CE96-19

IECC: C202 (New), C402.5, C402.5.1, C402.5.1.2, C402.5.1.2.3 (New)

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2018 International Energy Conservation Code

SECTION C202
GENERAL DEFINITIONS

Add new definition as follows:

TESTING UNIT ENCLOSURE AREA. The area sum of all the boundary surfaces that define the *dwelling unit*, *sleeping unit*, or occupiable *conditioned space* including top/ceiling, bottom/floor, and all side walls. This does not include interior partition walls within the *dwelling unit*, *sleeping unit*, or occupiable *conditioned space*. Wall height shall be measured from the finished floor of the *conditioned space* to the finished floor or roof/ceiling air barrier above.

Revise as follows:

C402.5 Air leakage—thermal envelope (Mandatory). The building thermal envelope ~~of buildings~~ shall comply with Sections C402.5.1 through C402.5.8, or the building thermal envelope shall be tested in accordance with ASTM E 779 at a pressure differential of 0.3 inch water gauge (75 Pa) or an equivalent method approved by the code official and deemed to comply with the provisions of this section when the tested air leakage rate of the building thermal envelope is not greater than 0.40 cfm/ft^2 (2.0 L/s • m^2). Where compliance is based on such testing, the building shall also comply with Sections C402.5.5, C402.5.6 and C402.5.7.

C402.5.1 Air barriers. A continuous air barrier shall be provided throughout the building thermal envelope. The continuous air barriers shall be ~~permitted to be~~ located on the inside or outside of the building thermal envelope, located within the assemblies composing the building thermal envelope, or any combination thereof. The air barrier shall comply with Sections C402.5.1.1 and C402.5.1.2.

Exception: Air barriers are not required in buildings located in Climate Zone 2B.

C402.5.1.1 Air barrier construction. The continuous air barrier shall be constructed to comply with the following:

1. The air barrier shall be continuous for all assemblies that are the thermal envelope of the building and across the joints and assemblies.
2. Air barrier joints and seams shall be sealed, including sealing transitions in places and changes in materials. The joints and seals shall be securely installed in or on the joint for its entire length so as not to dislodge, loosen or otherwise impair its ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation.
3. Penetrations of the air barrier shall be caulked, gasketed or otherwise sealed in a manner compatible with the construction materials and location. Sealing shall allow for expansion, contraction and mechanical vibration. Joints and seams associated with penetrations shall be sealed in the same manner or taped. Sealing materials shall be securely installed around the penetration so as not to dislodge, loosen or otherwise impair the penetrations' ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation. Sealing of concealed fire sprinklers, where required, shall be in a manner that is recommended by the

manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.

4. Recessed lighting fixtures shall comply with Section C402.5.8. Where similar objects are installed that penetrate the air barrier, provisions shall be made to maintain the integrity of the air barrier.

C402.5.1.2 Air barrier compliance ~~options.~~ A continuous air barrier for the opaque building envelope shall comply with the following:

1. Buildings or portions of buildings including Group R and Group I occupancy shall meet the provisions of Section C402.5.1.2.3.

   Exception: Buildings in Climate Zones 2B, 3C, and 5C.

2. Buildings or portions of buildings including Group R and Group I occupancy in Climate Zones 3C and 5C shall meet the provisions of Section C402.5.1.2.1 or C402.5.1.2.2.
3. Buildings or portions of buildings other than Group R and Group I occupancy shall meet the provisions of Section C402.5.1.2.1 or C402.5.1.2.2.

C402.5.1.2.1 Materials. Materials with an air permeability not greater than 0.004 cfm/ft^2 (0.02 L/s • m^2) under a pressure differential of 0.3 inch water gauge (75 Pa) when tested in accordance with ASTM E2178 shall comply with this section. Materials in Items 1 through 16 shall be deemed to comply with this section, provided that joints are sealed and materials are installed as air barriers in accordance with the manufacturer's instructions.

