BUILDING ENVELOPE – GENERAL

General Instructions

Form 3a contains several spaces that require the applicant to complete. The information provided is either a description of the portions of qualify for a specific exemption or entering the specific location where the requirements is specified, either on the plans or in the specifications. When a specification is provided, provide the exact location. This means the specific Section must be provides as well as subparagraph – 08800 is not acceptable, 08800, 2, 2 is acceptable.

Example

1. Exceptions (Section 1312)

☐ **No Envelope Components**. The building plans do not call for new or altered building envelope components, e.g., walls, floors or roof/ceilings.

☐ **A Non-conditioned Building.** The proposed structure has no spaces heated or cooled by an HVAC system.

☑ **Exception.** All new or altered building envelope components do not comply with the requirements, Section 1312, but qualify for Exception: ☐-1 ☑-2 ☐-3 ☐-4 ☐-5

Portions of the building that qualify:

Auto repair area and adjacent work areas

The plans/specs show compliance in the following locations: Drawing A-2

Line 1. Exceptions

No Envelope Components. If your building plans do not call for any new or altered building envelope components, check this box. Skip the rest of this form and all other forms and worksheets in Chapter 3.

A Non-Conditioned Building. If the space within your project is not heated or cooled by an HVAC system, check this box. Skip the rest of this form and all other forms and worksheets in Chapter 3.

Exceptions. If your project meets one of the five exceptions cited below, check the appropriate box number that applies. See below for a discussion of code exceptions. ***Next, indicate in the text box if your entire building or only a portion of your building qualifies for the exception***. In some cases you will need to complete part of the Prescriptive Path form. You can skip the rest of Form 3a if the exception applies to the entire building.

Exceptions 1 and 2 are not blanket exceptions to the envelope requirements. In both cases, the code sets requirements that are unique to the exception. Read these requirements carefully to be certain that your plans meet the code.

Section 1312, Exception 1 is for semi-conditioned spaces. To qualify as a semi-conditioned space in Climate Zone 1, the heating system output capacity for the space shall not exceed 15 Btu/hr/ft^2 or 4 Watts/ft^2 of heated floor area. In Climate Zone 2, the heating system output capacity for the space shall not exceed 20 Btu/hr/ft^2 or 6 Watts/ft^2 of heated floor area. In both zones, only the wall insulation requirements are exempt from prescriptive path requirements. A thermostat shall control the heating system with a maximum setpoint capacity of 45 degrees F, mounted no lower than the heating unit. If you qualify for this exception, check the Exception box and box 1, and complete lines the Prescriptive Path form (Forms 3b) to show you meet all requirements except wall insulation. Submit the Prescriptive Path form along with this form.

Section 1312, Exception 2 applies to motor vehicle service station occupancies only (Group S-3 or H-3), in spaces where the temperature is maintained below 55 degrees F. These spaces often have large, overhead doors that are open during operating hours. Code requires the roof/ceiling assembly meet the Prescriptive Path for that climate zone and heating system be controlled by a thermostat having a maximum setpoint capacity of 55 degrees F. If you qualify for this exception, check the Exception box and box 2, and complete the Prescriptive Path form (Form 3b) to show you meet the roof/ceiling requirement.

BUILDING ENVELOPE – GENERAL

Section 1312, Exception 3 is for windows installed in demising walls. If you qualify for this exception, check the Exception box and box 3.

Section 1312, Exception 4 is for buildings whose sole source of space conditioning energy is from on-site solar or wind resources. If you qualify for this exception, check the Exception box and box 4.

Section 1312, Exception 5 is for greenhouses intended primarily for plant propagation. If you qualify for this exception, check the Exception box and box 5.

Example

2. Air Leakage (Section 1312.1.1)

☑ **Complies**. Plans require penetrations in building envelope are sealed and windows and doors are caulked, gasketed or weatherstripped.
The plans/specs show compliance in the following locations:

Drawing A-6 and specifications section 08710.4.a

Line 2. Air Leakage

Complies. The code requires that all penetrations or through openings in the building envelope be caulked, gasketed, weatherstripped, or otherwise sealed to limit infiltration and exfiltration. Exterior joints around windows and door frames, between wall cavities and window or door frames, between wall and foundation, between wall and roof, between wall panels, at penetrations or utility services through walls, floors and roofs, and all other openings in the exterior envelope shall be sealed in a manner approved by the building official. If the building plans specify how this requirement is met, check the Complies box and indicate where on your plans and specifications you show compliance with this requirement.

Example

3. Suspended Ceiling (Section 1312.1.2.1)

☑ **Complies**. Building plans do not show suspended ceilings used to separate conditioned space from unconditioned space. No exceptions permitted.

Line 3. Suspended Ceiling

Complies. Since suspended ceilings are not permanent building features, placing insulation over (directly on top of) suspended ceilings does not qualify as exterior building envelope insulation. If the requirement is met, check the Complies box.

Example

4. Recessed Light Fixtures (Section 1312.1.2.2)

☐ **Complies**. The building plans do not show recessed light fixtures installed in ceilings separating conditioned spaces from unconditioned spaces.

☑ **Exception.** The building plans require that fixtures installed in direct contact with insulation be insulation coverage (IC) rated. The plans/specs show compliance in the following locations:

Drawing E-3, Luminaire Schedule and specifications section 16000.4.a

Line 4. Recessed Light Fixtures

Complies. The code prohibits, with one exception, recessed light fixtures installed in ceilings separating conditioned space from unconditioned space. If your building plans comply with this requirement, check the Complies box. An example of a ceiling that complies is a ceiling with recessed fixtures, with insulation on top of the roof deck or located in the roof structure and not in contact with, or penetrated by light fixtures.

Exception. Light fixtures with an insulation coverage (IC) rating may have insulation placed on top of them. If your building plans

specify IC-rated fixtures in an insulated ceiling, check the Exception box and indicate where on your plans and specifications you show compliance with this requirement. Placing insulation on non-IC-rated fixtures is a fire hazard.

Example

5. Moisture Control (Section 1312.1.4)

☐ **Complies**. A one-perm vapor retarder is installed on the warm side (in winter) of all exterior floors, walls and ceilings, and a ground cover installed in the crawl space of both new and existing buildings where insulation is installed.
The plans/specs show compliance in the following locations:

☑ **Exception.** All new or altered building envelope components do not comply with the vapor retarder requirements of the code, but qualify for an exception. Note applicable exception.
Section 1312.1.4, Exception: ☑ -1 ☐ -2
Portions of the building that comply:

North wing, ground floor

Line 5. Moisture Control

Complies. If your plans specify a one-perm vapor retarder on the warm side (in winter) in all exterior floors, walls and ceilings, and a ground cover in the crawl space (if applicable), check the Complies box and indicate where on your plans and specifications you show compliance with this requirement. The ground cover shall be installed as specified in Section 1312.1.4.

Exception. There are several exceptions to the requirements for vapor barriers: 1) Masonry walls with exposed interior surfaces. If your building qualifies for this exception, check the Exception box, and box 1, as the basis for the exception.

2) Slab-on-grade floors. If your building qua-lifies for this exception, check the Exception box and, and box 2, as the basis for the exception.

The building official may accept designed moisture-control systems that may include vapor barriers, ventilation, dehumidification or combinations of these. If you think you qualify for this exception, check with your permit granting agency. The building official also may require designed moisture-control systems for refrigerated buildings, buildings covering swimming pools, or similar buildings with unusual potential for moisture damage.

Example

6. Climate Zones

☑ **Zone 1 -** A building site is in Climate Zone 1 if its elevation is less than 3000 feet above sea level and it is in one of the following counties: Benton, Columbia, Clackamas, Clatsop, Coos, Curry, Douglas, Jackson, Josephine, Lane, Lincoln, Linn, Marion, Multnomah, Polk, Tillamook, Yamhill, or Washington.

☐ **Zone 2 -** Building sites not in Zone 1, or where construction site elevation is 3000 feet or higher in Zone 1, are in Zone 2.

Line 6. Climate Zones

Zone 1 - Indicates building is sited in climate zone 1. Zone 1 requirements in Form 3b must be used to show compliance with the prescriptive path.

Zone 2 - Indicates building is sited in climate zone 2. Zone 2 requirements in Form 3b must be used to show compliance with the prescriptive path

Excel Spreadsheet Note: You must select either Zone 1 or Zone 2 or the algorithms on Form 3b will not function properly.

BUILDING ENVELOPE – PRESCRIPTIVE PATH

Form 3b Instructions

Example

	Window Area (total rough frame ft2)		Exterior Wall Area (gross ft2)		Glazing %	Maximum Glazing Fraction Complies
Conditioned Space	3,000	÷	20,000	X 100 =	15.0%	Yes
Semi-Conditioned Space	0	÷	10,000	X 100 =	0.0%	Yes
Conditioned Mechanical Penthouse		÷		X 100 =	0.0%	Yes

Check the appropriate checkbox for the Climate Zone where the project is located.

Excel Spreadsheet Note: There are **four** worksheets/pages that must be completed for Form 3a. Unless an "other" wall type requires a description, there may be nothing to complete on Form 3b-2.

Based on the selection made on the bottom of Form 3b, The appropriate Climate Zone will propagate on Form 3b.

More than one glazing percent needs to be calculated whenever glazing is installed in two or more different conditions: the glazing percent in conditioned space, the glazing percent in semi-conditioned space or glazing percent in conditioned mechanical penthouse.

The window area consists of the entire window assembly (glass and framing) in square feet. Enter the total area of all windows in exterior walls in the first box (Window Area).

The total building exterior wall area includes all elements that separate conditioned spaces from the exterior. Enter this gross exterior wall area in the second box (Total Building Exterior Wall Area). Do not subtract windows and doors from this area.

