

## R-2: Fenestration U-factor (R402.1)

*Summary:* Lower the maximum allowable fenestration U-factors in climate zones 3-8 to approximately match older ENERGY STAR requirements that are now shown to be cost effective. There is high market penetration of these low-U windows, and beyond-code programs such as ENERGY STAR continue to incorporate further improvements.

The DOE proposal R-2 reason statement was revised on December 18, 2015.

*Stakeholder Feedback:* There were six public comments received for proposal R-2. Comments are summarized below, followed by a DOE review:

- Three comments expressing general support of the proposal and/or suggesting that DOE expand the change to address additional climate zones.

*Review:* DOE analyzed the proposal's cost-effectiveness using its established economic analysis methodology and found that the improvements were cost-effective in the proposed zones.

- One comment asking for details on the size and configuration of the residential prototype used in the energy/economic analysis.

*Review:* The prototype configuration is detailed in the established DOE cost-effectiveness methodology, which is referenced in the proposal's *Reason* statement.

- One comment requesting that DOE conduct sensitivity analyses on fuel prices.

*Review:* DOE analyzes its proposals using its established cost-effectiveness methodology, which relies on an expert source for fuel price and fuel price escalation estimates.

- Two comments noting that DOE's proposal included a change to the fenestration U-factor in climate zone 3 even though Energy Star 5.0, which was cited as the basis for the proposed U-factors, did not include the proposed U-factor in that zone.

*Review:* Energy Star 5.0 was the inspiration for the proposal, but the economic analysis showed that U-factor improvement in climate zone 3 to match the proposed zone-4 requirement is cost-effective. DOE has modified its documentation to clarify that the proposal does not exactly match the Energy Star values.

- One comment suggesting that DOE extend the proposal to also cover skylights.

*Review:* DOE considered a skylight proposal but was unable to conduct an adequate economic analysis due to a lack of data on the cost, performance, and market penetration of the latest generation of skylight technologies.

In response to these comments DOE is revising the reason statement for this proposal.

== IECC PROPOSAL:

Revise Table R402.1.2 as follows:

**TABLE R402.1.2  
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT<sup>a</sup>**

CLIMATE ZONE	FENESTRATION U-FACTOR <sup>b</sup>	SKYLIGHT <sup>d</sup> U-FACTOR	GLAZED FENESTRATION SHGC <sup>b,e</sup>	CEILING R-VALUE	WOOD FRAME WALL R-VALUE	MASS WALL R-VALUE <sup>f</sup>	FLOOR R-VALUE	BASEMENT <sup>c</sup> WALL R-VALUE	SLAB <sup>d</sup> VALUE & DEPTH	CRAWL SPACE <sup>c</sup> WALL R-VALUE
1	NR	0.75	0.25	30	13	3/4	13	0	0	0
2	0.40	0.65	0.25	38	13	4/6	13	0	0	0
3	<del>0.35</del> <u>0.32</u>	0.55	0.25	38	20 or 13+5 <sup>h</sup>	8/13	19	5/13 <sup>f</sup>	0	5/13
4 except Marine	<del>0.35</del> <u>0.32</u>	0.55	0.40	49	20 or 13+5 <sup>h</sup>	8/13	19	10 /13	10, 2 ft	10/13
5 and Marine 4	<del>0.32</del> <u>0.30</u>	0.55	NR	49	20 or 13+5 <sup>h</sup>	13/17	30 <sup>g</sup>	15/19	10, 2 ft	15/19
6	<del>0.32</del> <u>0.30</u>	0.55	NR	49	20+5 or 13+10 <sup>h</sup>	15/20	30 <sup>g</sup>	15/19	10, 4 ft	15/19
7 and 8	<del>0.32</del> <u>0.30</u>	0.55	NR	49	20+5 or 13+10 <sup>h</sup>	19/21	38 <sup>g</sup>	15/19	10, 4 ft	15/19

Revise Table R402.1.4 as follows:

