Comparison of Air Leakage Testing Requirements

As we have started to reach limits in the amount of insulation that can feasibly be installed in buildings, energy codes have been stepping up the effort to reduce air leakage. MBMA has recognized this for some time, first with our ORNL partnership on the Flexible Research Platform and more recently with our program to test a variety of newly constructed metal buildings to evaluate air leakage and to eventually develop a best practices guide.

Energy codes have started to move toward a requirement for whole building tests to ensure an adequate air barrier in addition to, or in place of, the prescriptive requirements for materials or assemblies. This recognizes that prescriptive requirements alone are only effective if good installation is practiced (or if a verification program is used that includes inspections during construction). While there are many similarities in what the codes are adopting, there are differences that are important to understand, since we work with all of the codes across the United States. This bulletin is provided to compare the various codes, including the International Energy Conservation Code (IECC), ASHRAE 90.1, State of Washington (WSEC), State of California (Title 24), and U.S. Army Corps of Engineers (COE). We will be evaluating several editions of these codes since we have to look at the present and future as newer codes are adopted. Also, only the nonresidential requirements are addressed here, as most of the codes have separate requirements for residential buildings. The table below summarizes the key test requirements for the various code editions of interest.

	IECC			ASHRAE 90.1			WA		CA		COE
	2015	2018	2021	2013	2016	2019	2015	2018[1]	2016	2019[2]	2012
Whole Building Test Required?	Opt.	Opt.	Req.[3]	No[4]	Opt.	Req.[3]	Req.	Req.	Opt.	Opt.	Req.
ASTM Test(s)	E779	E779	E779 E1827[5]	NA	E779 E1827	E779 E1827	E779[6]	E779[6]	E779[6]	E779[6]	COE[7]
Pass Limit (cfm/ft^2)[8]	0.40	0.40	0.40	0.40[4]	0.40	0.40	0.40	0.25	0.40	0.40	0.25
Grace Range (cfm/ft^2)[9]	None	None	0.60	NA	0.60	0.60	Seal/No Test[10]	0.40[11]	None	None	None
Fenestration	Yes[12]	Yes[12]	Yes[13]	Yes[4]	Yes[12]	Yes[12]	No	No	Yes[14]	Yes[14]	No
Loading Dock Vehicle Seals	Yes	Yes	Yes	Yes[15]	Yes[15]	Yes	Yes	Yes	No	No	No
Vestibules	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes[16]

[1]Effective Nov. 1, 2020 (Note, original effective date was July 1, but this was delayed due to COVID-19).

[2]Effective Jan. 1, 2020.

[3]See the discussion of exceptions for each code below.

[4]Even though this edition does not mention whole building testing as an option for compliance, under fenestration, an exception indicates that if an ASTM E779 test if performed and the air leakage for the building is less than 0.40, the prescriptive requirements for fenestration are waived.

[5]ASTM E3158 for large or multi-zone buildings.

[6]Or equivalent approved by building official, or in CA by the energy commission.

[7]The COE test is based on ASTM E779, but has differences.

[8]All tests are conducted at the same differential pressure of 0.3 in of water gauge (75 Pa).

[9]Provides some wiggle room if the air leakage exceeds the Pass Limit, but is less than the Grace Range. This is discussed further for each applicable code below.

[10]If the air leakage is greater than 0.40, leaks have to be sealed and reported, but no additional test is required.

[11]If the air leakage is between 0.25 and 0.40, leaks have to be sealed and reported, but no additional test is required. However, if the air leakage is greater than 0.40 corrective action must be taken and the building retested until 0.40 or better is met.

[12]If prescriptive path is used, fenestration components must meet the maximum air leakage in the itemized table in the code/standard. However, if the whole building test is used, prescriptive requirements for fenestration are exempted.

[13]The 2021 IECC is a little unclear, with several accepted revisions that need to be fit together, but we think the prescriptive requirements, including fenestration also have to be met, even if a whole building test is completed.

