

(Effective until July 1, 2020)

WAC 51-11C-40215 Section C402.1.5—Component performance alternative.

**C402.1.5 Component performance alternative.** Building envelope values and fenestration areas determined in accordance with Equation 4-2 shall be permitted in lieu of compliance with the *U*-factors and *F*-factors in Table C402.1.4 and C402.4 and the maximum allowable fenestration areas in Section C402.4.1.

**Equation 4-2**

$$A + B + C + D \leq \text{Zero}$$

Where:

A = Sum of the (UA Dif) values for each distinct assembly type of the building thermal envelope, other than slabs on grade

$$\text{UA Dif} = \text{UA Proposed} - \text{UA Table}$$

$$\text{UA Proposed} = \text{Proposed } U\text{-value} \times \text{Proposed Area}$$

$$\text{UA Table} = (U\text{-factor from Table C402.1.4 or C402.4}) \times \text{Area}$$

B = Sum of the (FL Dif) values for each distinct slab on grade perimeter condition of the building thermal envelope

$$\text{FL Dif} = \text{FL Proposed} - \text{FL Table}$$

$$\text{FL Proposed} = \text{Proposed } F\text{-value} \times \text{Proposed Perimeter length}$$

$$\text{FL Table} = (F\text{-factor specified in Table C402.1.4}) \times \text{Proposed Perimeter length}$$

The maximum allowed prescriptive vertical fenestration area, identified as "Vertical Fenestration Area allowed" in factor CA below, is the gross above-grade wall area times either:

1. 30%
2. 40% if the building complies with Section C402.4.1.1 or Section C402.4.1.4; or
3. 40% if the *U*-values used in calculating A for vertical fenestration are taken from Section C402.4.1.3 rather than Table C402.4

Where the proposed vertical fenestration area is less than or equal to the Vertical Fenestration Area allowed, the value of C (Excess Vertical Glazing Value) shall be zero. Otherwise:

$$C = (\text{CA} \times \text{UV}) - (\text{CA} \times \text{U}_{\text{Wall}}), \text{ but not less than zero}$$

$$\text{CA} = (\text{Proposed Vertical Fenestration Area}) - (\text{Vertical Fenestration Area allowed})$$

$$\text{UAW} = \text{Sum of the (UA table) values for each above-grade wall assembly}$$

$U_{Wall}$	=	$U_{AV}/(\text{sum of proposed wall area} + CA)$
$U_{AV}$	=	Sum of the (UA Table) values for each vertical fenestration assembly
$U_V$	=	$U_{AV}/\text{Total Vertical Fenestration Area allowed}$

Where the proposed skylight area is less than or equal to the skylight area allowed by Section C402.4.1, the value of D (Excess Skylight Value) shall be zero. Otherwise:

$D$	=	$(DA \times U_S) - (DA \times U_{Roof})$ , but not less than zero
$DA$	=	$(\text{Proposed Skylight Area}) - (\text{Allowable Skylight Area from Section C402.4.1})$
$U_{AR}$	=	Sum of the (UA Table) values for each roof assembly
$U_{Roof}$	=	$U_{AR}/(\text{sum of proposed roof area} + DA)$
$U_{AS}$	=	Sum of the (UA Table) values for each skylight assembly
$U_S$	=	$U_{AS}/\text{the Allowable Skylight Area from Section C402.4.1}$

Where required by other sections of the code Proposed Total Envelope UA and Allowed Total Envelope UA shall be calculated as:

Proposed Total Envelope UA	=	Sum of UA Proposed and FL Proposed for each distinct envelope assembly
Allowed Total Envelope UA	=	Sum UA Table - C — D

Where:

Sum UA Table	=	Sum of UA Table and FL Table for each distinct envelope assembly
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**C402.1.5.1 Component U-factors.** The *U*-factors for typical construction assemblies are included in Chapter 3 and Appendix A. These values shall be used for all calculations. Where proposed construction assemblies are not represented in Chapter 3 or Appendix A, values shall be calculated in accordance with the ASHRAE *Handbook—Fundamentals*, using the framing factors listed in Appendix A.

