

STATE OF WASHINGTON

STATE BUILDING CODE COUNCIL

Washington State Energy Code Development Standard Energy Code Proposal Form

Jan 2025

Log No. 24-GP1-176 Rev 2 Received 4/30/25 (post TAG revision)

Code being amended:

Commercial Provisions

____ Residential Provisions

Code Section # _C402.4, C402.4.1.1.2, C402.1.4_____

Brief Description: Rev 2: 20% triple glazing

Revision summary:

- Superfluous language from Seattle code deleted.
- General exception threshold changed from 5,000 ft2 floor area to 1,000 ft2 fenestration area, per TAG comment
- Additional cost information added, related to the "thin triple" glazing developed by PNNL and now available on the market

Proposed code change text:

C402.4 Fenestration. Fenestration shall comply with Sections C402.4.1 through C402.4.5 and Table C402.4. Column A values in Table C402.4 apply to a maximum of 80 percent of the total building vertical fenestration area, or 65 percent for compliance with the exception to Section C402.4.1. The minimum 20 percent of fenestration required to meet the Column B high-performance U-factors, or 35 percent for compliance with the exception to Section C402.4.1, is permitted to be met using any combination of vertical fenestration types with Column B values listed, and those maximum Column B U-factors must be maintained when using the component performance alternative in Section C402.1.4. An area-weighted average of Column B U-factors is permitted, in compliance with the exception to Section C402.1.4. Daylight responsive controls shall comply with this section and Section C405.2.5.

Exception: Buildings or additions with less than ((5,000 square feet of conditioned floor area)) 1,000 square feet of fenestration area are not required to provide the Column B high performance vertical fenestration and are permitted to use Column A values for all fenestration.

Table C402.4

Building Envelope Fenestration Maximum U-factor and SHGC

Requirements^f

CLIMATE ZONE	5 AND MARINE 4					
	<u>Column A</u>		Column B			
	Standard performance portion,		High performance portion applicable to no			
	applicable to no more than 80% of		less than 20% of vertical fenestration area,			
	vertical fenestration	area.	35% for compliance with Exception 1 to			
	<u>-65% for compliance</u>	e with Exception 1	Section C402.4.1			
	to Section C402.4.1					
	U-factor for Class A	W windows rated in a	accordance with AAMA/CSA101/I.S.2/A440,			
	vertical curtain walls and site-built fenestration products ^a					
Fixed ^b U-factor	U-0.34		<u>U-0.22</u>			
Operable ^c U-factor	U-0.36		<u>U-0.26</u>			
Entrance doors ^d						
U-factor	U-0.60		N/A <u>U-0.60</u>			
	<u>U-factor for all othe</u>		er vertical fenestration			
Fixed U-factor	U-0.26		<u>U-0.20</u>			
Operable or mulled	U-0.28		<u>U-0.22</u>			
windows with fixed						
and operable						
sections U-factor						
SHGC for all vertical fenestration						
	Fixed	Operable				
PF < 0.2	0.38	0.33				
$0.2 \le \mathrm{PF} < 0.5$	0.46	0.40				
$PF \ge 0.5$	0.61	0.53				
Skylights						
U-factor	U-0.50					
SHGC	0.35					

a *U*-factor and SHGC shall be rated in accordance with NFRC 100.

b "Fixed" includes curtain wall, storefront, picture windows, and other fixed windows.

c "Operable" includes openable fenestration products other than "entrance doors," <u>and</u> <u>includes only the operable portions of multi-pane assemblies.</u>

- ^d "Entrance door" includes glazed swinging entrance doors and automatic glazed sliding entrance doors. Other doors which are not entrance doors, including manually operated sliding glass doors, are considered "operable."
- e Reserved.
- f Fenestration that is entirely within the conditioned space or is between conditioned and other enclosed space is exempt from solar heat gain coefficient requirements and not included in the SHGC calculation.

C402.4.1.1.2 High-performance fenestration. All of the following requirements shall be met:

1. All vertical fenestration in the building shall comply with the ((following)) U-factors in Table C402.4.1.1.2:

1.1. *U*-factor for Class AW windows rated in accordance with AAMA/CSA101/I.S.2/A440, vertical curtain walls and site built fenestration products (fixed) = 0.31

1.2. U-factor for Class AW windows rated in accordance with AAMA/CSA101/I.S.2/A440, vertical curtain walls and site built fenestration products (operable) = 0.36

1.3. Entrance doors = 0.60

1.4. U-factor for all other vertical fenestration, fixed = 0.23

1.5. U-factor for all other vertical fenestration, operable, or mulled windows with fixed and operable sections =

0.24

2. The SHGC of the vertical fenestration shall be no more than 0.9 times the maximum SHGC values listed in Table C402.4.

An area-weighted average shall be permitted to satisfy the *U*-factor requirement for each fenestration product category listed in Item 1 of this section. Individual fenestration products from different fenestration product categories shall not be combined in calculating the area-weighted average *U*-factor, except that fenestration from the same column in lines a. and b. are permitted to be combined, and the fenestration from the same column in lines d. and e. are permitted to be combined. Maximum U-factors for skylights, and maximum SHGC values for all fenestration, shall comply with Section C402.4.

