REC2D-4-23

IECC RE: TABLE R405.4.2(1)

Proponents:

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2024 International Energy Code [RE] [RE Project] R3

Revise as follows:

TABLE R405.4.2(1) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS
Portions of table not shown remain unchanged.

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 reflectance = 0.25.	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 reflectance = 0.25.	As proposed
	Emittance = 0.90.	As proposed
Attics	Type: vented with an aperture of 1 ft^2 per 300 ft^2 of ceiling area.	As proposed
Foundations	Type: same as proposed.	As proposed

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
	Foundation wall ~~or slab~~ extenstion above and below grade: same as proposed ~~+ foot (30 cm)~~ ~~Foundation wall or slab extension below grade: same as proposed~~ Foundation wall or slab perimeter length: same as proposed Soil characteristics: same as proposed.	As proposed
	Foundation wall *U*-factor and slab-on-grade *F*-factor: as specified in Table R402.1.2	
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	Total area[h] = (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
Air leakage rate	For detached one-family dwellings, the air leakage rate at a pressure of 0.2 inch water gauge (50 Pa) shall be Climate Zones 0 through 2: 4.0 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. For detached one-family dwellings that are 1,500 ft2 (139.4 m^2) or smaller and attached *dwelling units*, the *air leakage* rate at a pressure of 0.2 inch water gauge (50 Pa) shall be 0.27 cfm/ft^2 of the *dwelling unit enclosure area*.	The measured air leakage rate.[a]
Mechanical ventilation rate	-	

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
	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: B = 0.01 × CFA + 7.5 × (Nbr + 1), cfm. M = 1.0 where the measured air leakage 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 measured mechanical ventilation rate[b], Q, shall be in addition to the measured air leakage rate .
Mechanical ventilation fan energy	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.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 Mechanical Ventilation Rate row of this table. e_f = the minimum fan efficacy, as specified in Table 403.6.2, corresponding to the system type at a flow rate of B × M. *CFA* = conditioned floor area, ft^2. N_{br} = number of bedrooms.	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: *CFA* = conditioned floor area, ft^2. N_{br} = number of bedrooms.	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 a thermal storage element[c] but not integral to the *building thermal 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

<table>
<tr><th>BUILDING COMPONENT</th><th>STANDARD REFERENCE DESIGN</th><th>PROPOSED DESIGN</th></tr>
<tr><td></td><td>For other walls, ceilings, floors, and interior walls: wood frame construction.</td><td>As proposed</td></tr>
<tr><td rowspan="6">Heating systems[d, e, j, k]</td><td>Fuel Type/Capacity: Same as proposed design</td><td>As proposed</td></tr>
<tr><td>Product class: Same as proposed design</td><td>As proposed</td></tr>
<tr><td>Efficiencies:</td><td>As proposed</td></tr>
<tr><td>Heat pump: Complying with 10 CFR §430.32</td><td>As proposed</td></tr>
<tr><td>Fuel gas and liquid fuel furnaces: Complying with 10 CFR §430.32</td><td>As proposed</td></tr>
<tr><td>Fuel gas and liquid fuel boilers: Complying with 10 CFR §430.32</td><td>As proposed</td></tr>
<tr><td rowspan="2">Cooling systems[d, f, k]</td><td>Fuel Type: Electric
Capacity: Same as proposed design</td><td>As proposed</td></tr>
<tr><td>Efficiencies: Complying with 10 CFR §430.32</td><td>As proposed</td></tr>
<tr><td rowspan="11">Service water heating[d, g, k]</td><td rowspan="6">Use, in units of gal/day = 25.5 + (8.5 × N_{br})
where: N_{br} = number of bedrooms.</td><td>Use, in units of gal/day = 25.5 + (8.5 × N_{br}) × (1 − HWDS)
where:
N_{br} = number of bedrooms.
HWDS = factor for the compactness of the hot water distribution system.</td></tr>
<tr><td><table>
<tr><th colspan="2">Compactness ratio[i] factor</th><th>HWDS</th></tr>
<tr><td>1 story</td><td>2 or more stories</td><td></td></tr>
<tr><td>> 60%</td><td>> 30%</td><td>0</td></tr>
<tr><td>> 30% to ≤ 60%</td><td>> 15% to ≤ 30%</td><td>0.05</td></tr>
<tr><td>> 15% to ≤ 30%</td><td>> 7.5% to ≤ 15%</td><td>0.10</td></tr>
<tr><td>< 15%</td><td>< 7.5%</td><td>0.15</td></tr>
</table></td></tr>
<tr><td>Fuel Type: Same as proposed design</td><td>As proposed</td></tr>
<tr><td>Rated Storage Volume: Same as proposed design</td><td>As proposed</td></tr>
<tr><td>Draw Pattern: Same as proposed design</td><td>As proposed</td></tr>
<tr><td>Efficiencies: Uniform Energy Factor complying with 10 CFR §430.32</td><td>As proposed</td></tr>
<tr><td></td><td></td></tr>
</table>