Glazing Percent Calculation

Divide "total building window area" by "total building exterior wall area." Multiply this sum by 100 and insert value into third box (Glazing Percent).

Repeat calculation for Semi-Conditioned Space if applicable.

Repeat calculation for Conditioned Mechanical Penthouse if applicable.

Excel Spreadsheet Note: The user only needs to enter applicable Window Area and gross Exterior Wall Area. The Glazing Percentage and Compliance with Maximum Glazing Fraction will automatically propagate. Maximum Glazing Fraction Compliance **IS NOT** tied to compliance with U-factor or Shading Coefficient. This compliance is determining maximum window area allowed for your Climate Zone. **This glazing Fraction DOES NOT take into consideration which prescriptive window performance or wall type is used.**

Window (from Worksheet 3d)	Max U-Factor[1]	Minimum Assembly
N/A	N/A	☑
U-Value Complies	N/A	
Required Minimum Assembly (Fixed Windows)	Double-glazed with 0.5 inch airspace, low-e coating, alum frame	
Required Mini-mum Assembly (Operable Windows and Curtainwall)	Double-glazed window with a 0.5 inch air space, low-e coating and thermally broken frame	

Example

Window (from Worksheet 3d)	Shading Coefficient[2]	Minimum Assembly
Storefront	0.530	☐
SC Complies	Yes	
Required Minimum Assembly	N/A	

BUILDING ENVELOPE – PRESCRIPTIVE PATH

Windows

Windows

The U-factor (Thermal Performance) requirement is for overall window. The Shading Coefficient (SC) requirement is based on a center-of-glass value.

There are three options for complying with window U-Factor and SC code requirements.

NFRC Certification
Windows may have U-factor and SHGC determined by the NFRC Rating, Certification and Labeling program. SHGC value can be converted to SC values using the equation, SHGC/0.87=SC. Center of glass SC values may also be obtained from manufacturer data.

Default Tables
U-factor and SC values can be found in Table 3e and 3f. Values these tables are from ASHRAE Handbook, 2001, Fundamentals. Center of Glass U-factors shall have factors adjusted for specific type of window frame.

Minimum Assembly (MA)
Windows comply with either U-factor and SC requirements if they meet the descriptions provided in Notes 7, 10, 11 and 12 in Form 3b, page 3-3. This description is called "MA" (Minimum Assembly).

Worksheet 3d must be completed, which describes all windows in a project. Both U-factor (or matching MA) AND Shading Coefficient (or matching MA) must comply for the "worst case" window.

All glazing used in a project must be listed in Worksheet 3d. If there is more than one type of glazing used, each type of glazing must comply. If a project contains both Fixed and Operable or Curtainwall, assure that both operator styles meet the MA requirements. A combination of Fixed may comply with MA and Operable/Curtainwall may comply with overall U-factor.

In either the Required Minimum Assembly for Fixed Windows or Operable Windows/ Curtainwall, write-in the complying description for that product from the applicable Notes at the bottom of page 3-3.

For "Shading Coefficient," either write-in "MA" (if applicable AND acceptable for that product) or provide the highest center-of-glass SC value from Worksheet 3d.

Code-required fire-rated windows and other windows that constitute no more than one percent of exterior wall area can be exempt from U-factor and SC requirements.

***Window Area Percentage cannot exceed maximum window percentage allowed for corresponding wall type with lowest allowable percentage*.**

Excel Spreadsheet Note: The user must complete Worksheet 3d to describe all windows in the project. You have the option of using the values provided (overall U and center SC) to determine compliance OR check the Minimum Assembly checkbox if it is applicable/acceptable for this product.

Walls

Walls

Example

Wall / Insulation Type	R-Value Insulation Only		U-Factor[3]
CMU Masonry, w/integral loose fill insulation		or	MA
Frame (wood or metal framing)	13	or	
		or	
		or	
		or	
		or	

BUILDING ENVELOPE – PRESCRIPTIVE PATH

Walls (Cont.)

Enter energy conservation requirements for each exterior wall assembly in building. Wall/Insulation Types are described on Form 3b, Part 2 of 4, page 3-3. Write-in under Wall/Insulation Type each wall in proposed building. Write-in a short description for "Other" Wall Types (see example). Exterior walls include those separating conditioned from unconditioned spaces. Walls separating conditioned from semi-heated space are also considered exterior walls.

There are two compliance options for each exterior wall assembly: Insulation R-value *or* wall assembly U-factor. Insulation R-value is for the insulation only. Appropriate Worksheet(s) 3a must be completed for each wall assembly U-factor entered on Forms 3b. It is not necessary to enter both Insulation R-value and Component U-factor. Each wall assembly must comply with code.

If there are similar wall types, wall with highest U-factor can be submitted as the representative value. Example: 4-inch steel stud, 16-inches on-center, R-13 batt insulation; one assembly with wood siding and the second assembly with brick veneer. The wall assembly with wood siding can be the representative value for both types of construction.

Except for below-grade walls, every wall on this form has a maximum allowed glazing percent. The amount of glass for any wall type cannot exceed maximum allowed for wall type with lowest allowed glazing percentage. Example: Building has CMU walls with open cells insulated (up to 15% window allowed, Zone 1) and 2x6 wood framing with R-19 batt (up to 30% windows allowed, Zone 1). Total exterior window area in this building cannot exceed 15 percent of total exterior wall area.

If a building does not comply with Prescriptive Path requirements, or cannot be redesigned to pass, the Simplified Trade-off Approach using CodeComp software is the alternative methodology to determine compliance.

Insulation R-values shall be taken from the tables on page 3 of these forms. When not listed in these tables, value may be taken from 2001 ASHRAE Handbook of Fundamentals. When not listed in either the tables or ASHRAE, submit manufacturer's literature including certified test reports to the building official for approval.

Masonry, Integral w/Loose Fill

Minimum Assembly wall: 8-inch CMU with at least 50% of the cores filled with vermiculite or equivalent fill insulation. If proposed wall meets or exceeds this construction, "MA" can be written-in the U-Factor column (see Example).

Most CMU walls, 8 inches thick or thicker, with perlite or vermiculite insulation in all unreinforced cells, meet the requirements for this wall. Except in rare cases having large numbers of reinforced and grouted cells, there should be no need to calculate the percent of insulated cells, as long as specifications require that unreinforced cells are not grouted. The percent of insulated cells was set low to avoid this calculation.

Other qualifying walls of this type are 10-inch or 12-inch CMU walls with integral loose-fill insulation or any qualifying wall with an applied exterior or interior insulation layer.

CMU walls less than 8 inches thick do not meet the requirement for 45 lb/ft^2 of wall weight and are not allowed. Table 3b in this chapter gives wall weights in lb/ft^2 of face area for building materials.

Masonry, Integral w/Rigid Fill

Minimum Assembly wall: 8-inch CMU. Each block has a pre-installed, individually molded insert of expandable polystyrene. With insert in place, the insulated non-grouted unit should have a maximum U-factor of 0.21 in Zone 1 and 0.16 in Zone 2, assuming a density of 100 lb/ft^3 for the concrete used in the block. CMU walls less than 8 inches thick do not meet the 45 lb/ft^2 weight requirement and are not allowed. If proposed wall meets or exceeds this construction, "MA" can be written in the U-Factor column.

Enter the U-factor for your wall on line 2, column (e). You must demonstrate this U-factor by showing test reports or engineering calculations. Calculations must account for grouted cells. Several products are available that meet or exceed the U-factor requirement for this wall. Note that all cells (except bond beams) must be insulated.

BUILDING ENVELOPE – PRESCRIPTIVE PATH

Walls (Cont.)

Masonry or Concrete w/Interior Insulation

Minimum Assembly wall: Walls equal to or greater than 4-inch concrete or 8-inch CMU with 4-inch metal stud furring on inside. R-11 fiberglass batt insulation is required in Zone 1 and R-13 insulation in Zone 2.

A CMU wall does not require insulating the block itself. All insulation is within a furred interior cavity. Any interior, continuous rigid insulation with the required R-value or assembly U-factor also qualifies.

Concrete walls less than 4 inches thick or CMU walls less than 8 inches thick do not meet the 45-lb/ft^2 wall weight requirement and are not allowed.

If your R-value meets or exceeds the requirement, enter the value in the cell under proposed R-value. Otherwise, attach Worksheet 3a with wall U-factor calculations.

Masonry or Concrete w/Continuous Exterior Insulation

Minimum Assembly wall for up to and including 15 percent glazing fraction: Concrete or CMU wall with a minimum weight of 45 lbs per square foot with continuous insulation board, R-1.4 in Zone 1 and R-2.8 in Zone 2. Insulation requirement can be met with 1/2-inch cellular glass insulation board (R-2.86/inch) in Zone 1, and 1-inch molded polystyrene board (R-3.85/inch) in Zone 2.

Minimum Assembly wall for up to and including 40 percent glazing fraction: Concrete or CMU wall with a minimum weight of 45 lbs. per square foot with continuous insulation board, R-2.8 in Zone 1 and R-4.3 in Zone 2. Insulation requirement can be met with 1-inch cellular glass insulation board (R-2.86/inch) in Zone 1 and 1½-inch molded polystyrene board (R-3.85/inch) in Zone 2.

The insulation on this wall type must be continuous over entire wall area. If R-value meets or exceeds requirement, enter value in cell under proposed R-value. Otherwise, attach Worksheet 3a with your wall U-factor calculations and enter the calculated number in U-factor column.

Frame

Minimum Assembly wall, Zone 1: 4-inch (nominal) metal studs with R-13 fiberglass batt insulation in all framing cavities.

Minimum Assembly wall, Zone 2: 6-inch (nominal) metal studs with R-19 fiberglass batt insulation in all framing cavities.

