

Thermal Envelope Minimum Requirements Summary

2021 Washington State Energy Code for Commercial Buildings

Revised July 2023

Minimum Requirements for Prescriptive Compliance		<i>This table summarizes prescriptive compliance requirements for opaque elements and fenestration. Refer to Tables C402.1.3, C402.1.4 and C402.4 in the 2021 WSEC-C for important footnotes that apply to these tables. Refer to Section C402 for all applicable requirements that apply for each envelope element type and applicable exceptions.</i>			
Prescriptive Path	Table C402.1.3 ^{Notes a, j}		Table C402.1.4 ^{Notes a, f}		
	Insulation Minimum R-Value		Assembly Maximum U-factor		
Occupancy Group	All Other	Group R	All Other	Group R	
Opaque Elements					
Roofs					
Insulation entirely above deck	R-38 CI		U-0.027		
Metal building	R-25 + R-22 LS + R-3.5 TSB		U-0.031		
Attic and other	R-49		U-0.021		
Joist or single rafter	See Table C402.1.4		U-0.027		
Walls, Above-grade					
Mass	R-9.5 CI	R-13.3 CI	U-0.104	U-0.078	
Integral insulated CMU	Exempt ^{Note c}	Same as Mass	Exempt ^{Note d}	Same as Mass	
Peripheral edge of intermediate mass floors	R-9.5 CI ^{Note h}	R-13.3 CI ^{Note h}	U-0.104 ^{Note g}	U-0.078 ^{Note g}	
Mass transfer deck slab	See Table C402.1.4 ^{Note g}		U-0.20 ^{Note j}		
Metal building	R-13 + R-14 CI		U-0.050		
Steel-framed	R-13 + R-10 CI	R-19 + R-8.5 CI	U-0.055		
Wood-framed and other	R-13 + R-7.5 CI Std or R-20 + R-3.8 CI Std	R-13 + R-7.5 CI Std or R-20 + R-3.8 CI Std or R-25 std	U-0.051		
Mech equip thru-wall penetrations (> 1%)	See Table C402.1.4 ^{Note i}		U-0.50 ^{Note k}		
Below Grade Wall	Same as above grade ^{Notes d & h}		Same as above grade ^{Notes b & g}		
Floors					
Mass	R-30 CI ^{Note f}		U-0.031 ^{Note e}		
Steel joist	R-38 + R-10 CI		U-0.029		
Wood-framed joist and other	R-30		U-0.029		
Slab-On-Grade Floors					
Unheated	R-10 for 24" below (from top of slab)		F-0.54		
Heated	R-10 perimeter & under entire slab ^{Note d}		F-0.55 ^{Note c}		
Opaque Doors					
Non-swinging door	See Table C402.1.4		U-0.31		
Swinging door			U-0.37 ^{Note h}		
Garage door < 14% glazed			U-0.31		
Garage door ≥ 14% & ≤ 25% single row			U-0.44 ^{Note i}		
Garage door ≥ 14% & ≤ 50% glazed			U-0.34		
	Table C402.4 - 0-30% of wall area, or 30%-40% per Section C402.4.1.1.1 Optimized Daylighting		Section C402.4.1.1.2 High Performance Vertical Fenestration - 0-40% of wall area		
Fenestration	Assembly Maximum U-factor^{Note a}				
Vertical Fenestration - Fixed^{Note b}					
Class AW	U-0.34		U-0.31		
Curtain walls	U-0.34		U-0.31		
Site-built	U-0.34		U-0.31		
All other	U-0.26		U-0.23		
Vertical Fenestration - Operable^{Note c}					
Class AW	U-0.36		U-0.36		
Site-built	U-0.36		U-0.36		
All other including mulled (fixed/operable)	U-0.28		U-0.24		
Entrance doors ^{Note d}	U-0.60		U-0.60		
Skylights	U-0.50		U-0.50		
	Assembly Maximum SHGC^{Notes a, f}				
Vertical Fenestration - Fixed					
PF < 0.2	SHGC-0.38		SHGC-0.34		
0.2 ≤ PF < 0.5	SHGC-0.46		SHGC-0.41		
PF ≥ 0.5	SHGC-0.61		SHGC-0.55		
Vertical Fenestration - Operable					
PF < 0.2	SHGC-0.33		SHGC-0.30		
0.2 ≤ PF < 0.5	SHGC-0.40		SHGC-0.36		
PF ≥ 0.5	SHGC-0.53		SHGC-0.48		
Skylights	SHGC-0.35				