<table>
<tr><th>BUILDING COMPONENT</th><th colspan="4">STANDARD REFERENCE DESIGN</th><th>PROPOSED DESIGN</th></tr>
<tr><td></td><td colspan="4">Tank Temperature: 120° F (48.9° C)</td><td>Same as standard reference design</td></tr>
<tr><td rowspan="4">Thermal distribution systems</td><td colspan="4">Duct location:</td><td rowspan="3">Duct location: as proposed[l] .</td></tr>
<tr><td>Foundation Type</td><td>Slab on grade</td><td>Unconditioned crawl space</td><td>Basement or conditioned crawl space</td></tr>
<tr><td>Duct location (supply and return)</td><td>One-story building: 100% in unconditioned attic

All other: 75% in unconditioned attic and 25% inside conditioned space</td><td>One-story building: 100% in unconditioned crawlspace

All other: 75% in unconditioned crawlspace and 25% inside conditioned space</td><td>75 % inside conditioned space

25 % unconditioned attic</td></tr>
<tr><td colspan="4">Duct insulation: in accordance with Section R403.3.1.</td><td>Duct insulation: as proposed[m] .</td></tr>
</table>

<table>
<tr><th>BUILDING COMPONENT</th><th>STANDARD REFERENCE DESIGN</th><th>PROPOSED DESIGN</th></tr>
<tr><td></td><td>Duct system leakage to outside:
For duct systems serving > 1,000ft^2 (92.9 m^2) of conditioned floor area, the duct leakage to outside rate shall be 4 cfm (113.3 L/min) per 100 ft^2 (9.29 m^2) of conditioned floor area.
For duct systems serving ≤ 1,000ft^2 (92.9 m^2) of conditioned floor area, the duct leakage to outside rate shall be 40 cfm (1132.7 L/min).</td><td>Duct System Leakage to Outside: The measured total duct system leakage rate shall be entered into the software as the duct system leakage to outside rate.
Exceptions:
<table><tr><td>1.</td><td>Where duct system leakage to outside is tested in accordance ANSI/ RESNET/ICC 380 or ASTM E1554, the measured value shall be permitted to be entered.</td></tr><tr><td>2.</td><td>Where total duct system leakage is measured without the space conditioning equipment installed, the simulation value shall be 4 cfm (113.3 L/min) per 100 ft^2 (9.29 m^2) of conditioned floor area.</td></tr></table></td></tr>
<tr><td></td><td>Distribution System Efficiency (DSE): 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.</td><td>Distribution System Efficiency (DSE): For hydronic systems and ductless systems, DSE shall be as specified in Table R405.4.2(2).</td></tr>
<tr><td>Thermostat</td><td>Type: Manual, cooling temperature setpoint = 75°F;
Heating temperature setpoint = 72°F.</td><td>Same as standard reference design.</td></tr>
<tr><td>Dehumidistat</td><td>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.</td><td>Same as standard reference design.</td></tr>
</table>

