper right corner of any RED tool) to see the User Guide.* This resource should answer all your questions about the tool.

C. *All of the air leakage metrics require values to be entered in the upper section of the tool; some require only "Floor area", others require all to be entered.* For example, if you want to know the equivalent CFM_{50} for a given ACH_{50}, you must enter the building volume. If you are not seeing the results you want (results are always displayed with a blue font, inputs are displayed with black font), make sure you have entered all the inputs in the top section of the tool.

And Finally . . .

When Charlie and I were designing the Air Leakage Metrics tool, we included all the leakage metrics that were useful AND credible, a total of eight. Notice that Air Changes per Hour (ACH) is not included. Many of you remember the `ACH_ included in the BPI Building Analyst Professional Standard, which was used for determining mechanical ventilation for the obsolete ASHRAE 62-1989 Standard; 0.35 ACH. Because this value has no meaningful use any longer, we did not include it as one of the tool metrics. If you are currently using ACH in your work, we recommend you find a substitute.


Rick Karg