

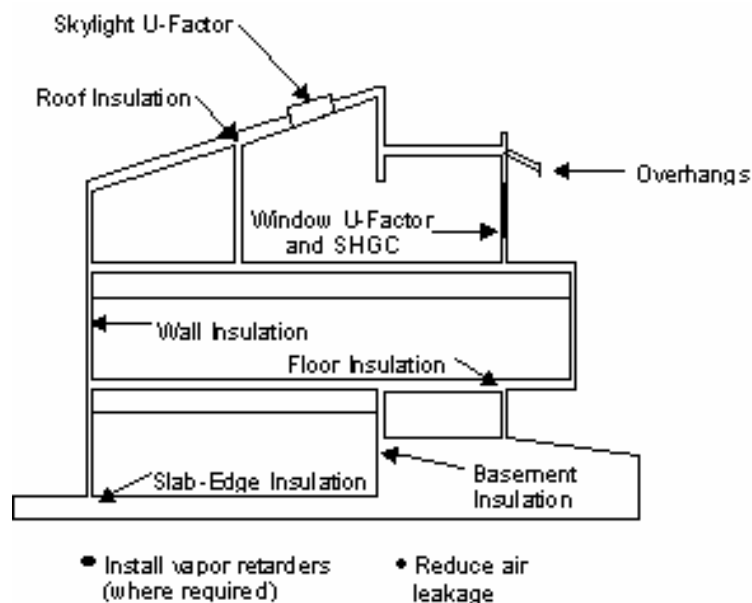
Envelope Compliance

Envelope Requirements

You can use *COMcheck-EZ*TM to demonstrate that your commercial or high-rise residential building design complies with energy codes based on the ASHRAE Energy Code for Commercial and High-Rise Residential Buildings [ASHRAE 90.1 ('89) Code]. This revised *COMcheck-EZ* guide is not restricted to use with buildings of three stories or less, as was the previous version.

This guide covers the energy code requirements for building envelope and provides a simple prescriptive method (manual method) for demonstrating compliance. Most envelope requirements vary with climate. This guide contains requirements for all climate locations within the United States, as well as instructions on how to demonstrate compliance with these requirements.

The *COMcheck-EZ* software is an alternative compliance method offering greater design flexibility by allowing tradeoffs between envelope components, including roofs, walls, windows, floors, and skylights. You can demonstrate compliance with minimal inputs and generate a compliance report to submit with your building permit application. Refer to the *COMcheck-EZ Software Compliance Guide* for instructions on obtaining and using the software.



What the Energy Code Covers

To promote energy efficiency in building envelopes of commercial and high-rise residential buildings, the energy code requires that

- air leakage be limited through the building envelope. This guide contains requirements for limiting air leakage.
- insulation R-values and glazing and door U-factors be certified. This guide contains requirements for certified building components.
- vapor retarders be installed in nonvented framed ceiling, wall, and floor areas in many climates. This guide contains requirements for vapor retarders.
- insulation levels for walls, roofs, and below-grade walls and glazing areas, and U-factors for windows and skylights meet or exceed minimum efficiency levels – these minimums are listed in prescriptive package tables for specific climate locations. This guide contains instructions on how to determine if your design complies with these levels.

Demonstrating Compliance

The *COMcheck-EZ* manual method (prescriptive compliance path) requires minimal calculations and is the simplest way to comply. It is a package approach that requires all components in your design to meet or exceed prescribed efficiency levels contained in the prescriptive package table for your building's climate zone. If one component does not meet the prescribed efficiency level, you must use the *COMcheck-EZ* software method (or other compliance option available under the code) to demonstrate compliance. State maps showing climate zones, prescriptive package tables for each zone, and instructions are provided separately from this guide. You must have the appropriate prescriptive package table for your building's climate zone to use this method. To demonstrate compliance, complete the *Envelope Compliance Certificate* included with this guide.

Air Leakage

All joints and penetrations in the building envelope that are potential sources of air leakage must be caulked, gasketed, weatherstripped, or otherwise sealed in an approved manner.