For SI: 1 square foot = 0.93 m^2, 1 British thermal unit = 1055 J, 1 pound per square foot = 4.88 kg/m^2, 1 gallon (US) = 3.785 L, °C = (°F-32)/1.8, 1 degree = 0.79 rad.

a.	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* 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* without a proposed water heater, the following assumptions shall be made for both the proposed design and *standard reference design*. <u>For a proposed design with a heat pump water heater, the following assumptions shall be made for the *standard reference design*, except the fuel type shall be electric.</u> 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 § <u>430.32</u>

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	$= A_s \times FA \times F$
where:	
AF	= Total glazing area.
A_s	= *Standard 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-grade thermal 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.

<table>
<tr><td>i.</td><td>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.

<table><tr><td>1.</td><td>Sources of hot water include water heaters, or in multiple-family buildings with central water heating systems, circulation loops or electric heat traced pipes.</td></tr><tr><td>2.</td><td>The hot water rectangle shall include the source of hot water and the points of termination of all hot water fixture supply piping.</td></tr><tr><td>3.</td><td>The hot water rectangle shall be shown on the floor plans and the area shall be computed to the nearest square foot.</td></tr><tr><td>4.</td><td>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.</td></tr><tr><td>5.</td><td>The basement or attic shall be counted as a story when it contains the water heater.</td></tr><tr><td>6.</td><td>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.</td></tr></table></td></tr>
<tr><td>j.</td><td>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.</td></tr>
<tr><td>k.</td><td>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.</td></tr>
<tr><td>l.</td><td>Only sections of ductwork that are installed in accordance with Items 1 or 2 of Section R403.3.4, are assumed to be located completely inside conditioned space. All other sections of ductwork are not assumed to be located completely inside conditioned space.</td></tr>
<tr><td>m.</td><td>Sections of ductwork installed in accordance with Section R403.3.5.1, are assumed to have an effective duct insulation R-value of R-25.</td></tr>
</table>

Reason:

It was discovered recently that the reference design requirement (added by a prior proposal action) to have the foundation wall or slab extension above grade set at 1 foot (while leaving the extension below grade “same as proposed”) can create some odd or wrong configurations of the reference design foundation. For example, consider an 8’ basement wall that is proposed to be 3 ft above grade and 5 ft below grade. The current reference design requirements would then result in a basement wall that is 1 foot above grade and only 5 ft below grade (for a total wall height of 6 ft). Attempting to fix this by setting a below grade depth for the reference design would then require different values to be established for basement walls vs. conditioned crawlspace walls in a somewhat arbitrary fashion without a clear basis to establish these geometry conditions for a standard reference design.

Given the above, it was decided the best way to fix this for the 2024 code would be to return to the language used in the 2021 code as

shown by the changes made in this proposal. Please note that while the term “slab” is used in describing the nature of foundation elements in the table, the term “slab-on-grade” is purposefully used when referencing the F-factors in Table R402.1.2. This is because F-factors are only applicable to slabs-on-grade, not slabs below grade (such as a conditioned basement slab or condition crawlspace ground area). In fact, the F-factors for slabs-on-grade are specifically based on a 6” slab edge extension above grade. Slabs that are some distance below grade are addressed in various rating and modeling software, but are not specifically addressed within the minimum criteria in Table R402.1.2. Consequently, if greater specificity in a standard reference design is to be addressed for a slab or foundation wall geometry relative to exterior grade, more work will be needed to properly coordinate this with the prescriptive requirements as well as how these foundation elements are modeled in various software.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The code change will neither increase nor decrease the cost of construction

The proposal corrects an error by restoring the reference design foundation wall description related to extension above or below grade to the approach currently in the 2021 IECC. Therefore, there is no cost increase or decrease. Although, this could have soft cost benefits by avoiding confusion in modeling and code compliance.