For envelope assemblies containing metal framing, the *U*-factor shall be determined by one of the following methods:

1. Results of laboratory measurements according to acceptable methods of test.
2. ASHRAE *Handbook—Fundamentals* where the metal framing is bonded on one or both sides to a metal skin or covering.
3. The zone method as provided in ASHRAE *Handbook—Fundamentals*.
4. Effective framing/cavity *R*-values as provided in Appendix A.

When return air ceiling plenums are employed, the roof/ceiling assembly shall:

- a. For thermal transmittance purposes, not include the ceiling proper nor the plenum space as part of the assembly; and
- b. For gross area purposes, be based upon the interior face of the upper plenum surface.

5. Tables in ASHRAE 90.1 Normative Appendix A.

**C402.1.5.2 SHGC rate calculations.** Fenestration SHGC values for individual components and/or fenestration are permitted to exceed the SHGC values in Table C402.4 and/or the maximum allowable fenestration areas in Section C402.4.1 where the proposed values result in  $SHGCA_p$  less than  $SHGCA_t$  as determined by Equations 4-3 and 4-4.

**Equation 4-3—Target  $SHGCA_t$**

**Equation C402-3**

**Target  $SHGCA_t$**

$$SHGCA_t = SHGC_{ogt}(A_{ogt}) + SHGC_{vgt}(A_{vgt} + A_{vgmt} + A_{vgmot} + A_{vgdt})$$

Where:

$SHGCA_t$  = The target combined solar heat gain of the target fenestration area.

$SHGC_{ogt}$  = The solar heat gain coefficient for skylight fenestration found in Table C402.4.

$A_{ogt}$  = The target skylight area.

$SHGC_{vgt}$  = The solar heat gain coefficient for vertical fenestration found in Table C402.4 which corresponds to the proposed total fenestration area as a percentage of gross exterior wall.

$A_{vgt}$  = The target vertical fenestration area with nonmetal framing.

$A_{vgmt}$  = The target vertical fenestration area with fixed metal framing.

$A_{vgmot}$  = The target vertical fenestration area with operable metal framing.

$A_{vgdt}$  = The proposed vertical fenestration area of entrance doors.

NOTE: The vertical fenestration area does not include opaque doors and opaque spandrel panels.

If the proposed vertical fenestration area does not exceed the Vertical Fenestration Area allowed, the target area for each vertical fenestration type shall equal the proposed area. If the proposed vertical fenestration area exceeds the Vertical Fenestration Area allowed, the target area of each vertical fenestration element shall be reduced in the base envelope design by the same percentage and the net area of each above-grade wall type increased proportionately by the same percentage so that the total vertical fenestration area is exactly equal to the Vertical Fenestration Area allowed.

If the proposed skylight area does not exceed the Allowable Skylight Area from Section C402.4.1, the target area shall equal the proposed area. If the proposed skylight area exceeds the Allowable Skylight Area from Section C402.4.1, the area of each skylight element shall be reduced in the base envelope design by the same percentage and the net area of each roof type increased proportionately by the

same percentage so that the total skylight area is exactly equal to the allowed percentage per Section C402.3.1 of the gross roof area.

**Equation 4-4**  
**Proposed SHGCA<sub>p</sub>**

$$\text{SHGCA}_p = \text{SHGC}_{og}A_{og} + \text{SHGC}_{vg}A_{vg}$$

Where:

$\text{SHGCA}_t$  = The combined proposed solar heat gain of the proposed fenestration area.

$\text{SHGC}_{og}$  = The solar heat gain coefficient of the skylights.

$A_{og}$  = The skylight area.

$\text{SHGC}_{vg}$  = The solar heat gain coefficient of the vertical fenestration.