Table C402.4.1.1.2

	CLIMATE ZONE	5 AND MARINE 4		
		<u>Column A</u> <u>Standard performance portion,</u> <u>applicable to no more than 80% of</u> <u>vertical fenestration area</u> . <u>65% for compliance with</u> <u>Exception 1 to Section C402.4.1</u>	<u>Column B</u> <u>High performance portion applicable to</u> <u>no less than 20% of vertical fenestration</u> <u>area₃</u> <u>35% for compliance with Exception 1</u> <u>to Section C402.4.1</u>	
		<i>U</i> -factor for Class AW windows rated in accordance with AAMA/CSA101/I.S.2/A440, vertical curtain walls and site-built fenestration products ^a		
a.	Fixed ^b U-factor	U-0.26	U-0.22	
b.	Operable ^c U-factor	U-0.30	U-0.26	
	I	Entrance doors ^d		
c.	U-factor	U-0.60	N/A	
		U-factor for all other vertical fenestration		
d.	Fixed U-factor	U-0.22	U-0.20	
e.	Operable or mulled windows with fixed and operable sections U-factor	U-0.23	U-0.22	

Building Envelope High-Performance Fenestration Maximum U-factor

a *U*-factor and SHGC shall be rated in accordance with NFRC 100.

b "Fixed" includes curtain wall, storefront, picture windows, and other fixed windows.

c "Operable" includes openable fenestration products other than "entrance doors," <u>and</u> <u>includes only the operable portions of multi-pane assemblies.</u>

d <u>"Entrance door" includes glazed swinging entrance doors and automatic glazed sliding entrance</u> <u>doors. Other doors which are not entrance doors, including manually operated sliding glass doors,</u> <u>are considered "operable."</u>

C402.1.4 Component performance method. Building thermal envelope values and fenestration areas determined in accordance with Equation 4-3 shall be an alternate to compliance with the U-, F-, psi-, chi-, and C-factors in Tables C402.1.2, C402.1.2.7, C402.1.4 and C402.4 and the maximum allowable fenestration areas in Section C402.4.1. Fenestration shall meet the applicable SHGC requirements of Section C402.4.3.

For buildings with more than one space conditioning category, component performance compliance shall be demonstrated separately for each space conditioning category. Interior partition ceilings, walls, fenestration and floors that separate space conditioning areas shall be applied to the component performance calculations for the space conditioning category with the highest level of space conditioning.

<u>High-performance vertical fenestration types required by Column B of Table C402.4 shall be calculated</u> separately from other vertical fenestration types in Equation 4-2. The maximum U-factors permitted in Column <u>B of Table C402.4 shall not be exceeded for the required Column B vertical fenestration area.</u>

Exception. The maximum U-factor permitted for operable vertical fenestration in Column B of Table C402.4 is permitted to be exceeded when the Proposed Column B vertical fenestration area weighted UA is less than or equal to the Allowable Column B vertical fenestration area weighted UA for all types of Column B vertical fenestration.

Purpose of code change:

Reduce heat loss by using lower U-factor fenestration, get industry prepared for increase to larger percentage of high-performance glazing in future code cycles.

Your amendment must meet one of the following criteria. Select at least one: Addresses a critical life/safety need. Consistency with state or federal regulations. Addresses a unique character of the state. The amendment clarifies the intent or application of the code. Corrects errors and omissions. \square Addresses a specific state policy or statute. (Note that energy conservation is a state policy) Check the building types that would be impacted by your code change: Multi-family 4 + stories Institutional Single family/duplex/townhome Multi-family 1 – 3 stories Commercial / Retail 🛛 Industrial **Duane Jonlin** Other contact name Your name

Your organization	Seattle Department of	Email address	duane.jonlin@seattle.gov
Construction and Inspections		Phone number	206-233-2781
		Thome number	200 233 2701

Economic Impact Data Sheet

Is there an economic impact: \square Yes \square No

Briefly summarize your proposal's primary economic impacts and benefits to building owners, tenants, and businesses. If you answered "No" above, explain your reasoning.