[14]There are mandatory prescriptive requirements except for field fabricated fenestration. These do not seem to be waived even with the optional whole building test.

[15]Only required for climate zones 4 through 8.

[16]General requirement to provide air-tight vestibules at building entrances with high traffic.

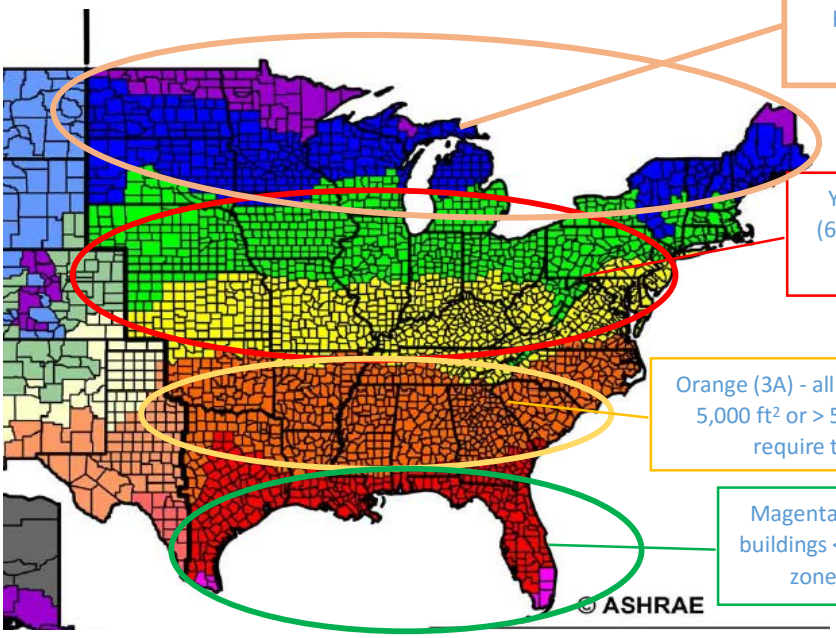
IECC

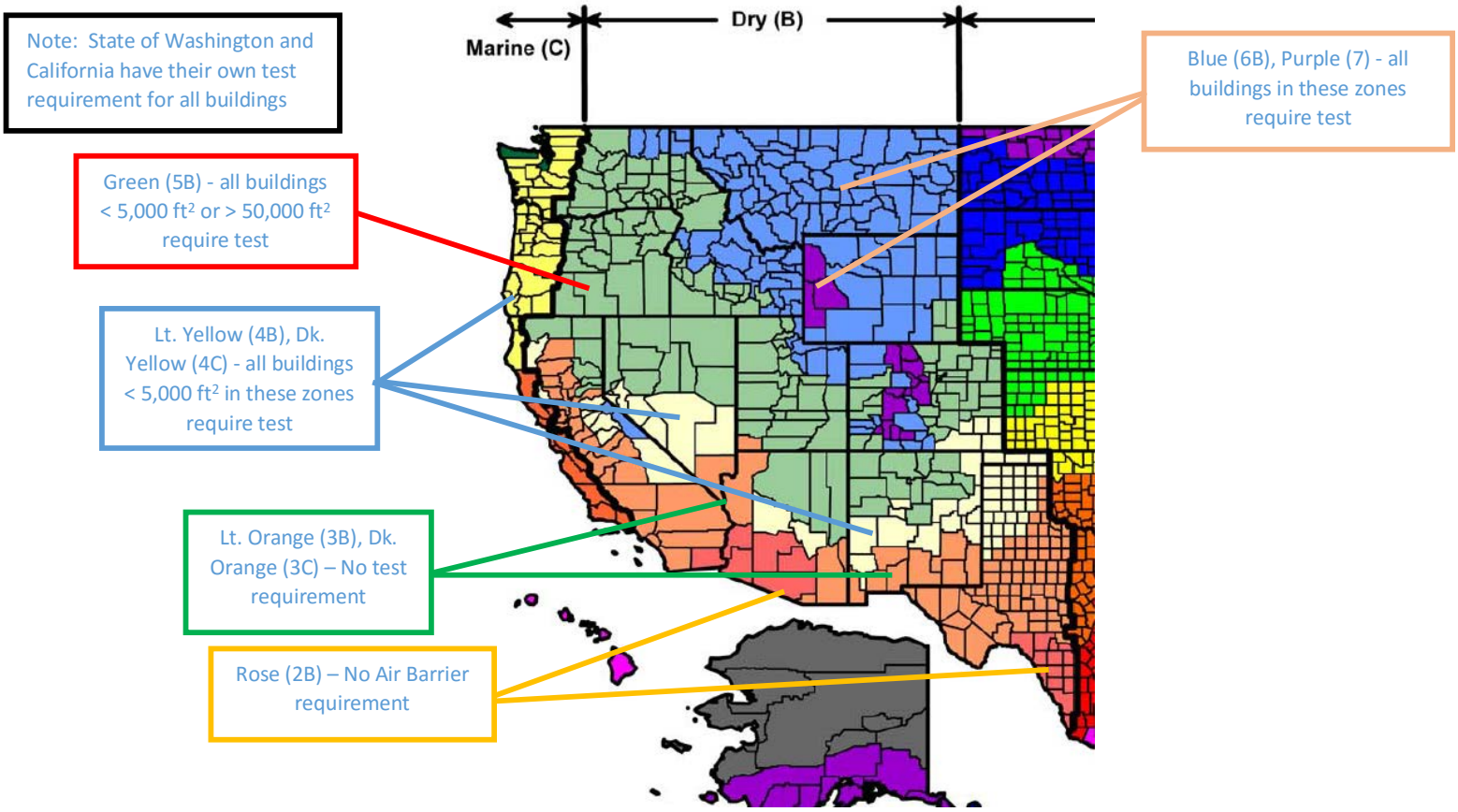
The 2021 IECC is the first edition to require a whole building air leakage test, but there are exceptions based on building size and/or climate zone. Keep in mind that the 2021 IECC also gives the alternate compliance path of using the 2019 ASHRAE 90.1.

Whole building tests would be required for all nonresidential buildings unless they are exempted based on climate zone and/or square footage as follows.

- Climate zone 2B is exempt from all air barrier requirements (no change from previous editions).
- Buildings in zones 3C, 5C, and 3B.
- Buildings with floor space > 5,000 ft^2 in climate zones 1, 2A, 4B, and 4C.
- Buildings with floor space between 5,000 and 50,000 ft^2 in climate zones 3A and 5B.

The ASHRAE maps below summarize when air leakage testing will be required for non-residential buildings. Note this will kick in when the 2021 IECC begins to be adopted starting in 2022.





As mentioned in the summary table above, some of the codes provide a "grace" range. For the IECC, if the test yields between 0.40 and 0.60 cfm/ft^2, the building is still deemed to pass if smoke tracer or infrared imaging is used to detect leaks and these are sealed, where possible, and a report of these corrective actions is submitted.

Where testing is not required because of an exception, the same prescriptive requirements as currently provided in all editions of IECC are used for materials or assemblies. However, what is new in 2021 is a requirement for a building envelope verification by the code official, a registered design professional or approved agency. This verification involves a review of the construction documents, inspections (and possibly repairs) during construction and a final commissioning report. Note that even if a test is not required, it could still be done to show compliance and might be a better option than the building envelope verification in some cases.

ASHRAE 90.1

The 2019 ASHRAE 90.1 is the first edition to require a whole building air leakage test, but there are some exceptions.