Refrigerated Spaces Envelope	Section C410.2 Walk-in and Warehouse Coolers & Freezers	
	Insulation Minimum R-value	Assembly Maximum U-factor
Freezers - Walk-in and Warehouse		
Roof/Ceiling, Walls, Doors - Opaque	R-32	U-0.030
Doors - Transparent reach-in	Triple-pane w/ heat-reflective treated glass or gas filled	
Floor	R-28	U-0.035
Coolers - Walk-in and Warehouse		
Roof/Ceiling, Walls, Doors - Opaque	R-25	U-0.039
Doors - Transparent reach-in	Double-pane w/ heat-reflective treated glass or gas filled, or comply with freezer requirements	
Floor	R-25	U-0.040
Floor - Mounted directly on slab on grade	R-0	
		Table C402.1.1.3
Greenhouse Fenestration		Assembly Maximum U-factor
Skylights including Glazed Roof		0.5
Vertical Fenestration		0.6

Definitions:

LS = Liner system -- A continuous membrane in a metal building roof assembly that is installed below the purlins and uninterrupted by framing members. Uncompressed, unfaced insulation rests on top of the membrane between the purlins. Refer to Section A102.2.5.4.

TSB = Thermal spacer blocks in a metal building roof assembly.

CI = Continuous insulation -- Insulation that is continuous across all structural members without thermal bridges other than service openings and penetrations by metal fasteners with a cross-sectional area of less than 0.04% of the opaque surface area of the assembly.

Std = Standard framing -- Refer to Section A103.2 for framing definitions.

SHGC = Solar heat gain coefficient

Vertical fenestration -- Windows that are fixed or operable, doors with < 50% glazed area and glazed block composed of glass or other transparent or translucent glazing materials and installed at a slope ≥ 60 degrees (91.05 rad) from horizontal.

Class AW rated vertical fenestration -- The highest level Performance Grade (PG) per the North American Fenestration Standard/ Specification for Windows, Doors and Skylights AAMA/WDMA/CSA 101/I.S. 2/A440-08. Criteria includes uniform load deflection, water penetration resistance, air leakage resistance and operating force (if applicable).

Skylights -- Glass or other transparent or translucent glazing material installed at a slope of < 60 degrees (91.05 rad) from horizontal. Includes unit skylights, tubular daylighting devices and glazing materials in solariums, sunrooms, roofs, greenhouses and sloped walls.

Continuous insulation alternate R-value compliance option per Table C402.1.3 Footnote j:

Assemblies with continuous insulation	Alternate option for assemblies with metal penetrations > 0.04% and ≤ 0.08%, or for assemblies with stainless steel penetrations > 0.12% and ≤ 0.24%	Alternate option for assemblies with metal penetrations > 0.04% and ≤ 0.08%, or for assemblies with stainless steel penetrations > 0.24% and ≤ 0.48%
R-9.5 CI	R-11.9 CI	R-13 CI
R-11.4 CI	R-14.3 CI	R-15.7 CI
R-13.3 CI	R-16.6 CI	R-18.3 CI
R-15.2 CI	R-19 CI	R-21 CI
R-30 CI	R-38 CI	R-42 CI
R-38 CI	R-48 CI	R-53 CI
R-13 + R-7.5 CI	R-13 + R9.4 CI	R-13 + R10.3 CI
R-13 + R-10 CI	R-13 + R-12.5 CI	R-13 + R-13.8 CI
R-13 + R-12.5 CI	R-13 + R-15.6 CI	R-13 + R-17.2 CI
R-13 + R-13 CI	R-13 + R-16.3 CI	R-13 + R-17.9 CI
R-19 + R-8.5 CI	R-19 + R-10.6 CI	R-19 + R-11.7 CI
R-19 + R-14 CI	R-19 + R-17.5 CI	R-19 + R-19.2 CI
R-19 + R-16 CI	R-19 + R-20 CI	R-19 + R-22 CI
R-20 + R-3.8 CI	R-20 + R-4.8 CI	R-20 + R-5.3 CI
R-21 + R-5 CI	R-21 + R-6.3 CI	R-21 + R-6.9 CI

