**Reduced air leakage requirements for building envelope (1379) IECC: R402.5.1.2, R402.5.1.3, TABLE R405.4.2(1)**

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**2024 International Energy Conservation Code [RE Project]**

**Revise as follows:**

**R402.5.1.2 Testing.** The building or each dwelling unit in the building shall be tested for air leakage. The maximum air leakage rate for any building or dwelling unit under any compliance path shall not exceed 4.0 air changes per hour or 0.22 cfm/ft (1.1 L/s x m ) of building or dwelling unit enclosure area. Testing shall be conducted in accordance with ANSI/RESNET/ICC 380, ASTM E779, ASTM E1827 or ASTM E3158 and reported at a pressure differential of 0.2 inch water gauge (50 Pa). Where required by the code official, testing shall be conducted by an approved third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the code official. Testing shall be performed at any time after creation of all penetrations of the building thermal envelope have been sealed.

**Exceptions:**

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1. When testing individual dwelling units, an air leakage rate not exceeding 0.27 cubic feet per minute per square foot [1.35 L/s x m )] of the dwelling unit enclosure area, tested in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pa), shall be permitted in all climate zones for:

1.1 Attached single and multiple family building dwelling units.

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1.2 Buildings or dwelling units that are 1,500 square feet (139.4 m ) or smaller.

2. For heated, attached private garages and heated, detached private garages accessory to one- and two-family dwellings and townhouses not more than three stories above grade plane in height, building envelope tightness and insulation installation shall be considered acceptable where the items in Table R402.5.1.1, applicable to the method of construction, are field verified. Where required by the code official, an approved third party independent from the installer shall inspect both air barrier and insulation installation criteria. Heated, attached private garage space and heated, detached private garage space shall be thermally isolated from all other habitable, conditioned spaces in accordance with Sections R402.2.13 and R402.4.5, as applicable.

3. Where tested in accordance with R402.5.1.4, testing of each dwelling unit is not required.

4. Where air leakage testing is performed by an *approved* installer during installation of the continuous air barrier, independent third party testing shall not be required where a written report of the results of the test is signed by the party conducting the test and provided to the code official.

During testing:

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed, beyond the intended weatherstripping or other infiltration control measures.

2. Dampers including exhaust, intake, makeup air, backdraft and flue dampers shall be closed, but not sealed beyond intended infiltration control measures.

3. Interior doors, where installed at the time of the test, shall be open.

4. Exterior or interior terminations for continuous ventilation systems shall be sealed.

5. Heating and cooling systems, where installed at the time of the test, shall be turned off.

6. Supply and return registers, where installed at the time of the test, shall be fully open.

Mechanical ventilation shall be provided in accordance with Section M1505 of the International Residential Code or Section 403.3.2 of the International Mechanical Code, as applicable, or with other approved means of ventilation.

**R402.5.1.3 Prescriptive air leakage rate.** When complying with Section R401.2.1, the building or each dwelling unit in the building shall have an air leakage rate not exceeding ~~5.0~~ 3.0 air changes per hour in Climate Zones 0, 1 and 2, and ~~3.0~~ 2.5 air changes per hour in Climate Zones 3 through ~~5~~ 8, ~~and 2.5 air changes per hour in Climate Zones 6 through 8, w~~hen tested in accordance with Section R402.5.1.2.