The following areas in the building envelope must be sealed:

- exterior joints around window and door frames
- areas between wall sole plates, floors, and exterior-wall panels
- openings for plumbing, electricity, refrigerant, and gas lines in exterior walls, floors, and roofs
- openings in the attic floor (e.g., where ceiling panels meet interior and exterior walls and masonry fireplaces)
- service and access doors or hatches
- all other similar openings in the building envelope.

Recessed-lighting fixtures must be gasketed and IC rated; i.e., rated for direct contact with insulation.

The code specifies maximum air leakage rates for manufactured windows and doors. Windows and doors certified by an accredited laboratory (such as the National Wood Window and Door Association [NWWDA] or the Architectural Aluminum Manufacturers Association [AAMA]) meet these requirements and are labeled. For noncertified windows and doors, check manufacturers' test reports to verify compliance with these air leakage requirements.

Frame Type	Windows (cfm per ft of operable sash crack)	Doors (cfm per ft of door area)	
		Sliding	Swinging
Wood	0.25	N/A	0.25
Aluminum	0.37	0.37	1.25
PVC	0.06	0.37	N/A

Maximum Allowed Air Leakage Rates

Building Component Certification

Insulation R-values and glazing and door U-factors must be clearly marked on building plans or specifications. If two or more different insulation levels exist for the same building component, record each level separately on the plans or specifications. For example, if the walls adjacent to an unheated warehouse have less insulation than the building's exterior walls, record both insulation levels.

You must provide component R-values and U-factors so compliance can be determined. These values may be provided on

- product labels - For example, the R-value of the insulation is often printed directly on the insulation or can be determined from a striping code. Window U-factors are often included on the manufacturer label posted directly on the window.
- contractor statements certifying the products they have installed - For example, the insulation contractor should certify the R-value of the installed insulation.

For blown or sprayed insulation, the initial installed thickness, settled thickness, coverage area, and number of bags used must be clearly posted at the job site. For components having a manufacturer's guaranteed R-value rating, thickness markers must be placed at least every 300 ft². For components without a manufacturer's guaranteed R-value rating, contact the Insulation Contractors Association of America for an approved way to ensure proper insulation levels are obtained.

Finally, check with your code enforcement official having jurisdiction for requirements on certifying building components.

Standard Insulation Thicknesses

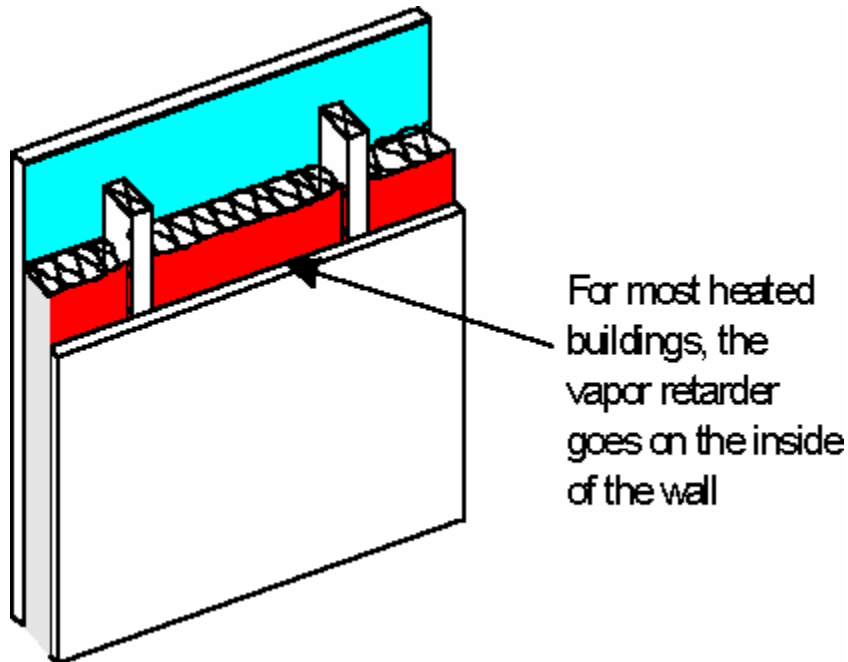
Insulation can be compressed if not properly installed. The insulation R-value is dependent on the installed thickness of the insulation. All COMcheck-EZ insulation

requirements assume the insulation is installed at its standard thickness. If insulation is compressed, the R-value is reduced and the building may not meet the requirements. This situation is of particular concern in metal building construction because of the way the insulation is installed to create a clean-finish appearance. The following table shows the R-values and standard thicknesses of fiberglass batts. However, when using an R-19 batt in a typical 2x6 wall, you can assume the full R-value of 19.