Any frame wall, regardless of framing material, thickness, spacing of framing, or finish material, qualifies as long as cavity insulation satisfies R-value requirement.

If R-value meets or exceeds requirement, enter value in the cell under proposed R-value. Otherwise, attach Worksheet 3a with wall U-factor calculations.

Other

This covers any leftover, oddball wall types, e.g., prefabricated metal panels, sandwich panels of pre-cast concrete, and structural insulated panels.

If R-value meets or exceeds requirement, enter value in the cell under proposed R-value. Otherwise, attach Worksheet 3a with wall U-factor calculations.

Example

Below-Grade Walls	R-Value Insulation Only (Min. R-7.5)		U-Factor[3] (Max. 0.11)
Continuous rigid board insulation	7.5	or	

Below-Grade Walls

Below-grade Walls

The only way to comply with this requirement is to meet or exceed requirement for R-7.5 insulation. This insulation can be a continuous rigid board or insulation placed inside or outside the wall, or insulation placed within a furred wall, e.g., R-13 insulation in a 4-inch furred interior cavity.

BUILDING ENVELOPE – PRESCRIPTIVE PATH

If R-value meets or exceeds requirement, enter value in the cell under proposed R-value.

Otherwise, attach Worksheet 3a with wall U-factor calculations.

Below-Grade Walls (cont.)

Example

Roof / Ceiling[11]	R-Value Insulation Only (Min. R-19)	or	U-Factor[12] (Max. 0.050)
2x10 wood joists, 24" o.c.	19	or	

Roof/Ceilings

Roof/Ceiling

Minimum Assembly roofs in both Zone 1 and Zone 2: is R-19 insulation. Any roof with R-19 insulation within framing or as a continuous layer meets code requirements.

It is possible to meet U-factor requirement by using a continuous insulation less than R-19, but compliance must be demonstrated on Worksheet 3b.

Example

	Skylight Area (total rough frame ft2)		Roof Area (gross ft2)		Skylight % [13]	Maximum Skylight Fraction Complies
Conditioned Space	280	÷	10,000	X 100 =	2.8%	Yes
Semi-Conditioned Space	0	÷	2,000	X 100 =	0.0%	Yes
Conditioned Mechanical Penthouse	25	÷	500	X 100 =	5.0%	Yes
	Skylight Area (total rough frame ft2)		Roof/Ceiling Area (gross ft2)		Skylight Percent[13]	

Skylights

Skylights

Skylight percentage, including glazed smoke vents (also referred to as “skylight”), must be calculated whenever skylight is installed in two or more different conditions: the skylight percent in conditioned space, the skylight percent in semi-conditioned space or skylight percent in conditioned mechanical penthouse.

The window area consists of the entire window assembly in square feet. Enter the total area of all windows in exterior walls in the first box (Conditioned Space Window Area).

Enter this gross roof/ceiling area in the second box (Total Roof/Ceiling Area).

Divide “total skylight area” by “total roof/ceiling area.” Multiply this sum by 100 and insert value into third box (Skylight Percent).

Glazing Percent Calculation

Repeat calculation for Semi-Conditioned Space.

Repeat calculation for Conditioned Mechanical Penthouse.

Excel Spreadsheet Notes: The user only needs to enter applicable Skylight Area and gross Exterior Roof Area. The Glazing Percentage and Compliance with Maximum Skylight Fraction will automatically propagate.

The combined skylight and glazed smoke vent area under conditioned space cannot exceed 6 percent of total roof area under Prescriptive Path approach. Use rough opening dimension for manufactured skylights. For other overhead glazing, use the area of the glazing and frame. There are three options for complying with window U-Factor and SC code requirements.

BUILDING ENVELOPE – PRESCRIPTIVE PATH

Skylights (Cont.)

NFRC Certification
Skylight may have horizontal U-factor and SHGC determined by the NFRC Rating, Certification and Labeling program. SHGC value can be converted to SC values using the equation, SHGC/0.87=SC. Center of glass SC values may also be obtained from manufacturer data.

Default Tables
U-factor and SC values can be found in Table 3e (second page) and 3f. Values in these tables are from ASHRAE Handbook, 2001, Fundamentals. Skylight U-factor is for overall assembly in the overhead position

Minimum Assembly (MA)
Minimum Assembly skylight in both Zone 1 and Zone 2: double-glazed, with a 0.5-inch air space and one pane tinted. Any skylight with these or better properties meets code requirements. Examples of better thermal properties are low-e coating, glazing with insulated spacers, thermal break frames and gas fills.

Worksheet 3e must be completed, which describes all skylights in a project. Both U-factor (or matching MA) AND Shading Coefficient must comply for the "worst case" skylight.

All skylights and glazed smoke vents used in a project must be listed in Worksheet 3e. If there is more than one type of skylight used, each type of skylight must comply.

If project has more than 6 percent skylights, the Simplified Trade-off Approach using CodeComp software is an alternate compliance method.

Excel Spreadsheet Note: The user must complete Worksheet 3e to describe all skylights in the project. You have the option of using the values provided (overall U-factor) to determine compliance OR check the Minimum Assembly checkbox if applicable/acceptable for this product.

Example

Floors over Unconditioned Spaces[16]	R-Value Insulation Only		U-Factor
Floors over Unconditioned Spaces	11	or	

Heated Concrete Slab Edge	R-Value Insulation Only
Concrete slab, hydronic heat	7.5

Floors & Heated Slabs

Floors Over Conditioned Space

Minimum Assembly floor in both Zone 1 and Zone 2: R-11 insulation. Any floor with R-11 insulation within framing or as a continuous layer meets the code. It is possible to comply with U-factor requirement by using a continuous insulation panel less than R-11, but compliance must be demonstrated on Worksheet 3c.

Heated Concrete Slabs

The requirement for insulating slab edges applies only to heated slabs, i.e., slabs with embedded sources of heat such as electric coils or piping with circulating hot water.

Confirm and check the compliance box indicating that Insulation for heated slabs-on-grade extends downward from top of slab (24 inches min) or downward and under the slab for 24 inches or to the bottom of thickened slab edge. Above grade insulation should be protected from physical and solar damage. Non-heated slabs-on-grade do not have insulation requirements.

BUILDING ENVELOPE – PRESCRIPTIVE PATH

Code Requirement

Component	Compliance Options: Min. R-Value Insulation Only		Max. U-Factor
Floor over Unconditioned Spaces	11	or	0.070

Component	Climate Zone 1		Climate Zone 2
Heated Concrete Slab Edge, Min. R-Value	7.5	or	10.0

Doors

Doors

The code establishes a maximum U-factor requirement for doors other than entry/exit doors with a leaf width of 4 feet or less and overhead coil doors. U-factor requirement applies to center of door panel (U-0.20 or R-5).

Most insulated overhead and sliding doors use polyurethane or polystyrene insulation and meet these requirements. If these doors (not doors with a leak width of 4 feet or less) are glazed, they must be included with Windows and must comply with Window U-factor and SC requirements.

Definitions

BUILDING ENVELOPE (EXTERIOR ENVELOPE) is that element of a building that encloses conditioned spaces through which thermal energy may be transmitted to or from the exterior or to or from unconditioned spaces.

CLIMATE ZONE. One of two geographic areas of the state with similar winter climate conditions. A building site is in Climate Zone 1 if its elevation is less than 3,000 ft above sea level and it is within one of the following counties: Benton, Columbia, Clackamas, Clatsop, Coos, Curry, Douglas, Jackson, Josephine, Lane, Lincoln, Linn, Marion, Multnomah, Polk, Tillamook, Yamhill or Washington. Building sites not in Zone 1 are in Zone 2.

GROSS AREA OF EXTERIOR WALLS consists of wall areas, as measured on the exterior, including foundation walls above grade; peripheral edges of floors; window areas, including sash; and door areas, where such surfaces are exposed to outdoor air and enclose a heated or mechanically cooled space. This includes wall(s) separ-ating conditioned from semi-heated spaces.

HEATED SLAB ON-GRADE is a concrete slab on-grade with embedded electric heating coils or embedded piping designed to carry a heated circulating fluid.

SEMI-CONDITIONED SPACES, CLIMATE ZONE 1: Spaces that have a heating system output capacity that does not exceed 15 Btu/hr.ft.2 (43 W/m2) or 4 Watts/ft.2 (43 W/m2) of heated floor area and where each heating system is controlled by a thermostat with a maximum setpoint capacity of 45ºF (7ºC), mounted no lower than heating unit.

SEMI-CONDITIONED SPACES, CLIMATE ZONE 2: Spaces that have a heating system output capacity that does not exceed 20 Btu/hr.ft.2 (64 W/m2) or 6 Watts/ft.2 (64 W/m2) of heated floor area and where each heating system is controlled by a thermostat with a maximum setpoint capacity of 45ºF (7ºC), mounted no lower than heating unit.

THERMAL BREAK is a non-metallic element of low heat conductivity placed in such a way as to eliminate all contact between interior and exterior framing members. Some metal-framed windows are designed with thermal breaks to improve their overall thermal performance.

THERMAL RESISTANCE (R) is the measure of the resistance of a material or building component to the passage of heat, has the value of (hr- ft2-ºF)/Btu, and is the reciprocal of thermal conductance.

THERMAL TRANSMITTANCE (U) is the coefficient of heat transfer. It is the time rate of heat flow per unit area under steady state conditions from the fluid on the warm side of the barrier to the fluid on the cold side, per unit temperature difference between the two fluids, Btu/(hr-ft2-ºF)

WALL FRAMING & INSULATION R-VALUES

Wall Framing

This table can be used to find R-value for wall framing with insulation. Values can be added to R-values of other layers to calculate total R-value (Rt) of wall.