**TABLE R405.4.2(1) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS**

| **BUILDING** **COMPONENT** | **STANDARD REFERENCE DESIGN**  | **PROPOSED DESIGN** |
| --- | --- | --- |
| Above-grade walls | Type: mass where the proposed wall is a mass wall; otherwise wood frame.  | As proposed |
| Gross area: same as proposed.  | As proposed |
| U-factor: as specified in Table R402.1.2.  | As proposed |
| Solar absorptance = 0.75.  | As proposed |
| Emittance = 0.90.  | As proposed |
| Basement and crawl space walls | Type: same as proposed.  | As proposed |
| Gross area: same as proposed.  | As proposed |
| U-factor: as specified in Table R402.1.2, with the insulation layer on the interior side of the walls. | As proposed |
| Above-grade floors | Type: wood frame.  | As proposed |
| Gross area: same as proposed.  | As proposed |
| U-factor: as specified in Table R402.1.2.  | As proposed |
| Ceilings | Type: wood frame.  | As proposed |
| Gross area: same as proposed.  | As proposed |
| U-factor: as specified in Table R402.1.2.  | As proposed |
| Roofs | Type: composition shingle on wood sheathing.  | As proposed |
| Gross area: same as proposed.  | As proposed |
| Solar absorptance = 0.75.  | As proposed |
| Emittance = 0.90.  | As proposed |
| Attics  | Type: vented with an aperture of 1 ft per 300 ft of ceiling area. 2 2 | As proposed |
| Foundations | Type: same as proposed.  | As proposed |
| Foundation wall area above and below grade and soil characteristics: same as proposed. | As proposed |
| Opaque doors | Area: 40 ft . 2 | As proposed |
| Orientation: North.  | As proposed |
| U-factor: same as fenestration as specified in Table R402.1.2.  | As proposed |
| Vertical fenestration other than opaque doors | hTotal area = (a) The proposed glazing area, where the proposed glazing area is less than 15 percent of the conditioned floor area. (b) 15 percent of the conditioned floor area, where the proposed glazing area is 15 percent or more of the conditioned floor area.  | As proposed |
| Orientation: equally distributed to four cardinal compass orientations (N, E, S & W). As proposed |  |
| U-factor: as specified in Table R402.1.2.  | As proposed |
| SHGC: as specified in Table R402.1.2 except for climate zones without an SHGC requirement, the SHGC shall be equal to 0.40. | As proposed |
| Interior shade fraction: 0.92 – (0.21 × SHGC for the standard reference design). | Interior shade fraction: 0.92 – (0.21 × SHGC as proposed) |
| External shading: none  | As proposed |
| Skylights  | None  | As proposed |
| Thermally isolated sunrooms | None  | As proposed |
|  | The air leakage rate at a pressure of 0.2 inch w.g. (50 Pa) shall be Climate Zones 0 through 2: 5.0 air changes per hour. Climate Zones 3 , 4, and 5: 3.0 air changes per hour. Climate Zones 6 through 8: 2.5 air changes per hour. | The measured air exchange rate.a |

The mechanical ventilation rate shall be in addition to the air leakage rate and shall

be the same as in the proposed design, but not greater than B x M

where:

| Air exchange rate | where: B = 0.01 × CFA + 7.5 × (Nbr + 1), cfm. M = 1.0 where the measured air exchange rate is > = 3.0 air changes per hour at 50 Pascals, and otherwise, M = minimum (1.7, Q/B) Q = the proposed mechanical ventilation rate, cfm. CFA = conditioned floor area, ft2. Nbr = number of bedrooms. The mechanical ventilation system type shall be the same as in the proposed design. Heat recovery or energy recovery shall be modeled for mechanical ventilation where required by Section R403.6.1. Heat recovery or energy recovery shall not be modeled for mechanical ventilation where not required by Section R403.6.1. | bThe mechanical ventilation rate , Q, shall be in addition to the air leakage rate and shall be as proposed.  |
| --- | --- | --- |
| Mechanical ventilation | Where mechanical ventilation is not specified in the proposed design: None Where mechanical ventilation is specified in the proposed design, the annual vent fan energy use, in units of kWh/yr, shall equal (8.76 × B × M)/ef where: B and M are determined in accordance with the Air Exchange Rate row of this table. e = the minimum fan efficacy, as specified in Table 403.6.2, corresponding to the f system type at a flow rate of B × M. 2 CFA = conditioned floor area, ft . N = number of bedrooms. br | As proposed |
| Internal gains | IGain, in units of Btu/day per dwelling unit, shall equal 17,900 + 23.8 ×CFA + 4,104 ×N br where: 2 CFA = conditioned floor area, ft . N = number of bedrooms. br | Same as standard reference design. |
| Internal mass  | Internal mass for furniture and contents: 8 pounds per square foot of floor area. | Same as standard reference design, plus any additional mass specifically designed as ca thermal storage element but not integral to the building envelope or structure.  |
| Structural mass | For masonry floor slabs: 80 percent of floor area covered by R-2 carpet and pad, and 20 percent of floor directly exposed to room air. | As proposed |
| For masonry basement walls: as proposed, but with insulation as specified in Table R402.1.3, located on the interior side of the walls. | As proposed |
| For other walls, ceilings, floors, and interior walls: wood frame construction.  | As proposed |
| Heating systemsd, e, j, k | For other than electric heating without a heat pump: as proposed. Where the proposed design utilizes electric heating without a heat pump, the standard reference design shall be an air source heat pump meeting the requirements of Section C403 of the IECC—Commercial Provisions. Capacity: sized in accordance with Section R403.7. |  |
| Fuel Type/Capacity: Same as proposed design  | As proposed |
| Product class: Same as proposed design  | As proposed |
| Efficiencies:  | As proposed |
| Heat pump: Complying with 10 CFR §430.32  | As proposed |
| Non-electric furnaces: Complying with 10 CFR §430.32  | As proposed |
| Non-electric boilers: Complying with 10 CFR §430.32  | As proposed |
| Cooling systemsd, f, k | As proposed. Capacity: sized in accordance with Section R403.7. |  |
| Fuel Type: Electric Capacity: Same as proposed design | As proposed |
| Efficiencies: Complying with 10 CFR §430.32  | As proposed |