Insulation R-Value	Standard Thickness (in.)
R-11	3 ½
R-13	3 5/8
R-15	3 ½
R-19	6 ¼
R-21	5 ½
R-22	6 ¼
R-30	9 ½
R-38	12

Vapor Retarders

Except in specified climate zones, vapor retarders must be installed in all nonvented framed areas in ceilings, walls, and floors. Nonvented areas are framed cavities without vents or other openings to allow for free air movement. The vapor retarder must have a perm rating of 1.0 or less and must be installed on the warm-in-winter side of the insulation (between the insulation and conditioned space).



Location of Vapor Retarders

Vapor retarders are not required where moisture or its freezing will not damage materials or where other approved measures are taken to avoid condensation. These vapor requirements do not apply to buildings located in the following climate zones:

Texas	Zones 2-5
Alabama, Georgia, North Carolina, Oklahoma, South Carolina	Zones 4-6
Arkansas, Tennessee	Zones 6-7
Florida, Hawaii, Louisiana, Mississippi	All Zones

[See the State Maps available with (or at the end of) these guides to determine the appropriate climate zone for your building.]

Insulation and Window Requirements

The *COMcheck-EZ* methods contain climate-specific envelope requirements for walls, windows, skylights, roofs, floors, and basement walls. The manual method prescribes insulation levels, glazing areas, and glazing U-factors. The software method provides additional flexibility because these requirements can be traded against each other.

The WWR is the gross window area divided by the gross wall area.

The gross wall area includes

- the opaque area of all above-grade exterior walls enclosing conditioned spaces (including above-grade portions of basement wall assemblies but excluding walls separating conditioned from unconditioned space)
- the area of the band joist and subfloor between floors
- the area of all doors and windows.

The gross window area includes the rough-opening area of the window, not just the transparent-glass area.

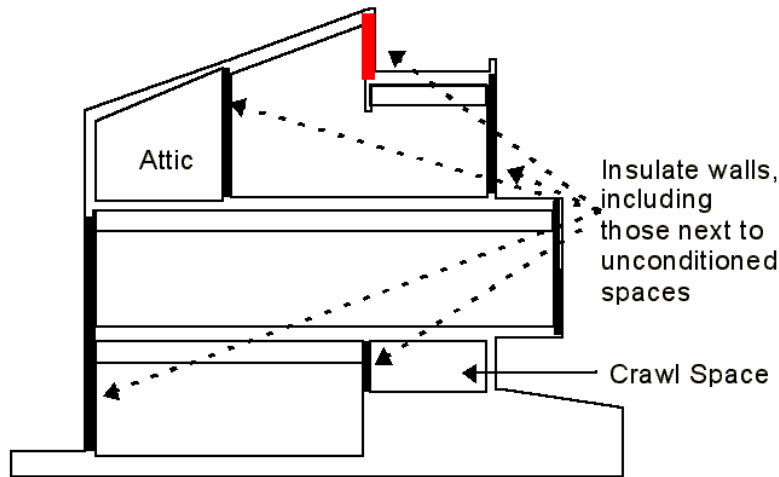
To determine if your proposed design complies with the climate-specific requirements

- determine the WWR category for your design (0-10%, 10-25%, 25-40%, 40-50%)
- determine the climate zone for your proposed building's location from the appropriate state map
- find the prescriptive package table for your building's climate zone
- select the package from the table that best fits your design's construction characteristics based on WWR
- find the corresponding requirements for walls, windows, skylights, roof, floors, and basement walls
- determine if your design complies based on criteria contained in the following sections.