Wood framing values are based on 20 and 15 percent framing factors for 16- and 24-inch spacing with compression of insulation if necessary. Framing factor is the percentage of a wall surface backed by framing. R-value for wood is based on fir, pine and similar softwood.

Metal framing values from ASHRAE 90.1-1999 Table 402.1.2.1b

Type of Framing	Spacing	Insulation R-value	Effective R-value
Wood, 2x2.	16" o.c	5	3.75
		7	4.55
	24" o.c.	5	4
		7	4.97
Wood, 2x4	16" o.c.	11	8.47
		13	9.36
		15	10.13
	24" o.c.	11	8.99
		13	10.06
		15	11.03
Wood, 2x6	16" o.c.	19	13.64
		21	14.94
	24" o.c.	19	14.52
		21	16.1
Wood, 2x8	16" o.c.	19	15.81
		21	16.88
		30	20.51
	24" o.c.	19	16.5
		21	17.75
		30	22.13
Metal[1], 2x4	16" o.c.	11	5.5
		13	6
	24" o.c.	11	6.6
		13	7.2
Metal[1], 2x6.	16" o.c	19	7.1
	24" o.c.	19	8.6

Notes

[1] Insulation specified shall be full-width batts to accommodate full module spacing afforded by metal framing.

Cavity Filled

Some R-values are not included because Oregon code requires wall cavities 6-inches or less be filled completely.

ROOF & FLOOR FRAMING R-VALUES

Type of Framing	Spacing	Insulation R-value	Effective R-value
Wood, 2x6	16" o.c.	11	10.39
		13	11.95
		15	13.44
		19	15.52
		21	17.46
	24" o.c.	11	10.63
		13	12.35
		15	14.02
		19	16.43
		21	18.72
Wood, 2x8	16" o.c.	13	12.53
		19	17.26
		25	20.12
	24" o.c.	13	12.71
		19	17.91
		25	21.18
Wood, 2x10	16" o.c.	19	17.95
		25	22.55
		30	26.07
		38	31.21
	24" o.c.	19	18.35
		25	23.47
		30	27.51
		38	33.61
Wood, 2x12	16" o.c.	19	18.43
		25	23.31
		30	27.1
		38	32.7
	24" o.c.	19	18.65
		25	23.96
		30	28.19
		38	34.63

Roof/Ceiling & Floor Framing

Use this table to find the R-value for insulation and framing in roofs, ceilings or floors. The values in this table can be added to R-values of other layers to calculate total effective R-value of framing assembly.

Wood framing values are based on 10 and 6 percent framing factors for 16- and 24-inch spacing with compression of insulation if necessary. R-value for wood is based on fir, pine and similar softwood.

ROOF & FLOOR FRAMING R-VALUES

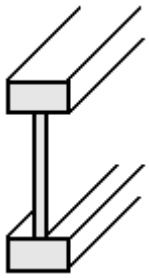
Roof/Ceiling & Floor Framing

Use this table to find R-value for framing and framing cavity in roofs, ceilings or floors. The values in this table can be added to R-values of other layers to calculate total effective R-value of framed assembly.

For compressed type batt insulation, see page 3-25 for effective U-factors.

Metal truss values from ASHRAE 90.1-1999, Table 402.1.2.1a. Values are based on 0.66-inch diameter cross members every one foot.

Engineered wood composite I-beams (e.g., "silent floor") are composite wood materials with an I-beam cross section. These are typically made of strandboard or plywood with small dimensional lumber on top and bottom cords.

Type of Framing	Spacing	Insulation R-value	Effective R-value
Metal Truss	4'0" o.c. or greater	5	4.8
		10	9.2
		15	13.2
		20	17
		25	20.3
		30	23.7
		35	26.6
		40	29.2
Engineered wood composite. I-beam 	16" o.c.	11	10.2
		13	12
		19	17.5
		25	23
		30	27.6
	24" o.c.	11	10.5
		13	12.3
		19	18
		25	23.7
		30	28.4
	48" o.c.	11	10.7
		13	12.7
		19	18.5
		25	24.3
		30	29.2

BUILDING MATERIAL R-VALUES

Description	Detail	R-value	lb/ft^2
Building Board			
Cement Board			
Asbestos-cement board	0.125"	0.03	1.25
Asbestos-cement board	0.25"	0.06	2.50
Cement board	0.375”	0.09	3.75
Ceiling Finishes			
Acoustic tile	3/8” mineral fiberboard	0.95	0.56
Acoustic tile	¾” mineral fiberboard	2.48	1.31
Gypsum or Plaster board			
Gypsum or plaster board	0.375"	0.32	1.56
Gypsum or plaster board	0.5"	0.45	1.56
Gypsum or plaster board	0.625"	0.56	2.60
Hardboard			
Medium density	¼”	1.37	4.17
High density service grade	¼”	1.22	4.58
High density standard grade	½”	1.00	5.25
Particleboard			
Low density	1” (per inch value)	1.41	3.08
Medium density	1” (per inch value)	1.06	4.17
High density	1” (per inch value)	0.85	2.20
Underlayment	5/8” underlayment	0.82	2.08
Waferboard	1” (per inch value)	1.59	3.08
Plywood			
Plywood (Douglas Fir)	0.25"	0.31	0.71
Plywood (Douglas Fir)	0.375"	0.47	1.06
Plywood (Douglas Fir)	0.5"	0.62	1.42
Plywood (Douglas Fir)	0.625"	0.77	1.77
Plywood (Douglas Fir)	0.75"	0.93	2.13
Vegetable Fiber Board			
Sheathing, regular density	0.5"	1.32	0.75
Sheathing, regular density	0.78125"	2.06	1.17
Sheathing intermediate density	0.5"	1.09	0.92
Nail-base sheathing	0.5"	1.06	1.04
Shingle backer	0.375"	0.94	0.56
Shingle backer	0.3125"	0.78	0.47
Sound deadening board	0.5"	1.35	0.63
Tile and lay-in panels, plain or acoustic	0.5"	1.25	0.75
Tile and lay-in panels, plain or acoustic	0.75"	1.89	1.13
Laminated paperboard		2.00	2.50
Homogeneous board from repulped paper		2.00	2.50
Building Membrane			
Vapor permeable felt		0.06	-
Vapor seal	2 layers of mopped 15lb felt	0.12	-
Finish Flooring Materials			
Floor Finishes			
Carpet	fibrous pad	2.08	-
Carpet	rubber pad	1.23	-
Cork tile		0.28	-
Terrazzo		0.08	11.67
Tile ceramic		0.05	-
Wood, hardwood finish		0.68	2.00

Insulating Materials

Description	Detail	R-value	Lb/ft^2
Batt and blanket insulation - uncompressed			
Mineral fiber batt	2 to 2.75"	7	0.25
Mineral fiber batt	3 to 4"	11	0.30
Mineral fiber batt	3.5"	13	0.35
Mineral fiber batt	3.5"	15	0.40
Mineral fiber batt	5.5 to 6.5"	19	0.60
Mineral fiber batt	5.5"	21	0.65
Mineral fiber batt	6 to 7.5"	22	0.65
Mineral fiber batt	8.25 to 10"	30	0.95
Mineral fiber batt	10 to 13"	38	1.20
Board and slab insulation			
Cellular glass 1"	1”	3.03	0.67
Glass fiber, organic bonded 1"	1”	4	0.50
Expanded perlite, organic bonded 1"	1”	2.78	0.09
Expanded rubber (rigid) 1"	1”	4.55	0.35
Foamed urethane board 1"	1”	7.15	0.54
Fiberglass urethane board 1"	1”	5.56	0.36
Polystyrene, extruded (smooth skin)	1", 1.8 to 3.5 lb/ft3	5	0.22
Expanded polystyrene, molded beads	1", 1.0 lb/ft3	3.85	0.08
Expanded polystyrene, molded beads	1", 1.25 lb/ft3	4	0.10
Expanded polystyrene, molded beads	1", 1.5 lb/ft3	4.17	0.13
Expanded polystyrene, molded beads	1", 1.75 lb/ft3	4.17	0.15
Expanded polystyrene, molded beads	1", 2.0 lb/ft3	4.35	0.17
Cellular polyisocyanurate	1", with foil face, 2.0 lb/ft3	7.04	0.17
Cellular polyisocyanurate	1", gas-perm. facers, 1.5 lb/ft3	5.56	0.13
Cellular polyisocyanurate	1" unfaced, 1.5 lb/ft3	5.56	0.13
Cellular phonolic	1", 3.0 lb/ft3 closed cell	8.2	0.25
Cellular phonolic	1", 1.8 to 2.2 lb/ft3 open cell	4.4	0.16
Mineral fiber	1", 15.0 lb/ft 3 with resin binder	3.45	1.25
Mineral fiber	1", 16 to 17 lb/ft3 , not felted	2.94	1.35
Cement fiber slabs (shredded wool)	1", 25 to 27 lb/ft3 with Portland cement	1.89	2.12
Cement fiber slabs (shredded wool)	1", 22 lb/ft3 with magnesia oxysulfide	1.75	1.86
Loose fill			
Cellulosic (milled paper and wood pulp)	1" loose fill	3.2	0.24
Mineral fiber (rock, slab or glass)	approx. 3.75 to 5", 0.6 to 2.0 lb/ft3	11	0.40
Mineral fiber (rock, slab or glass)	approx. 6.5 to 8.75", 0.6 to 2.0 lb/ft3	19	0.80
Mineral fiber (rock, slab or glass)	approx. 7.5 to 10", 0.6 to 2.0 lb/ft3	22	1.00
Mineral fiber (rock, slab or glass)	approx. 10.25 to 13.75 ", 0.6 to 2.0 lb/ft3	30	1.20
Perlite, expanded	1", 7.4 to 11.0 lb/ft3	2.4	0.48
Vermiculite	1" exfoliated 7 to 8.2 lb/ft3	2.13	0.63
Vermiculite	1" exfoliated 4 to 6 lb/ft3	2.27	0.42
Spray applied			
Ureaformaldehyde foam	1" sprayed, 0.7 to 1.6 lb/ft3	3.57	0.07
Cellulosic fiber	1" spray applied	2.94	0.30
Polyurethane foam	1" sprayed	5.56	0.20
Glass fiber	1" sprayed		0.30