Table C402.1.3 R-Value Prescriptive Compliance Method Footnotes Summary:

- Note a** -- Assembly descriptions can be found in Chapter 2 and Appendix A.
- Note b** -- Thermal space block (TSB) for metal building roofs shall be at least 1/2" thick with R-value per prescriptive table above. TSB is only required for R-value compliance method.
- Note c** -- Exception to the minimum required mass wall R-value for integral insulated CMU walls complying with ASTM C90, where at least 50% of cores are filled with insulation and walls enclose one of the eligible space types.
- Note d** -- Below grade heated slabs shall comply with the thermal performance requirements of heated slab-on-grade floors.
- Note e** -- Refer to prescriptive table above for minimum required insulation R-values for steel floor joist systems.
- Note f** -- Qualifying density requirements for a mass floor.
- Note g** -- Buildings with mass transfer deck slabs shall comply via component performance. Refer to prescriptive U-factor table above for required code target (default) U-factor.
- Note h** --Peripheral edges of intermediate concrete floors shall be accounted for as a separate wall assembly. Include thickness of slab multiplied by the perimeter length in the total above grade wall area. Refer to prescriptive table above for minimum required R-values. Refer to Table A103.3.7.2 for default U-factors.
- Note i** -- When the total area of penetrations from through-wall mechanical equipment exceeds 1% of the above-grade wall area, the mechanical equipment penetration area shall be accounted for as a separate wall assembly. Refer to prescriptive table above for required default U-factor.

Table C402.1.4 U-Factor Prescriptive Compliance Method Footnotes Summary:

- Note a** -- Use of default U-factors and F-factors from Appendix A for proposed envelope assemblies are required unless otherwise allowed by Section C402.1.4. (Also refer to Section C402.1.5.1 Component U-factors and F-factors.)
- Note b** -- Same information regarding below grade heated slabs as Table C402.1.3 Note d above.
- Note c** -- Heated slab F-factors shall be determined specifically for heated slabs. Unheated slab factors shall not be used.
- Note d** -- Same information regarding integral insulated CMU walls as Table C402.1.3 Note c above.
- Note e** -- Same qualifying density requirements for a mass floor as Table C402.1.3 Note f above.
- Note f** -- U-factors based on designs tested in accordance with ASTM C1363 may be used in lieu of 2021 WSEC Addendum A defaults. The R-value of continuous insulation is permitted to be added or subtracted from the original test design.
- Note g** -- Same information regarding peripheral edges of intermediate concrete floors as Table C402.1.3 Note h above.
- Note h** -- Swinging door U-factors shall be determined in accordance with NFRC-100.
- Note i** -- Refer to prescriptive table above for minimum required U-factor for garage doors having a single row of fenestration.
- Note j** -- A mass transfer deck, due to its configuration, is not insulated. Bldgs with mass transfer deck slabs shall comply via component performance or total bldg performance. Code target (default) U-factor shall be per the prescriptive U-factor table above and the proposed U-factor shall be per Table A103.3.7.2.
- Note k** - Same information regarding penetrations from through-wall mechanical equipment as Table C402.1.3 Note i above.

Table C402.4 Fenestration U-Factor and SHGC Footnotes Summary:

- Note a** -- U-factor and SHGC shall be rated in accordance with NFRC 100.
- Note b** -- "Fixed" includes curtain wall, storefront, picture windows and other fixed windows.
- Note c** -- "Operable" includes operable fenestration products other than "entrance doors."
- Note d** -- "Entrance door" includes glazed swinging entrance doors. Other doors which are not entrance doors, including sliding glass doors, are considered "operable."
- Note e** -- Reserved.
- Note 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.