You cannot use the manual method for buildings with WWR over 50%. For these buildings, use the *COMcheck-EZ* software or another compliance method permitted under the code.

Walls

Your design complies with the wall insulation requirement if the proposed wall insulation has an R-value equal to or greater than the requirement in the prescriptive package. Wall insulation requirements apply to both exterior and interior walls that separate conditioned from unconditioned space. The wall type, WWR, and whether the wall is on the exterior or just separating conditioned from unconditioned space, may affect the wall insulation requirement.



Location of Wall Insulation

To demonstrate compliance, enter the R-value of the insulation to be installed in each wall component in the *Proposed R-Value* column on the *Envelope Compliance Certificate*. R-values for walls represent wall cavity insulation and/or continuous insulation (insulating sheathing), depending on the package selected. For example, if R-13 batt insulation is to be used with R-6 insulating sheathing, enter "R-13 + R-6" in the *Proposed R-Value* column.

All wall components with the same R-value may be combined and entered as a single component on the certificate, provided these walls are of the same construction class (i.e., wood, metal, masonry).

Concrete Masonry Unit Walls

Concrete masonry unit walls may be insulated by filling the empty core with perlite, vermiculite, or some other insulating material. In some cases, even with filled cores, these wall types require additional insulation.

Metal Building Walls and Roofs

Special attention to the design and construction of metal buildings is required to ensure these buildings meet the code requirements. Two key elements exist in metal buildings that are not found in other building classes—thermally broken connections between the purlin and metal roof sheet and compression of insulation behind wall girths and roof purlins.

COMcheck-EZ includes requirements for metal building walls and roofs. These requirements are specified in the “Walls Framed - Metal Framing” category and in the “Roofs Metal Purlin” category in the Prescriptive Packages. There are two classes of metal building roofs. One class uses traditional techniques that drape the insulation over the purlin and fasten the metal roof sheets through the insulation directly to the purlin. The second class requires that a thermal block be placed between the metal roof sheet and purlin.

A thermal block consists of foam blocks or other materials/techniques that prevent heat from migrating from the purlin directly to the metal roof sheet. Compressed fiberglass batt insulation does not qualify as a thermal block.

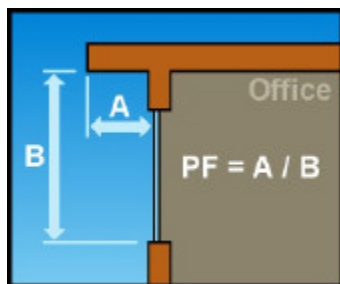
Windows

Your design complies with the window U-factor requirement if the proposed windows have a U-factor less than or equal to that in the prescriptive package. In most cases, the WWR will affect the window requirement.

A window U-factor is based on the interior-surface area of the entire assembly, including glazing, sash, and other framing elements. Center-of-glass U-factors cannot be used.

Your design must also have a Solar Heat Gain Coefficient (SHGC) less than or equal to that shown in the prescriptive package. The SHGC specifies the glazing's effectiveness in rejecting solar heat gain. SHGC is part of a system for rating window performance used by the National Fenestration Rating Council (NFRC). SHGC is gradually replacing the older index, shading coefficient (SC), in product literature and design standards. If you are using glass whose performance is listed in terms of SC, you may convert to SHGC by multiplying the SC value by 0.87. The SHGC requirement is affected by the projection factor (PF) of qualifying overhangs.

The projection factor is based on the ratio of the overhang depth to the overhang height above the window sill.



Projection Factor

Question
What is the projection factor of an overhang that extends 3 ft out and is 6 ft above the bottom window sill?
Answer
The projection factor is A divided by B. If A is 3 ft and B is 6 ft, the projection factor is 3/6 or 0.5.

For compliance, the SHGC cannot be modified to account for the effects of interior-shading devices. It can be modified for permanently attached devices that shade the exterior of the window. Examples of these devices include shade screens and architectural shade structures.

U-factors and SHGCs for glazing must be tested and documented by the manufacturer in accordance with the NFRC test procedure. Typical U-factor and SHGC values for windows and skylights are shown in the tables below. You may use these values to check compliance prior to selecting actual glazing products. However, the actual ratings for products installed in the building must meet or exceed (i.e., be no higher than) the values you assume in the compliance analysis.