BUILDING MATERIAL R-VALUES

Masonry Materials

Description	Detail	R-value	lb/ft^2
Brick			
Brick, fired clay, 6-inches	150 lb/ft3	0.65	75
Brick, fired clay, 4-inches	140 lb/ft3	0.49	45
Brick, fired clay, 6-inches	140 lb/ft3	0.73	70
Brick, fired clay, 6-inches	130 lb/ft3	0.85	65
Brick, fired clay, 4-inches	120 lb/ft3	0.65	40
Brick, fired clay, 6-inches	120 lb/ft3	0.97	60
Brick, fired clay, 6-inches	110 lb/ft3	1.11	55
Brick, fired clay, 6-inches	100 lb/ft3	1.29	50
Brick, fired clay, 6-inches	90 lb/ft3	1.52	45
Brick, fired clay, 6-inches	80 lb/ft3	1.79	40
Brick, fired clay, 6-inches	70 lb/ft3	2.14	35
Concrete			
h.w. aggregate concretes, 6-inches	150 lb/ft3 Sand & gravel or stone	0.40	75
h.w. aggregate concretes, 6-inches	140 lb/ft3 Sand & gravel or stone	0.44	70
h.w. aggregate concretes, 6-inches	130 lb/ft3 Sand & gravel or stone	0.60	65
Limestone concrete h.w., 6-inches	140 lb/ft3	0.54	70
Limestone concrete m.w., 6-inches	120 lb/ft3	0.76	60
Limestone concrete l.w., 6-inches	100 lb/ft3	1.09	50
Gypsum-fiber concrete	6 inches thick	3.61	25.5
Cement/lime, mortar, and stucco m.w., 6”	120 lb/ft3	0.62	60
Cement/lime, mortar, and stucco l.w., 6”	100 lb/ft3	0.90	50
Cement/lime, mortar, and stucco l.w., 6”	80 lb/ft3	1.33	40
l.w. aggregate concretes, 6-inches	120 lb/ft3	0.77	60
l.w. aggregate concretes, 6-inches	100 lb/ft3	1.10	50
l.w. aggregate concretes, 6-inches	80 lb/ft3	1.62	40
l.w. aggregate concretes, 6-inches	60 lb/ft3	2.61	30
l.w. aggregate concretes, 6-inches	40 lb/ft3	4.62	20
Perlite, vermiculite, and polystyrene beads	50 lb/ft3 – 6 inches thick	3.24	25
Perlite, vermiculite, and polystyrene beads	40 lb/ft3 – 6 inches thick	4.14	20
Perlite, vermiculite, and polystyrene beads	30 lb/ft3 – 6 inches thick	5.46	15
Perlite, vermiculite, and polystyrene beads	20 lb/ft3 – 6 inches thick	7.50	10
Foam concretes, 6-inches	120 lb/ft3	1.11	60
Foam concretes, 6-inches	100 lb/ft3	1.46	50
Foam concretes, 6-inches	80 lb/ft3	2.00	40
Foam concretes, 6-inches	70 lb/ft3	2.40	35
Foam concretes and cellular concretes	60 lb/ft3 – 6 inches thick	2.86	30
Foam concretes and cellular concretes	40 lb/ft3 – 6 inches thick	4.27	20
Foam concretes and cellular concretes	20 lb/ft3 – 6 inches thick	7.50	10
Clay tile, hollow			
Clay Tile, 3 inches, 1 Cell		0.8	17.5
Clay Tile, 4 inches, 1 Cell		1.11	23.33
Clay Tile, 6 inches, 2 Cell		1.52	35
Clay Tile, 8 inches, 2 Cell		1.85	46.67
Clay Tile, 10 inches, 2 Cell		2.22	58.33
Clay Tile, 12 inches, 3 Cell		2.5	70
Glass block			
4” thick block	8”x8”x4”	0.51	-

Plastering

Description	Detail	R-value	lb/ft^2
Gypsum plaster			
Cement plaster, sand aggregate	0.375"	0.08	3.63
Cement plaster, sand aggregate	0.75"	0.15	7.25
Gypsum plaster, lightweight aggregate	0.5"	0.32	1.56
Gypsum plaster, lightweight aggregate	0.625"	0.39	1.56
Gypsum plaster, lightweight aggregate on metal lath	0.75"	0.47	2.60
Perlite aggregate, sand aggregate	0.5"	0.09	4.38
Perlite aggregate, sand aggregate	0.625"	0.11	5.47
Perlite aggregate, sand aggregate on metal lath		0.13	-
Perlite aggregate, vermiculite aggregate		0.44	2.81

CMU Block

Concrete-filled cores may contain rebar or other reinforcements. Grout fill used is assumed to have a density of 140 lb/ff3.

R-values for CMU blocks are based on National Concrete and Masonry Association publication: "R-values for Single Wythe Concrete Masonry Walls, TEK 6-2A." Values are based upon the mid-range values.

Loose-fill insulation values are based on vermiculite.

Horizontal bond-beams (grout/steel) located every 48".

Description		Detail	R-Value	lbs/ft^2
CMU Block – Lightweight (100 lb/ft^3 concrete)				
6" block	all cores filled	solid grouted	0.70	55.81
8" block	48" o.c.	with no fill (hollow)	1.25	46.22
		with vermiculite fill	2.42	47.45
		with perlite fill	2.51	47.45
		with foamed-in-place fill	2.63	47.45
	40" o.c.	with no fill (hollow)	1.23	47.37
		with vermiculite fill	2.31	48.55
		with perlite fill	2.39	48.55
		with foamed-in-place fill	2.50	48.55
	32" o.c.	with no fill (hollow)	1.21	49.09
		with vermiculite fill	2.16	50.20
		with perlite fill	2.23	50.20
		with foamed-in-place fill	2.32	50.20
	24" o.c.	with no fill (hollow)	1.17	51.96
		with vermiculite fill	1.94	52.94
		with perlite fill	1.99	52.94
		with foamed-in-place fill	2.05	52.94
	16" o.c.	with no fill (hollow)	1.10	57.56
		with vermiculite fill	1.59	58.30
		with perlite fill	1.61	58.30
		with foamed-in-place fill	1.65	58.30
	all cores filled	solid grouted	0.90	74.91
12" block	48" o.c.	with no fill (hollow)	1.55	74.37
		with vermiculite fill	3.49	76.44
		with perlite fill	3.60	76.44
		with foamed-in-place fill	3.74	76.44
	40" o.c.	with no fill (hollow)	1.54	76.93
		with vermiculite fill	3.33	78.92
		with perlite fill	3.43	78.92
		with foamed-in-place fill	3.55	78.92
	32" o.c.	with no fill (hollow)	1.53	80.78
		with vermiculite fill	3.11	82.64
		with perlite fill	3.19	82.64
		with foamed-in-place fill	3.29	82.64
	24" o.c.	with no fill (hollow)	1.51	87.19
		with vermiculite fill	2.78	88.85
		with perlite fill	2.85	88.85
		with foamed-in-place fill	2.92	88.85

BUILDING MATERIAL R-VALUES

Description		Detail	R-Value	lbs/ft^2
12" block	16" o.c.	with no fill (hollow)	1.47	99.71
		with vermiculite fill	2.29	100.96
		with perlite fill	2.32	100.96
		with foamed-in-place fill	2.36	100.96
	all cores filled	solid grouted	1.35	115.40
CMU Block – Medium weight (120 lbs/ft^3 concrete)				
6" block	all cores filled	solid grouted	0.55	60.61
8" block	48" o.c.	with no fill (hollow)	1.02	52.49
		with vermiculite fill	1.85	53.72
		with perlite fill	1.88	53.72
		with foamed-in-place fill	1.95	53.72
	40" o.c.	with no fill (hollow)	1.00	53.63
		with vermiculite fill	1.77	54.82
		with perlite fill	1.80	54.82
		with foamed-in-place fill	1.87	54.82
	32" o.c.	with no fill (hollow)	0.98	55.36
		with vermiculite fill	1.66	56.47
		with perlite fill	1.69	56.47
		with foamed-in-place fill	1.74	56.47
	24" o.c.	with no fill (hollow)	0.94	58.22
		with vermiculite fill	1.50	59.21
		with perlite fill	1.52	59.21
		with foamed-in-place fill	1.56	59.21
	16" o.c.	with no fill (hollow)	0.88	63.83
		with vermiculite fill	1.24	64.57
		with perlite fill	1.25	64.57
		with foamed-in-place fill	1.27	64.57
	all cores filled	solid grouted	0.70	81.18
12" block	48" o.c.	with no fill (hollow)	1.30	83.69
		with vermiculite fill	2.70	85.75
		with perlite fill	2.75	85.75
		with foamed-in-place fill	2.83	85.75
	40" o.c.	with no fill (hollow)	1.29	86.30
		with vermiculite fill	2.59	88.29
		with perlite fill	2.64	88.29
		with foamed-in-place fill	2.71	88.29
	32" o.c.	with no fill (hollow)	1.28	90.22
		with vermiculite fill	2.43	92.08
		with perlite fill	2.47	92.08
		with foamed-in-place fill	2.53	92.08
	24" o.c.	with no fill (hollow)	1.26	96.75
		with vermiculite fill	2.20	98.41
		with perlite fill	2.23	98.41
		with foamed-in-place fill	2.28	98.41
	16" o.c.	with no fill (hollow)	1.22	109.50
		with vermiculite fill	1.83	110.76
		with perlite fill	1.85	110.76
		with foamed-in-place fill	1.88	110.76
	all cores filled	solid grouted	1.10	124.18

CMU Block (cont.)