**TABLE R402.1.4  
EQUIVALENT U-FACTORS<sup>a</sup>**

CLIMATE ZONE	FENESTRATION U-FACTOR	SKYLIGHT U-FACTOR	CEILING U-FACTOR	FRAME WALL U-FACTOR	MASS WALL U-FACTOR <sup>b</sup>	FLOOR U-FACTOR	BASEMENT WALL U-FACTOR	CRAWL SPACE WALL U-FACTOR
1	0.50	0.75	0.035	0.084	0.197	0.064	0.360	0.477
2	0.40	0.65	0.030	0.084	0.165	0.064	0.360	0.477
3	<del>0.35</del> <u>0.32</u>	0.55	0.030	0.060	0.098	0.047	0.091 <sup>c</sup>	0.136
4 except Marine	<del>0.35</del> <u>0.32</u>	0.55	0.026	0.060	0.098	0.047	0.059	0.065
5 and Marine 4	<del>0.32</del> <u>0.30</u>	0.55	0.026	0.060	0.082	0.033	0.050	0.055
6	<del>0.32</del> <u>0.30</u>	0.55	0.026	0.045	0.060	0.033	0.050	0.055
7 and 8	<del>0.32</del> <u>0.30</u>	0.55	0.026	0.045	0.057	0.028	0.050	0.055

**Reason:** Window efficiency has been aggressively targeted by programs such as ENERGY STAR because, compared to opaque walls, windows result in a much higher heat loss. Many Building America projects after 2010 incorporate window U-factors as low as 0.27, especially in cold climates, indicating that low-U glazing is finding widespread use in the marketplace.<sup>1</sup> Given these developments, this code change proposal considers improving maximum allowable fenestration U-factors to match older ENERGY STAR specifications where data indicate there is substantial market penetration. According to the 2013 ENERGY STAR market assessment conducted by Ducker Worldwide, the overall ENERGY STAR penetration for residential windows in the year 2013 was estimated to be 80%.<sup>2</sup> For new construction alone, ENERGY STAR residential window market penetration ranges from 70% to 88% based on climatic region, except for Florida which has a lower penetration rate of 36%. This proposed change only affects climate zones 3 through 8, for which data indicate excellent market penetration. It can thus be concluded that the current residential building market is sufficiently primed for lowering window U-factors in these climate zones. In evaluating the ENERGY STAR 5.0 requirements, it was found that the climate-zone 4 U-factor of 0.32 was also cost-effective in climate zone 3, so the proposal includes that level in zone 3.

<sup>1</sup> See Case Studies in the “cold/very cold” regions in the Building America Solution Center at <https://basc.pnnl.gov/optimized-climate-solutions/coldvery-cold>

<sup>2</sup> Available from ENERGY STAR by request

*Energy Savings:* Analysis of the energy impact of this proposed change found energy savings in climate zones 3 through 8. Savings ranged from about 0.7% to 1.1% of IECC-regulated end uses (heating, cooling, water heating, and lighting).

The U.S. Department of Energy (DOE) develops its proposals through a public process to ensure transparency, objectivity and consistency in DOE-proposed code changes. Energy savings and cost impacts are assessed based on established methods and reported for each proposal, as applicable. More information on the process utilized to develop the DOE proposals for the 2018 IECC can be found at: <https://www.energycodes.gov/development/2018IECC>.

**Cost Impact:** Data collected by DOE indicates an incremental cost of \$0.18/ft<sup>2</sup> for a window with a U-factor of 0.30 compared to a window with a U-factor of 0.35.<sup>3</sup> The present analysis conservatively assumes the same incremental cost of \$0.18/ft<sup>2</sup> for windows with a U-factor of 0.32 compared to windows with a U-factor of 0.35.

*Cost-effectiveness:* Assuming windows have a useful life of 30 years, an evaluation of the life-cycle cost savings of these improved levels over the 2015 IECC requirements using DOE's cost-effectiveness methodology shows positive life-cycle cost savings in climate zones 3 through 8. Life-cycle savings range from about \$57 in zone 3 to \$539 in zone 8.

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<sup>3</sup> Residential Energy Efficiency Measures – Prototype Estimate and Cost Data available at [http://bc3.pnnl.gov/sites/default/files/Residential\\_Report.pdf](http://bc3.pnnl.gov/sites/default/files/Residential_Report.pdf)