As proposed

Use, in units of gal/day = 25.5 + (8.5 × N ) ×

br

(1 – HWDS)

| Service water heatingd, g, k | As proposed. Use, in units of gal/day = 25.5 + (8.5 × N ) br where: N = number of bedrooms. br | (1 – HWDS) where: N = number of bedrooms. brHWDS = factor for the compactness of the hot water distribution system.  |  |
| --- | --- | --- | --- |
| **Compactness ratio factor i** | **HWDS** |  |
| 1 story  | 2 or more stories |  |  |
| > 60%  | > 30%  | 0 |  |
| > 30% to ≤ 60% > 15% to ≤ 30%  |  | 0.05 |  |
|  | > 15% to ≤ 30% > 7.5% to ≤ 15%  | 0.10 |  |
| < 15%  | < 7.5%  | 0.15 |  |
| Fuel Type: Same as proposed design  | As proposed |  |
| Rated Storage Volume: Same as proposed design  | As proposed |  |
| Draw Pattern: Same as proposed design  | As proposed |  |
| Efficiencies: Uniform Energy Factor complying with 10 CFR §430.32  | As proposed |  |
| Tank Temperature: 120° F (48.9° C)  | Same as standard reference design |  |
|  |  |  |
| Thermal distribution systems | Duct location: | Duct location: as proposed. |  |
| Foundation Type | Slab on grade  | Unconditioned crawl space | Basement or conditioned crawl space |  |
| Duct location (supply and return) | One-story building: 100% in unconditioned attic All other: 75% in unconditioned attic and 25% inside conditioned space | One-story building: 100% in unconditioned crawlspace All other: 75% in unconditioned crawlspace and 25% inside conditioned space | 50% inside conditioned space 50% unconditioned attic |  |
| Duct insulation: in accordance with Section R403.3.1.  | Duct insulation: as proposed. |  |
| Duct system leakage to outside: For duct systems serving > 1,000ft2 of conditioned floor area, the duct leakage to outside rate shall be 4 cfm (113.3 L/min) per 100 ft2 (9.29 m2) of conditioned floor area. For duct systems serving ≤ 1,000ft2 of conditioned floor area, the duct leakage to outside rate shall be 40 cfm (1132.7 L/min). | Duct System Leakage to Outside: The measure total duct system leakage rate shall be entered into the software as the duct system leakage to outside rate. **Exceptions:** When duct system leakage to outside is tested in accordance ANSI/ 1. RESNET/ICC 380 or ASTM E1554, the measured value shall be permitted to be entered. When total duct system leakage is measured without the air handler 2. installed, the simulation value shall be 4 2 2cfm (113.3 L/min) per 100 ft (9.29 m ) of conditioned floor area.  |  |
| For hydronic systems and ductless systems a thermal distribution system efficiency (DSE) of 0.88 shall be applied to both the heating and cooling system efficiencies. | For hydronic systems and ductless systems, |  |
| DSE shall be as specified in Table R405.4.2(2). |  |
| Thermostat | Type: Manual, cooling temperature setpoint = 75°F; Heating temperature setpoint = 72°F. | Same as standard reference design. |  |
| Dehumidistat | Where a mechanical ventilation system with latent heat recovery is not specified in the proposed design: None. Where the proposed design utilizes a mechanical ventilation system with latent heat recovery: Dehumidistat type: manual, setpoint = 60% relative humidity. Dehumidifier: whole-dwelling with integrated energy factor = 1.77 liters/kWh. | Same as standard reference design. |  |

2 2

For SI: 1 square foot = 0.93 m , 1 British thermal unit = 1055 J, 1 pound per square foot = 4.88 kg/m , 1 gallon (US) = 3.785 L, °C = (°F-32)/1.8, 1 degree = 0.79 rad.

a. Where required by the code official, testing shall be conducted by an approved party. Hourly calculations as specified in the ASHRAE Handbook of Fundamentals, or the equivalent, shall be used to determine the energy loads resulting from infiltration.