1. Plywood with a thickness of not less than $^{3}/_{8}$ inch (10 mm).
2. Oriented strand board having a thickness of not less than $^{3}/_{8}$ inch (10 mm).
3. Extruded polystyrene insulation board having a thickness of not less than $^{1}/_{2}$ inch (12.7 mm).
4. Foil-back polyisocyanurate insulation board having a thickness of not less than $^{1}/_{2}$ inch (12.7 mm).
5. Closed-cell spray foam having a minimum density of 1.5 pcf (2.4 kg/m^3) and having a thickness of not less than 1$^{1}/_{2}$ inches (38 mm).
6. Open-cell spray foam with a density between 0.4 and 1.5 pcf (0.6 and 2.4 kg/m^3) and having a thickness of not less than 4.5 inches (113 mm).
7. Exterior or interior gypsum board having a thickness of not less than $^{1}/_{2}$ inch (12.7 mm).
8. Cement board having a thickness of not less than $^{1}/_{2}$ inch (12.7 mm).
9. Built-up roofing membrane.
10. Modified bituminous roof membrane.
11. Fully adhered single-ply roof membrane.
12. A Portland cement/sand parge, or gypsum plaster having a thickness of not less than $^{5}/_{8}$ inch (15.9 mm).
13. Cast-in-place and precast concrete.
14. Fully grouted concrete block masonry.
15. Sheet steel or aluminum.
16. Solid or hollow masonry constructed of clay or shale masonry units.

C402.5.1.2.2 Assemblies. Assemblies of materials and components with an average air leakage not greater than 0.04 cfm/ft^2 (0.2 L/s • m^2) under a pressure differential of 0.3 inch of water gauge (w.g.)(75 Pa) when tested in accordance with ASTM E2357, ASTM E1677 or ASTM E283 shall comply with this section. Assemblies listed in Items 1 through 3 shall be deemed to comply, provided that joints are sealed and the requirements of Section C402.5.1.1 are met.

1. Concrete masonry walls coated with either one application of block filler or two applications of a

paint or sealer coating.

2. Masonry walls constructed of clay or shale masonry units with a nominal width of 4 inches (102 mm) or more.
3. A Portland cement/sand parge, stucco or plaster not less than $^1/_2$ inch (12.7 mm) in thickness.

Add new text as follows:

C402.5.1.2.3 Dwelling and sleeping unit enclosure testing The building thermal envelope shall be tested in accordance with ASTM E 779, ANSI/RESNET/ICC 380, ASTM E1827 or an equivalent method approved by the code official. The measured air leakage shall not exceed 0.30 cfm/ft^2 (1.5 L/s · m^2) of the testing unit enclosure area at a pressure differential of 0.2 inch water gauge (50 Pa). Where multiple dwelling units or sleeping units or other occupiable conditioned spaces are contained within one building thermal envelope, each unit shall be considered an individual testing unit and the building air leakage shall be the weighted average of all testing unit results, weighted by each testing unit's testing unit enclosure area. Units shall be tested separately with an unguarded blower door test as follows:

1. Where buildings have fewer than eight testing units, each testing unit shall be tested.
2. For buildings with eight or more testing units the greater of seven units or 20 percent of the testing units in the building shall be tested including a top floor unit, a ground floor unit, and a unit with the largest testing unit enclosure area. Where any tested unit exceeds the maximum air leakage rate, an additional 20 percent of units shall be tested, including a mixture of testing unit types and locations.

Reason: Air leakage can be a significant source of energy waste in buildings, contributing to higher heating and cooling costs for building owners and occupants, and increasing risk related to comfort and durability. Air tightness testing can result in more attention to air barrier sealing and significantly reduced building leakage. Currently, the residential energy code requires air tightness testing for residential buildings three stories and less in height to ensure proper tightness and a controlled indoor environment. However, in the commercial energy code there is no testing requirement for residential buildings four stories or more in height (e.g., apartments, dormitories, hotel guest rooms). Industry standards affecting these buildings have historically relied upon visual verification, as well as material and assembly requirements. Providing adequate control over air leakage can also allow many benefits, including reduced HVAC equipment sizing, better building pressurization, and energy savings due to reduced heating and cooling of infiltrated outside air. In moist climates, ensuring lower leakage through testing can also result in better humidity control and reduced risk of durability issues.
Air barrier testing saves energy by reducing infiltration of outside air into and out of the building. Most of the time, outside air is hotter or colder than the comfort temperature being maintained in the residence by the heating and cooling systems. Therefore, reducing the infiltration will reduce energy use for heating and cooling. This proposal would require that blower door testing be applied to a sample of units or occupiable spaces in a multiple unit residential construction project. The equipment and staff required are the same as are needed in current air leakage testing required under the residential energy code.