$A_{vg}$  = The vertical fenestration area.

NOTE: The vertical fenestration area does not include opaque doors and opaque spandrel panels.

[Statutory Authority: RCW 19.27A.020, 19.27A.025 and chapters 19.27A and 19.27 RCW. WSR 19-02-089, § 51-11C-40215, filed 1/2/19, effective 7/1/19. Statutory Authority: RCW 19.27A.025, 19.27A.045, 19.27A.160, and 19.27.074. WSR 17-10-062, § 51-11C-40215, filed 5/2/17, effective 6/2/17; WSR 16-24-070, § 51-11C-40215, filed 12/6/16, effective 5/1/17; WSR 16-13-089, § 51-11C-40215, filed 6/15/16, effective 7/16/16. Statutory Authority: RCW 19.27A.025, 19.27A.160, and 19.27.074. WSR 16-03-072, § 51-11C-40215, filed 1/19/16, effective 7/1/16.]

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**C402.1.5 Component performance alternative.** Building envelope values and fenestration areas determined in accordance with Equation 4-2 shall be permitted in lieu of compliance with the *U*-factors and *F*-factors in Table C402.1.4 and C402.4 and the maximum allowable fenestration areas in Section C402.4.1.

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.

**Equation 4-2**

**Proposed Total UA ≤ Allowable Total UA**

Where:

$$\text{Proposed Total UA} = \text{UA-glaz-prop} + \text{UA sky-prop} + \text{UA-opaque-prop} + \text{FL-slab-prop}$$

<b>Allowable Total UA</b>	=	UA-glaz-allow + UA-glaz-excess + UA sky-allow + UA-sky-excess + UA-opaque-allow + FL-slab-allow
<b>UA-glaz-prop</b>	=	Sum of (proposed <i>U</i> -value x proposed area) for each distinct vertical fenestration type, up to code maximum area
<b>UA-sky-prop</b>	=	Sum of (proposed <i>U</i> -value x proposed area) for each distinct skylight type, up to the code maximum area
<b>UA-opaque-prop</b>	=	Sum of (proposed <i>U</i> -value x proposed area) for each distinct opaque thermal envelope type
<b>FL-slab-prop</b>	=	Sum of (proposed <i>F</i> -value x proposed length) for each distinct slab on grade perimeter assembly
<b>UA-glaz-allow</b>	=	Sum of (code maximum vertical fenestration <i>U</i> -value from Table C402.4, or Section C402.4.1.1.2 if applicable, x proposed area) for each distinct vertical fenestration type, not to exceed the code maximum area <sup>1</sup>
<b>UA-glaz-excess</b>	=	<i>U</i> -value for the proposed wall type from Table C402.4 <sup>2</sup> x vertical fenestration area in excess of the code maximum area
<b>UA-sky-allow</b>	=	Sum of (code maximum skylight <i>U</i> -value from Table C402.4 x proposed area) for each distinct skylight type proposed, not to exceed the code maximum area
<b>UA-sky-excess</b>	=	<i>U</i> -value for the proposed roof type from Table C402.4 <sup>3</sup> x skylight area in excess of the code maximum area
<b>UA-opaque-allow</b>	=	Code maximum opaque envelope <i>U</i> -value from Table C402.1.4 for each opaque door, wall, roof, and floor assembly x proposed area
<b>FL-slab-allow</b>	=	Code maximum <i>F</i> -value for each slab-on-grade perimeter assembly x proposed length

**Notes:**

<sup>1</sup> Where multiple vertical fenestration types are proposed and the code maximum area is exceeded, the *U*-value shall be the average Table C402.1.4 *U*-value weighted by the proposed vertical fenestration area of each type.

<sup>2</sup> Where multiple wall types are proposed the *U*-value shall be the average Table C402.1.4 *U*-value weighted by the proposed above grade wall area of each type.