The additional cost is approximately \$4.00 per square foot, or \$80 for 20% of the fenestration in a small apartment. The savings in energy use are several dollars per year, per apartment.

Provide your best estimate of the construction cost (or cost savings) of your code change proposal?

\$Click here to enter text./square foot (For residential projects, also provide \$102/ dwelling unit)

Show calculations here, and list sources for costs/savings, or attach backup data pages

<u>Triple glazing</u>. Costs are taken from a recent bid by a Seattle window fabricator, which included a base bid for standard double glazing with an additive alternate to upgrade to triple glazing. The triple-glazed package cost was 12% higher than double glazed.

- Seattle code requirement is for 20% of glazing to be triple glazed (or equivalent)
- Assumed one 5' x 4' bedroom window is used to meet the 20% requirement
- Add 77 + 15% installation = 89 + 15% contractor O&P = $102 \times 30\%$ escalation = 133
- <u>For conventional triple glazing</u>: High-rise "window wall" would be more expensive because it's not a standard product, so an increase of more like 40%, so perhaps add \$35/sf x 20 = **\$700** (Oldcastle email)
- For conventional triple glazing: Upgrading curtain wall to triple glazing would be somewhat less expensive than upgrading window wall, as triple glazed curtain wall is an available option, approximately **\$520** per unit (see table below)

Thin Triple Glazing. Three major glass fabricators, two in US and one in Europe, now offer the "thin triple" glazing developed by LBNL. This product has the same overall thickness as conventional double-pane glass, and a 20 ft² window weighs only one additional pound, so the same framing system that's used for double=pane glazing can be used, and costs for installation are the same. (Fabricators install a sheet of the same glass used for laptop computer screens between two outer panes of standard glass.)

- For "thin triple" glazing, the additional cost from the fabricator (Luke Albin, Alpen Glass, 3/28/2025) is approximately \$3 \$4 per ft², and therefore about \$3.50 \$4.50 per ft² total additional cost.
- Since this product uses exactly the same framing system as conventional double-pane glass, the additional cost per square foot will be identical for punched openings, curtain wall, and window wall.
- Thin triple glazing is available in sizes up to 88" x 102", in either orientation.
- There is some disagreement about whether the inner lite of a triple-pane panel is required to be safety glazing for hazard locations (within 18" of floor, within 24" of door swings, at stairs) but safety glazing in the form of a coating on the inner lite is available at additional cost.
- <u>The 20% requirement could either be met by installing one smaller window in an apartment, or by using the triple glazing for one entire face of a building, perhaps facing north or facing a noisy street.</u>

Instructions: Send this form as an email attachment, along with any other documentation available, to: <u>sbcc@des.wa.gov</u>. For further information, call the State Building Code Council at 360-407-9255.

All questions must be answered to be considered complete. Incomplete proposals will not be accepted.

\$102	Upgrade 5'x4' bedroom	Typical cost increase for triple is now 12% - 15% over double pane
<u>\$133</u>	window to triple pane	Energy savings \$6.76/year (@ \$0.13/ kWh)
	(\$102 upgrade cost based	15-year simple payback for 30- or 50-year life system.
	on recent Seattle bid)	
<u>\$80</u>	For the same 5' x 4'	This would be a 12-year simple payback
	window, \$80 per	
	apartment using "thin	
	triple" glazing	

Provide your best estimate of the annual energy savings (or additional energy use) for your code change proposal?

Click here to enter text.KWH/ square foot (or) Click here to enter text.KBTU/ square foot

(For residential projects, also provide 37 KWH/ dwelling unit)

Show calculations here, and list sources for energy savings estimates, or attach backup data pages

U-0.26 – U-0.20 = 0.06 x 20sf x 4423 HDD x 24 hours = 127,382 Btu = 127 kBtu = 37 kWh x \$0.11 = \$4.12 savings

List any **code enforcement** time for additional plan review or inspections that your proposal will require, in hours per permit application:

Possibly 5 minutes per project

Small Business Impact. Describe economic impacts to small businesses:

Small fabrication shops will need to tool up to accommodate triple glazing

Housing Affordability. Describe economic impacts on housing affordability:

Slight increase in construction cost, slight decrease in utility bills

Other. Describe other qualitative cost and benefits to owners, to occupants, to the public, to the environment, and to other stakeholders that have not yet been discussed:

Reduced noise transmission. If the triple glazing were used for bedroom windows, then the noise protection would provide optimal occupant comfort.

Improved thermal comfort near windows for occupants

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