Concrete-filled cores may contain rebar or other reinforcements. Grout fill used is assumed to have a density of 140 lb/ff3.

R-values for CMU blocks are based on National Concrete and Masonry Association publication: "R-values for Single Wythe Concrete Masonry Walls, TEK 6-2A." Values are based upon the mid-range values.

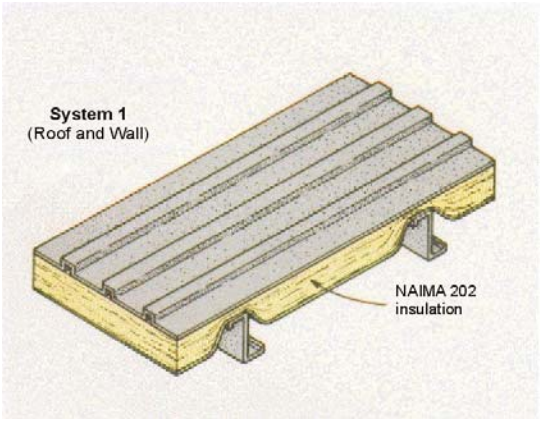
Loose-fill insulation values are based on vermiculite.

Horizontal bond-beams (grout/steel) located every 48".

BUILDING MATERIAL R-VALUES

	Description	Detail	R-Value	lbs/ft^2
Roofing	Roofing			
	Asbestos shingles	-	0.21	0.00
	Asphalt roll	-	0.15	0.00
	Asphalt shingles	-	0.44	0.00
	Built-up roofing	3/8”	0.33	2.19
	Slate	½”	0.05	0.00
	Wood shingles	Plain and plastic film faced	0.94	0.00
Siding Materials	Shingles			
	Asbestos-cement		0.21	7.50
	Wood	16", 7.5 exposure	0.87	1.30
	Wood double	16", 12" exposure asbestos-cement	1.19	2.30
	Wood "	Plus insulated backer board, 0.312"	1.40	2.00
	Siding			
	Asbestos-cement,	0.25" lapped	0.21	8.00
	Asphalt roll		0.15	10.00
	Asphalt insulating		1.46	-
	Hardwood	0.4375"	0.67	-
	Wood drop	0.125"	0.79	2.13
	Wood bevel	0.075"	0.81	1.30
	Wood bevel	0.0625"	1.05	2.00
	Wood plywood	0.375" lapped	0.59	1.00
	Aluminum, steel or vinyl	over sheathing hollow-backed	0.61	-
	Aluminum, steel or vinyl	over 0.375" shtg insul-board	1.82	-
	Aluminum, steel or vinyl	over 0.375"shtg insul-board foil bckd	2.96	-
	Architectural (soda-lime float) glass		-	3.29
Wood & Wood Products	Plywood			
	Plywood (Douglas Fir)	0.25"	0.31	0.71
	Plywood (Douglas Fir)	0.375"	0.47	1.06
	Plywood (Douglas Fir)	0.5"	0.62	1.42
	Plywood (Douglas Fir)	0.625"	0.77	1.77
	Plywood (Douglas Fir)	0.75"	0.93	2.13
	Woods			
	Hardwood finish		0.68	-
	Hardwood Oak		-	3.67
	Hardwood Birch		-	3.67
	Hardwood Maple		-	3.50
	Hardwood Ash		-	3.33
	Softwood Southern Pine		-	3.20
	Softwood Southern Douglas Fir-Larch		-	2.91
	Softwood Southern Cypress		-	2.65
	Softwood Hem-Fir, Spruce-Pine-Fir		-	2.33
	Softwood Coast Woods, Cedars		-	2.21
	Softwood California Redwood		-	2.19

METAL BUILDING U-FACTORS

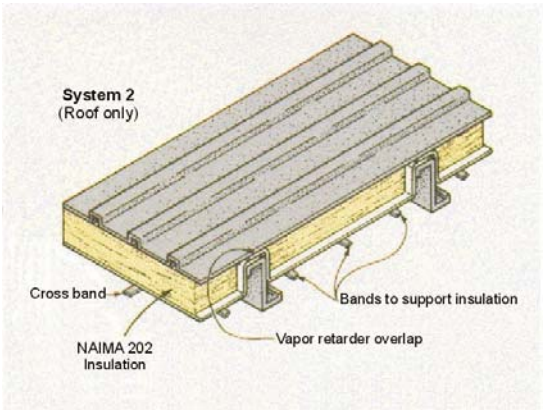


System 1

In this system, NAIMA 202 fiberglass blanket insulation is rolled out over, and perpendicular to the structural frame. The metal covering sheets are fastened to the frame, holding the insulation in place.

U-factors

R10	R11	R13	R-19
0.133	0.127	0.114	0.091

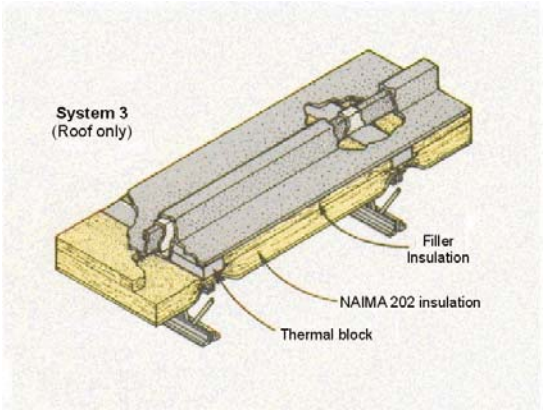


System 2

This method accommodates thicker insulation without compression at the structural members by applying the faced NAIMA 202 between the purlins rather than perpendicular to them. There is, however the problem of thermal bridging through the structural members in direct contact with the metal covering sheets.

U-factors

R10	R11	R13	R-19
0.131	0.123	0.107	0.079

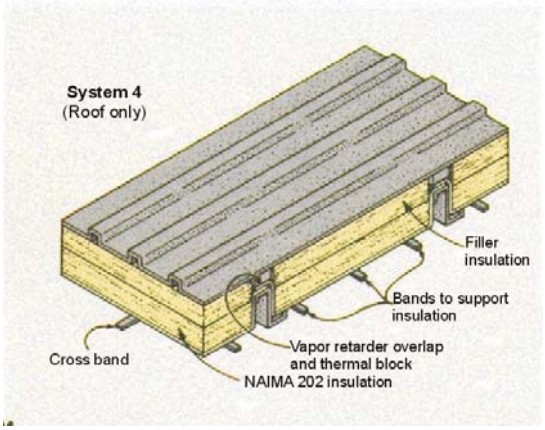


System 3

Vapor retarder faced NAIMA 202 insulation is installed over and perpendicular to the structure (joists or purlins) prior to applying the roof. Additional unfaced fiberglass blanket filler insulation can then be applied between the purlins and over the first later to fill the space formed by the roof sheet standoffs. Thermal blocks of rigid foam are placed over joists or purlins where faced insulation will be compressed.

U-factors

R10	R11	R13	R-19
0.102	0.096	0.084	0.065



System 4

This system uses a vapor retarder faced NAIMA 202 blanket between the purlins with the retarder overlapping on the top face of the purlins. Plain filler blanket is installed as a second layer, also between the purlins. Rigid foam thermal blocks are placed on top of the purlins to create a thermal break at the structural member.

U-factors

R10	R11	R13	R-19	R30
0.099	0.093	0.080	0.059	0.041

SURFACE & AIR SPACE R-VALUES

	Description	Detail	R-value	lb/ft²
Surfaces	Still air to surface			
	Wall		0.68	–
	Roof		0.61	–
	Floor		0.92	–
	Vaulted ceiling		0.62	–
Air Spaces	Moving air to surface			
	15 mph		0.17	–
	7.5 mph		0.25	–
	Walls	¾"	0.94	–
		1½"	0.9	–
		3½"	0.91	–
	Roofs	¾"	0.77	–
		1½"	0.8	–
		3½"	0.84	–
	Floors	¾"	1.02	–
		1½"	1.14	–
		3½"	1.22	–
	Vaulted Ceiling	¾"	0.82	–
		1½"	0.84	–
		3½"	0.86	–

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DEFAULT WINDOW U-FACTORS

Part 1 of 3

U-Factor

Values are based on the 2005 ASHRAE Handbook of Fundamentals, Table 30-4.

Interpolate between emissivities when needed. When manufacturer's data is not available, assume that glass with a pyrolytic (hard) coating has an emmisivity of 0.40 and glass with a sputtered (soft) coating has an emissivity of 0.10.

Krypton gas fills, or krypton/argon combinations can be substituted for argon.

For glazing airspace between ¼ inch and ½ inch, use ¼ inch.

For glazing airspace over ½ inch, use ½ inch.