- An air barrier is not required for semi-heated buildings in zones 1 through 6, unless required to complete the air barrier of an adjacent conditioned space. There are specific requirements for testing a building with both conditioned and semi-heated spaces.
- For buildings over 50,000 sf of gross conditioned floor space, the whole building test can be conducted on less than the entire building, and this is spelled out in the provisions; but for one story buildings, it seems likely that an entire building test would need to be done.
- In lieu of doing a whole building test, an installation verification program can be utilized. This includes a design review of the air barrier and periodic inspections during construction by an independent third party. Repairs need to be performed as needed and a final report submitted.

There is one major difference between IECC and ASHRAE 90.1 in that IECC requires a whole building test unless an exemption applies due to climate zone and/or building size. However, ASHRAE 90.1 permits the installation verification program to be utilized in lieu of a whole building test for any building.

As mentioned in the summary table above, some of the codes provide a "grace" range. ASHRAE 90.1 is similar to IECC whereby a test result between 0.40 and 0.60 cfm/ft^2, is still deemed to pass if smoke tracer or infrared imaging is used to detect leaks and these are sealed, where possible, and a report of these corrective actions is submitted.

WSEC

Washington was the first state to introduce a requirement for whole building air leakage testing in their 2015 WSEC that went into effect on July 1, 2016. However, even though the pass limit was set at 0.40 cfm/ft^2, it was very lenient if this limit was not met. It states that, "If the tested rate exceeds that defined here (0.40 cfm/ft^2), a visual inspection of the air barrier shall be conducted and any leaks noted shall be sealed to the extent practicable. An additional report identifying the corrective actions taken to seal air leaks shall be submitted to the building owner and the Code Official and any further requirement to meet the leakage air rate will be waived."

However, the 2018 edition that will now go into effect on Nov. 1, 2020 sets the pass limit at 0.25 cfm/ft^2, but if the test is between 0.25 and 0.40 cfm/ft^2, leaks have to be sealed where practicable, and a report submitted with no further testing required. If the air leakage is greater than 0.40 cfm/ft^2, leaks have to be sealed and retests conducted until the air leakage is 0.40 cfm/ft^2 or less.

Note that the 2018 ASTM E779 tells you to report pressurization, depressurization, and combined (average) air leakage, but is silent on what to use to compare to a code limit. The WSEC is very specific with respect to pressurization and depressurization readings saying that the test must be conducted with either (1) both pressurization and depressurization (average), or (2) pressurization only. But depressurization only is not allowed. The WSEC also is more specific than others in that the pressure differential of 75 Pa is permitted to vary within a given range.

Title 24

California has not been out in front of other energy codes with respect to air leakage testing. Current editions of Title 24 only have whole building testing as an optional compliance path. However, the 2022 Edition that will go into effect on January 1, 2023 will likely require whole building testing, and first drafts are currently looking at something similar to WSEC, but a little less stringent (substitute 0.30 and 0.60 cfm/ft^2 for WSEC's 0.25 and 0.40 cfm/ft^2, respectively).

COE

The COE started publishing a standard for building air tightness and building air leakage testing for new and renovation construction projects in 2009. The current edition (3rd revision) was published in 2012. The COE used ASTM E779 as the basis for their standard, but there are differences, and they are clear in stating "ASTM E779 is not the governing document in this standard except where specific provisions of it are mentioned."

The pass limit is 0.25 cfm/ft^2. But, the COE test states that, "Even if the building achieves the required airtightness requirement, a thorough diagnostic evaluation should be conducted to help the construction team identify additional areas of leakage that could be sealed on the current building or similar future buildings. At a minimum, a visual inspection, a feel test, a fog test, and a thermography test shall be performed to identify leakage areas." It also states that

any building that does not meet the 0.25 cfm/ft^2 leakage rate shall be repaired and retested until it conforms to the leakage rates specified.

Some other items of interest are that the test shall be done under pressurization and de-pressurization conditions unless an air flow in excess of 200,000 cfm @75 Pa is required to perform the test and the only air flow testing method can pressurize or depressurize but not both. The mean value (of pressurization and depressurization if both are performed) of the air leakage flow must not exceed 0.25 cfm/ft^2.