b. The combined air exchange rate for infiltration and mechanical ventilation shall be determined in accordance with Equation 43 of 2001 ASHRAE Handbook of Fundamentals, page 26.24 and the “Whole-house Ventilation” provisions of 2001 ASHRAE Handbook of Fundamentals, page 26.19 for intermittent mechanical ventilation.

c. Thermal storage element shall mean a component that is not part of the floors, walls or ceilings that is part of a passive solar system, and that provides thermal storage such as enclosed water columns, rock beds, or phase-change containers. A thermal storage element shall be in the same room as fenestration that faces within 15 degrees (0.26 rad) of true south, or shall be connected to such a room with pipes or ducts that allow the element to be actively charged.

d. For a proposed design with multiple heating, cooling or water heating systems using different fuel types, the applicable standard reference design system capacities and fuel types shall be weighted in accordance with their respective loads as calculated by accepted engineering practice for each equipment and fuel type present.

e. For a proposed design without a proposed heating system, a heating system having the prevailing federal minimum efficiency shall be assumed for both the standard reference design and proposed design.

f. For a proposed design home without a proposed cooling system, an electric air conditioner having the prevailing federal minimum efficiency shall be assumed for both the standard reference design and the proposed design.

g. For a proposed design the following assumptions shall be made for both the proposed design and standard reference design. Fuel Type: Same as the predominant heating fuel type

Rated Storage Volume: 40 Gallons

Draw Pattern: Medium

Efficiency: Uniform Energy Factor complying with 10 CFR §130.32

h. For residences with conditioned basements, R-2 and R-4 residences, and for townhouse units, the following formula shall be used to determine glazing area:

AF = A × FA × F s

where:

AF = Total glazing area.

A = Standard

s

reference

design total

glazing area.

FA = (Above grade thermal

boundary

gross wall

area)/(above

grade

boundary wall

area + 0.5 ×

below-grade

boundary wall

area).

F=(above- gradethermal

boundary wall

area)/(above-

grade thermal

boundary wall

area +

common wall

area) or 0.56,

whichever is

greater.

and where:

- Thermal boundary wall

is any wall

that

separates

conditioned

space from

unconditioned

space or

ambient

conditions.

- Above-grade thermal

boundary wall

is any

thermal

boundary wall

component

not in contact

with soil.

- Below-grade boundary wall

is any

thermal

boundary wall

in soil

contact.

- Common wall area is the

area of walls

shared with

an adjoining

dwelling unit.

i. The factor for the compactness of the hot water distribution system is the ratio of the area of the rectangle that bounds the source of hot water and the fixtures that it serves (the “hot water rectangle”) divided by the floor area of the dwelling.

1. Sources of hot water include water heaters, or in multiple-family buildings with central water heating systems, circulation loops or electric heat traced pipes.

2. The hot water rectangle shall include the source of hot water and the points of termination of all hot water fixture supply piping. 3. The hot water rectangle shall be shown on the floor plans and the area shall be computed to the nearest square foot.

4. Where there is more than one water heater and each water heater serves different plumbing fixtures and appliances, it is permissible to establish a separate hot water rectangle for each hot water distribution system and add the area of these rectangles together to determine the compactness ratio.

5. The basement or attic shall be counted as a story when it contains the water heater.

6. Compliance shall be demonstrated by providing a drawing on the plans that shows the hot water distribution system rectangle(s), comparing the area of the rectangle(s) to the area of the dwelling and identifying the appropriate compactness ratio and HWDS factor.

j. For a proposed design with electric resistance heating, a split system heat pump complying with 10 CFR §430.32 (2021) shall be assumed modeled in the standard reference design.

k. For heating systems, cooling systems, or water heating systems not included in Table R405.4.2(1), the standard reference design shall be the same as proposed design.

**Reason:** Air leakage can cause huge energy losses, accounting for up to a third of a home's energy use. Additionally, air leakage can significantly reduce indoor air quality and comfort levels. Compared to individual components of a building or equipment, a building's envelope has a much longer life-span and requiring lower levels of air leakage can result in long-term energy benefits.

Certain technology providers, such as Aeroseal and AeroBarrier, measure envelope leakage pre- and post-delivery of their service for every project. As part of each project, they deliver an instantly verifiable envelope sealing report which eliminates the need for additional third party testing. By eliminating the need for additional testing in such cases, the barriers and cost to deploying additional efficiency measures are reduced.

**Cost Impact:** The code change proposal will neither increase nor decrease the cost of construction.

Any increase in cost will be marginal and will be offset by long-term gains.