Product Type	Glass Only	Operable					Fixed					Curtain Wall		
Frame Type	n/a	Alum w.o. Therm Break	Alum with Therm Break	Re-inforced Vinyl/ Alum Clad Wood	Wood/ Vinyl	Insul Fibrglas /Vinyl	Alum w.o. Therm Break	Alum with Therm Break	Re-inforced Vinyl/ Alum Clad Wood	Wood/ Vinyl	Insul Fibrglas /Vinyl	Alum w.o. Therm Break	Alum with Therm Break	Struct Glzg
Glazing Type	Cntr-of-Glass													
Single Glazing														
1/8 in. glass	1.04	1.27	1.08	0.90	0.89	0.81	1.13	1.07	0.98	0.98	0.94	1.22	1.11	1.11
1/4 in. acrylic/polycarbonate	0.88	1.14	0.96	0.79	0.78	0.71	0.99	0.92	0.84	0.84	0.81	1.08	0.96	0.96
1/8 in. acrylic/polycarbonate	0.96	1.21	1.02	0.85	0.83	0.76	1.06	1.00	0.91	0.91	0.87	1.15	1.04	1.04
Double Glazing														
1/4 in. airspace	0.55	0.87	0.65	0.57	0.55	0.49	0.69	0.63	0.56	0.56	0.53	0.79	0.68	0.63
1/2 in. airspace	0.48	0.81	0.60	0.53	0.51	0.44	0.64	0.57	0.50	0.50	0.48	0.73	0.62	0.57
1/4 in. argon space	0.51	0.84	0.62	0.55	0.53	0.46	0.66	0.59	0.53	0.52	0.50	0.75	0.64	0.60
1/2 in. argon space	0.45	0.79	0.58	0.51	0.49	0.43	0.61	0.54	0.48	0.48	0.45	0.70	0.59	0.55
Double Glazing, e=0.40 surface 2 or 3														
1/4 in. airspace	0.49	0.82	0.61	0.53	0.51	0.45	0.64	0.58	0.51	0.51	0.49	0.74	0.63	0.58
1/2 in. airspace	0.40	0.75	0.54	0.48	0.45	0.40	0.57	0.50	0.44	0.44	0.41	0.66	0.55	0.51
1/4 in. argon space	0.43	0.78	0.57	0.50	0.47	0.41	0.59	0.53	0.46	0.46	0.44	0.69	0.57	0.53
1/2 in. argon space	0.36	0.72	0.52	0.45	0.43	0.37	0.53	0.47	0.41	0.40	0.38	0.63	0.51	0.47
Double Glazing, e=0.20 surface 2 or 3														
1/4 in. airspace	0.45	0.79	0.58	0.51	0.49	0.43	0.61	0.54	0.48	0.48	0.45	0.70	0.59	0.55
1/2 in. airspace	0.35	0.71	0.51	0.44	0.42	0.36	0.53	0.46	0.40	0.39	0.37	0.62	0.51	0.46
1/4 in. argon space	0.38	0.74	0.53	0.46	0.44	0.38	0.55	0.48	0.42	0.42	0.40	0.64	0.53	0.49
1/2 in. argon space	0.30	0.67	0.47	0.41	0.39	0.33	0.48	0.41	0.36	0.35	0.33	0.57	0.46	0.42
Double Glazing, e=0.10 surface 2 or 3														
1/4 in. airspace	0.42	0.77	0.56	0.49	0.47	0.41	0.59	0.52	0.46	0.45	0.43	0.68	0.57	0.52
1/2 in. airspace	0.32	0.69	0.49	0.42	0.40	0.35	0.50	0.43	0.37	0.37	0.35	0.59	0.48	0.44
1/4 in. argon space	0.35	0.71	0.51	0.44	0.42	0.36	0.53	0.46	0.40	0.39	0.37	0.62	0.51	0.46
1/2 in. argon space	0.27	0.65	0.45	0.39	0.37	0.31	0.46	0.39	0.33	0.33	0.31	0.55	0.44	0.39
Double Glazing, e=0.05 surface 2 or 3														
1/4 in. airspace	0.41	0.76	0.55	0.48	0.46	0.40	0.58	0.51	0.45	0.44	0.42	0.67	0.56	0.51
1/2 in. airspace	0.30	0.67	0.47	0.41	0.39	0.33	0.48	0.41	0.36	0.35	0.33	0.57	0.46	0.42
1/4 in. argon space	0.33	0.70	0.49	0.43	0.41	0.35	0.51	0.44	0.38	0.38	0.36	0.60	0.49	0.44
1/2 in. argon space	0.25	0.63	0.44	0.38	0.36	0.30	0.44	0.37	0.32	0.31	0.29	0.53	0.42	0.38

DEFAULT WINDOW U-FACTORS

Part 2 of 3

U-Factor

Values are based on the 2005 ASHRAE Handbook of Fundamentals, Table 30-4.

Interpolate between emissivities when needed. When manufacturer's data is not available, assume that glass with a pyrolytic (hard) coating has an emmisivity of 0.40 and glass with a sputtered (soft) coating has an emissivity of 0.10.

Krypton gas fills, or krypton/argon combinations can be substituted for argon.

For glazing airspace between ¼ inch and ½ inch, use ¼ inch.

For glazing airspace over ½ inch, use ½ inch.

Product Type	Glass Only	Operable					Fixed					Curtain Wall		
Frame Type	n/a	Alum w.o. Therm Break	Alum with Therm Break	Re-inforced Vinyl/ Alum Clad Wood	Wood/ Vinyl	Insul Fibrglas /Vinyl	Alum w.o. Therm Break	Alum with Therm Break	Re-inforced Vinyl/ Alum Clad Wood	Wood/ Vinyl	Insul Fibrglas /Vinyl	Alum w.o. Therm Break	Alum with Therm Break	Struct Glzg
Glazing Type	Cntr-of-Glass													
Triple Glazing														
1/4 in. air spaces	0.38	0.72	0.51	0.44	0.43	0.38	0.55	0.48	0.42	0.41	0.40	0.63	0.52	0.47
1/2 in. air spaces	0.31	0.67	0.46	0.40	0.39	0.34	0.49	0.42	0.36	0.35	0.34	0.57	0.46	0.41
1/4 in. argon spaces	0.34	0.69	0.48	0.42	0.41	0.35	0.51	0.45	0.39	0.38	0.36	0.60	0.49	0.43
1/2 in. argon spaces	0.29	0.65	0.44	0.38	0.37	0.32	0.47	0.40	0.34	0.34	0.32	0.55	0.45	0.39
Triple Glazing, e=0.20 [a]														
1/4 in. air spaces	0.33	0.69	0.47	0.41	0.40	0.35	0.50	0.44	0.38	0.37	0.36	0.59	0.48	0.42
1/2 in. air spaces	0.25	0.62	0.41	0.36	0.35	0.30	0.43	0.37	0.31	0.30	0.29	0.52	0.41	0.35
1/4 in. argon spaces	0.28	0.65	0.44	0.38	0.37	0.32	0.46	0.40	0.34	0.33	0.32	0.54	0.44	0.38
1/2 in. argon spaces	0.22	0.60	0.39	0.34	0.33	0.28	0.41	0.34	0.29	0.28	0.27	0.49	0.38	0.33
Triple Glazing, e=0.20 [b]														
1/4 in. air spaces	0.29	0.65	0.44	0.38	0.37	0.32	0.47	0.40	0.34	0.34	0.32	0.55	0.45	0.39
1/2 in. air spaces	0.20	0.58	0.38	0.32	0.31	0.27	0.39	0.33	0.27	0.26	0.25	0.48	0.37	0.31
1/4 in. argon spaces	0.23	0.61	0.40	0.34	0.33	0.29	0.42	0.35	0.30	0.29	0.28	0.50	0.39	0.34
1/2 in. argon spaces	0.17	0.56	0.36	0.30	0.29	0.25	0.37	0.30	0.25	0.24	0.23	0.45	0.34	0.29
Triple Glazing, e=0.10 [a]														
1/4 in. air spaces	0.27	0.64	0.43	0.37	0.36	0.31	0.45	0.39	0.33	0.32	0.31	0.54	0.43	0.37
1/2 in. air spaces	0.18	0.57	0.36	0.31	0.30	0.25	0.37	0.31	0.25	0.25	0.23	0.46	0.35	0.29
1/4 in. argon spaces	0.21	0.59	0.39	0.33	0.32	0.27	0.40	0.34	0.28	0.27	0.26	0.48	0.38	0.32
1/2 in. argon spaces	0.14	0.54	0.33	0.28	0.27	0.23	0.34	0.28	0.22	0.21	0.20	0.42	0.32	0.26

DEFAULT OVERHEAD FENESTRATION U-FACTORS

Part 3 of 3

U-Factor

Values are based on the 2005 ASHRAE Handbook of Fundamentals, Table 30-4.

Use these values for demonstrating compliance with a default U-factor, not the NFRC procedure.

When a product has a U-factor that has been certified through the NFRC U-factor in the Overhead Plane may be used.