<sup>3</sup> Where multiple roof types are proposed the *U*-value shall be the average Table C402.1.4 *U*-value weighted by the proposed roof area of each type.

**C402.1.5.1 Component *U*-factors.** The *U*-factors for typical construction assemblies are included in Chapter 3 and Appendix A. These values shall be used for all calculations. Where proposed construction assemblies are not represented in Chapter 3 or Appendix A, values shall be calculated in accordance with the ASHRAE *Handbook—Fundamentals*, using the framing factors listed in Appendix A.

For envelope assemblies containing metal framing, the *U*-factor shall be determined by one of the following methods:

1. Results of laboratory measurements according to acceptable methods of test.

2. ASHRAE *Handbook—Fundamentals* where the metal framing is bonded on one or both sides to a metal skin or covering.

3. The zone method as provided in ASHRAE *Handbook—Fundamentals*.

4. Effective framing/cavity *R*-values as provided in Appendix A.

When return air ceiling plenums are employed, the roof/ceiling assembly shall:

a. For thermal transmittance purposes, not include the ceiling proper nor the plenum space as part of the assembly; and

b. For gross area purposes, be based upon the interior face of the upper plenum surface.

5. Tables in ASHRAE 90.1 Normative Appendix A.

6. Calculation method for steel-framed walls in accordance with Section C402.1.4.1 and Table C402.1.4.1.

**C402.1.5.2 SHGC rate calculations.** Fenestration SHGC values for individual components and/or fenestration are permitted to exceed the SHGC values in Table C402.4 and/or the maximum allowable fenestration areas in Section C402.4.1 where the proposed values result in SHGC<sub>A<sub>p</sub></sub> less than SHGC<sub>A<sub>t</sub></sub> as determined by Equations 4-3 and 4-4.

**Equation 4-3—SHGC Rate Calculations**

$$\text{Proposed Total SHGC}_{xA} \leq \text{Allowable Total SHGC}_{xA}$$

Where:

Proposed Total SHGC <sub>x</sub> A	=	SHGC <sub>x</sub> A-glaz-prop + SHGC <sub>x</sub> A-sky-prop
Allowable Total SHGC <sub>x</sub> A	=	SHGC <sub>x</sub> A-glaz-allow + SHGC <sub>x</sub> A-sky-allow
SHGC <sub>x</sub> A-glaz-prop	=	Sum of (proposed SHGC <sub>x</sub> proposed area) for each distinct vertical fenestration type
SHGC <sub>x</sub> A-sky-prop	=	Sum of (proposed SHGC <sub>x</sub> proposed area) for each distinct skylight type
SHGC <sub>x</sub> A-glaz-allow	=	Sum of (code maximum vertical fenestration SHGC from Table C402.4, or Section C402.4.1.3 if applicable, x proposed area) for each distinct vertical fenestration type, not to exceed the code maximum area

SHGCxA-sky-allow = Sum of (code maximum skylight SHGC from Table C402.4x proposed area) for each distinct skylight type, not to exceed the code maximum area

If the proposed vertical fenestration area does not exceed the Vertical Fenestration Area allowed, the target area for each vertical fenestration type shall equal the proposed area. If the proposed vertical fenestration area exceeds the Vertical Fenestration Area allowed, the target area of each vertical fenestration element shall be reduced in the base envelope design by the same percentage and the net area of each above-grade wall type increased proportionately by the same percentage so that the total vertical fenestration area is exactly equal to the Vertical Fenestration Area allowed.

If the proposed skylight area does not exceed the Allowable Skylight Area from Section C402.4.1, the target area shall equal the proposed area. If the proposed skylight area exceeds the Allowable Skylight Area from Section C402.4.1, the area of each skylight element shall be reduced in the base envelope design by the same percentage and the net area of each roof type increased proportionately by the same percentage so that the total skylight area is exactly equal to the allowed percentage per Section C402.3.1 of the gross roof area.

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