Why is building leakage testing superior to other approaches?

While it is important that the materials and assemblies have limited leakage, specification by individual materials and assemblies does not necessarily equate to an air-tight building. Recent research (Wiss 2014) shows that 40% of buildings constructed without an envelope consultant have air leakage exceeding the current optional test standard of 0.40 cfm/ft^2 at 75 Pa, while buildings with envelope consultants had leakage below 0.25 cfm/ft^2 at 75 Pa. Requiring testing will ensure that the goal of this section of the code—limiting unintended air infiltration in buildings—is achieved.

What strategies are considered to minimize compliance burdens in the field?

To manage testing cost, a testing approach is proposed that requires only 20% of the units (with a seven-unit minimum) to be tested in the building. The testing method is also an unguarded test of individual units that reduces cost significantly compared to whole building testing or guarded unit testing. To motivate high-quality air sealing, additional testing of an additional 20% of the units would be required if any unit exceeds the leakage limit. Then the weighted average of tested units is used for comparison to the required leakage limit. While the testing requirement is slightly less stringent than the residential code, it matches current optional commercial requirements and is an improvement over the current condition of no testing requirements in the commercial code. It also provides a more reasonable target than air changes per hour for these units, which are typically smaller and have less total leakage than detached residences.

Are there existing codes and standards that require similar testing measures?

This proposal is similar to the residential air leakage provisions in the 2018 IECC in that it also requires the use of ASTM E 779. The proposal is similar to air leakage testing that is required by the State of Washington and City of Seattle commercial building energy codes as well as procedures followed by the U.S. Department of Defense for testing of commercial buildings. The City of Seattle requirements have been in place since 2009 and hundreds of commercial buildings have been tested under that code, including many large buildings. Additionally, thousands of dwelling units have successfully been tested and achieved this metric through the USGBC's LEED for Homes Multifamily Mid-Rise program and the EPA's ENERGY STAR Multifamily High Rise program. It will also be a required test in ASHRAE 62.2-2019.

Bibliography: Hart R and B Liu. 2015. *Methodology for Evaluating Cost-effectiveness of Commercial Energy Code Changes.* Pacific Northwest National Laboratory for U.S. Department of Energy; Energy Efficiency & Renewable Energy. PNNL-23923, Rev. 1. https://www.energycodes.gov/development/commercial/methodology
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Cost Impact: The code change proposal will increase the cost of construction
PNNL performed a cost-effectiveness analysis to identify the net impacts associated with the proposal using the established DOE methodology (Hart and Liu 2015). Results of the cost-effectiveness analysis indicate that the average savings-to-investment ratio (SIR) and simple payback (SPP) for unguarded dwelling unit testing with a limit of 0.30 cfm/ft^2 (1.5 L/s · m^2) at a pressure differential of 0.2 inch water gauge (50 Pa) in mid-rise apartment buildings were:

· SIR: 7.8; cost-effective if greater than 1.0

· SPP: 5.3 years; cost-effective if less than 40 year life

A measure is cost-effective when the SIR is greater than 1.0, indicating that the present value of savings is greater than the incremental cost. The cost for individual unguarded unit testing is expected to be significantly lower than the cost for whole building testing, especially with the sampling protocol provided. Results of the cost-effectiveness analysis were taken into account when developing this proposal (i.e., the recommended language only targets building types and climate zones where the testing requirement was determined to be cost-effective).

For buildings already conducting whole-building testing as their compliance option, this may decrease the cost of construction. For buildings not conducting testing, this is an increase in costs to perform the tests. This proposal however does not require more than what is currently required in the residential IECC for similar types of commercial buildings 3 stories and lower.

Proposal # 4873

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