Product Type	Glass Only	Manufactured Skylights				Site-Assembled Sloped/Overhead Glazing		
Frame Type	n/a	Alum w.o. Therm Break	Alum with Therm Break	Reinforced Vinyl/Alum Clad Wood	Wood/ Vinyl	Alum w.o. Therm Break	Alum with Therm Break	Structural Glazing
Glazing Type	Cntr-of-Glass							
Single Glazing								
1/8 in. glass	1.19	1.98	1.89	1.75	1.47	1.36	1.25	1.25
1/4 in. acrylic/polycarbonate	1.03	1.82	1.73	1.60	1.31	1.21	1.10	1.10
1/8 in. acrylic/polycarbonate	1.11	1.90	1.81	1.68	1.39	1.29	1.18	1.18
Double Glazing								
1/4 in. airspace	0.58	1.31	1.11	1.05	0.84	0.82	0.70	0.66
1/2 in. airspace	0.57	1.30	1.10	1.04	0.84	0.81	0.69	0.65
1/4 in. argon space	0.53	1.27	1.07	1.00	0.80	0.77	0.66	0.62
1/2 in. argon space	0.53	1.27	1.07	1.00	0.80	0.77	0.66	0.62
Double Glazing, e=0.40 surface 2 or 3								
1/4 in. airspace	0.51	1.25	1.05	0.99	0.78	0.76	0.64	0.60
1/2 in. airspace	0.50	1.24	1.04	0.98	0.77	0.75	0.64	0.59
1/4 in. argon space	0.44	1.18	0.99	0.92	0.72	0.70	0.58	0.54
1/2 in. argon space	0.46	1.20	1.00	0.94	0.74	0.71	0.60	0.56
Double Glazing, e=0.20 surface 2 or 3								
1/4 in. airspace	0.46	1.20	1.00	0.94	0.74	0.71	0.60	0.56
1/2 in. airspace	0.46	1.20	1.00	0.94	0.74	0.71	0.60	0.56
1/4 in. argon space	0.39	1.14	0.94	0.88	0.68	0.65	0.54	0.50
1/2 in. argon space	0.40	1.15	0.95	0.89	0.68	0.68	0.55	0.51
Double Glazing, e=0.10 surface 2 or 3								
1/4 in. airspace	0.44	1.18	0.99	0.92	0.72	0.70	0.58	0.54
1/2 in. airspace	0.44	1.18	0.99	0.92	0.72	0.70	0.58	0.54
1/4 in. argon space	0.36	1.11	0.91	0.85	0.65	0.63	0.52	0.47
1/2 in. argon space	0.38	1.13	0.93	0.87	0.67	0.65	0.53	0.49
Double Glazing, e=0.05 surface 2 or 3								
1/4 in. airspace	0.42	1.17	0.97	0.91	0.70	0.68	0.57	0.52
1/2 in. airspace	0.43	1.17	0.98	0.91	0.71	0.69	0.58	0.53
1/4 in. argon space	0.34	1.09	0.89	0.83	0.63	0.61	0.50	0.45
1/2 in. argon space	0.36	1.11	0.91	0.85	0.65	0.63	0.52	0.47

Skylight Conversion

When a vertical tested U-factor for skylights is available, use formula to the right to convert to overhead U-factor

Vertical to Overhead Equation | Skylight U-Factor = 0.08 + 1.62 X U-Factor

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Part 1 of 2 DEFAUL FENESTRATION SHADING

Shading Coefficient

Oregon code requires center-of-glass shading coefficient equal to or less than 0.57, 0.47, 0.43, or 0.35 as the performance requirement

SC_c = Shading Coefficient for glazing system (center-of-glass)

$$SC_c = \frac{SHGC_c}{0.87}$$

$SHGC_c$ = Solar Heat Gain Coefficient (center-of-glass)

e = Infrared emissivity of glazing layer

Values are from the 2005 ASHRAE Fundamentals Handbook, Table 30-13. Unless otherwise noted, tinted glass and reflective glass coatings are on the outer pane and low-e coatings are applied to inner pane (surface 3) in double glazed systems.

When double-glazing has both tint and low-e, low-e is on surface 3, unless noted.

Glazing Description	Center-of-Glass Shading Coefficient (SC_c)	Equivalent $SHGC_c$
Single – $^1/_8$" thick		
Glazing, Clear	0.99	0.86
Glazing, Bronze	0.84	0.73
Glazing, Green or Gray	0.80	0.70
Single acrylic or polycarbonate clear	0.98	0.85
Single – $^1/_4$" thick		
Glazing, Clear	0.93	0.81
Glazing, Bronze	0.71	0.62
Glazing, Green	0.69	0.60
Glazing, Gray	0.68	0.59
Glazing, Bluegreen	0.71	0.62
Stainless steel reflective on clear 20%	0.36	0.31
Stainless steel reflective on green 14%	0.29	0.25
Titanium reflective on clear 30%	0.45	0.39
Single acrylic or polycarbonate clear	0.98	0.85
Glass Block		
Clear	0.66	0.57
Frosted	0.51	0.44
Double Glazing – $^1/_8$" thick		
Clear	0.87	0.76
Clear, low-*e* on surface 2 or 3 with *e*=0.4*	0.86	0.75
Clear, low-*e* with *e*=0.2	0.80	0.70
Clear, low-*e* on outer pane (surface 2) with *e*=0.2	0.75	0.65
Clear, low-*e* with *e*=0.1	0.69	0.60
Clear, low-*e* on outer pane (surface 2) with *e*=0.1	0.75	0.65
Clear, low-*e* on outer pane (surface 2) with *e*=0.05	0.47	0.41
Bronze	0.71	0.62
Green or Gray	0.69	0.60
Bronze, low-*e* with *e*=0.4*	0.71	0.62
Green, low-*e* with *e*=0.4*	0.69	0.60
Gray, low-*e* with *e*=0.4*	0.68	0.59
Bronze, low-*e* with *e*=0.2	0.66	0.57
Green, low-*e* with *e*=0.2	0.63	0.55
Gray, low-*e* with *e*=0.2	0.62	0.54
Bronze, low-*e* with *e*=0.1	0.55	0.48
Green or Gray, low-*e* with *e*=0.1	0.53	0.46
Double Glazing – $^1/_4$" thick		
Clear	0.80	0.70
Clear, low-*e* on surface 2 or 3 with *e*=0.4*	0.80	0.70
Clear, low-*e* with *e*=0.2	0.75	0.65
Clear, low-*e* on outer pane (surface 2) with *e*=0.2	0.69	0.60
Clear, low-*e* with *e*=0.1	0.64	0.56
Clear, low-*e* on outer pane (surface 2) with *e*=0.1	0.69	0.60
Clear, low-*e* on outer pane (surface 2) with *e*=0.05	0.43	0.37
Bronze or Green	0.56	0.49
Gray	0.54	0.47
Bluegreen	0.57	0.50
Hi-performance Green	0.45	0.39

Note: glazing is still required to comply with either prescriptive overall window U-factor or minimum assembly requirements.

* Values are from 2005 ASHRAE Fundamentals Handbook

DEFAUL FENESTRATION SHADING

Part 1 of 2

Glazing Description	Center-of-Glass Shading Coefficient (SC_c)	Equivalent $SHGC_c$
Double Glazing – $^1/_4$" thick *cont.*		
Bronze, low-*e* with *e*=0.4*	0.58	0.51
Green, low-*e* with *e*=0.4*	0.53	0.46
Gray, low-*e* with *e*=0.4*	0.50	0.44
Bluegreen, low-*e* with *e*=0.4*	0.57	0.50
Hi-performance Green, low-*e* with *e*=0.4*	0.45	0.40
Bronze, low-*e* with *e*=0.2	0.52	0.45
Green, low-*e* with *e*=0.2	0.47	0.41
Gray, low-*e* with *e*=0.2	0.45	0.39
Bluegreen, low-*e* with *e*=0.2	0.52	0.45
Hi-performance Green, low-*e* with *e*=0.2	0.39	0.34
Bronze, low-*e* with *e*=0.1	0.45	0.39
Green, low-*e* with *e*=0.1	0.41	0.36
Gray, low-*e* with *e*=0.1	0.39	0.34
Bluegreen, low-*e* with *e*=0.1	0.45	0.39
Hi-performance Green, low-*e* with *e*=0.1	0.36	0.31
Bronze, low-*e* on outer pane (surface 2) with *e*=0.05	0.30	0.26
Green, low-*e* on outer pane (surface 2) with *e*=0.05	0.36	0.31
Gray, low-*e* on outer pane (surface 2) with *e*=0.05	0.28	0.24
Blue, low-*e* on outer pane (surface 2) with *e*=0.05	0.31	0.27
Hi-perf. Green, low-*e* on outer pane (surface 2) with *e*=0.05	0.31	0.27
Stainless steel reflective on clear 20%	0.25	0.22
Titanium reflective on clear 30%	0.33	0.29
Triple Glazing – $^1/_8$" thick		
Clear	0.77	0.67
Clear, low-*e* on outer pane (surface 2) with *e*=0.4*	0.69	0.60
Clear, low-*e* on outer pane (surface 2) with *e*=0.2	0.69	0.60
Clear, low-*e* on inner pane (surface 5) with *e*=0.2	0.71	0.62
Clear, low-*e* on surfaces 2 and 5 with *e*=0.1	0.47	0.41
Clear, low-*e* on surfaces 2 and 4 with *e*=0.05	0.31	0.27
Triple Glazing – $^1/_4$" thick		
Clear	0.70	0.61
Clear, low-*e* on outer pane (surface 2) with *e*=0.4*	0.70	0.61
Clear, low-*e* on outer pane (surface 2) with *e*=0.2	0.61	0.53
Clear, low-*e* on inner pane (surface 5) with *e*=0.2	0.64	0.56
Clear, low-*e* on surfaces 2 and 5 with *e*=0.1	0.41	0.36
Clear, low-*e* on surfaces 2 and 4 with *e*=0.05	0.30	0.26
Hi-performance Green	0.37	0.32

Note: glazing is still required to comply with either prescriptive overall window U-factor or minimum assembly requirements.

* Values are from 2005 ASHRAE Fundamentals Handbook

Shading Coefficient

Oregon code requires center-of-glass shading coefficient equal to or less than 0.57, 0.47, 0.43, or 0.35 as the performance requirement

SC_c = Shading Coefficient for glazing system (center-of-glass)

$$SC_c = \frac{SHGC_c}{0.87}$$

$SHGC_c$ = Solar Heat Gain Coefficient (center-of-glass)

e = Infrared emissivity of glazing layer

Values are from the 2005 ASHRAE Fundamentals Handbook, Table 30-13. Unless otherwise noted, tinted glass and reflective glass coatings are on the outer pane and low-e coatings are applied to inner pane (surface 3) in double glazed systems.

When double-glazing has both tint and low-e, low-e is on surface 3, unless noted.