Glazing Layers	Window Frame Type		
	Metal	Metal with Thermal Break	Wood or Vinyl
Single	1.2	1.1	1.0
Double	0.7	0.7	0.6
Double Low-e	0.6	0.6	0.5
Triple	0.6	0.5	0.5
Triple Low-e	0.5	0.5	0.4

Typical Window U-Factors

Glazing Layers	Glass Type		
	Clear	Tinted	Reflective
Single	0.8	0.7	0.5
Double	0.7	0.6	0.4
Double Low-e	0.7	0.6	0.4
Triple	0.7	0.5	0.4
Triple Low-e	0.7	0.5	0.4

Typical Glass SHGC Values

To demonstrate compliance, enter the proposed window U-factors in the *Proposed U-Factor* column and the proposed SHGC in the *Proposed SHGC* column on the *Envelope Compliance Certificate*.

Doors

Glazed doors must meet the same SHGC and U-factor requirements as windows from the prescriptive package tables. Opaque doors just need to meet the U-factor requirements for windows from the tables. If doors have been specified that do not meet these requirements, compliance must be demonstrated using the software or other approved method.

Skylights

Your design complies with the skylight U-factor requirement if the proposed skylights have a U-factor less than or equal to that in the prescriptive package. The packages restrict the total skylight area to 3% or less of the gross roof area.

A skylight U-factor is based on the interior-surface area of the entire assembly, including glazing, sash, curbing, and other framing elements. Center-of-glass U-factors cannot be used.

Glazing Layers	Skylight Frame Type		
	Metal	Metal with Thermal Break	Wood or Vinyl
Single	2.0	1.9	1.5
Double	1.3	1.1	0.9
Double Low-e	1.2	1.0	0.8
Triple	1.2	0.9	0.7
Triple Low-e	1.1	0.9	0.6

Typical Skylight U-Factors

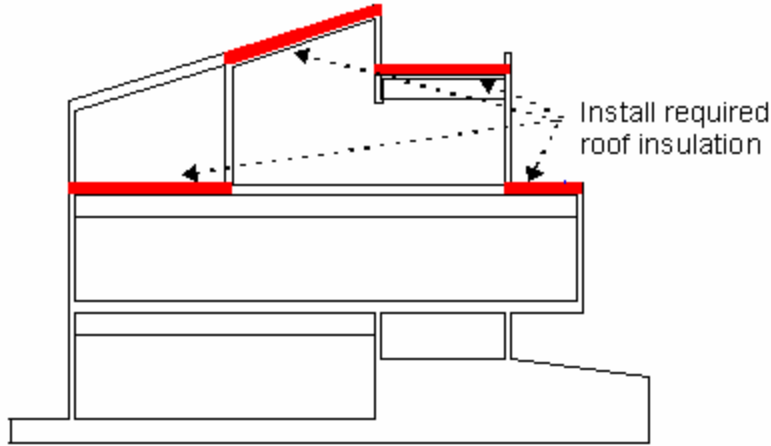
U-factors for skylights must be tested and documented by the manufacturer in accordance with the NFRC test procedure. If an NFRC U-factor rating is available for your skylight, you should use its BB-Size (i.e., 48 by 48 in.) rating.

To demonstrate compliance, enter the proposed skylight U-factors in the *U-Factor* column on the *Envelope Compliance Certificate*.

Roofs

Your design complies with the roof insulation requirement if the proposed roof insulation has an R-value equal to or greater than that in the prescriptive package. In some cases, the WWR will affect the roof insulation requirement.

Roof insulation in buildings with attics must be installed to allow for free circulation of air through the attic eave vents. To demonstrate compliance, enter the R-value of the insulation to be installed in each roof component in the *Proposed R-Value* column on the *Envelope Compliance Certificate*. R-values for roofs represent cavity insulation and/or insulating sheathing (depending on the package selected). For example, if R-19 batt insulation is to be used with R-4 insulating sheathing, enter "R-19 + R-4" in the *Proposed R-Value* column.



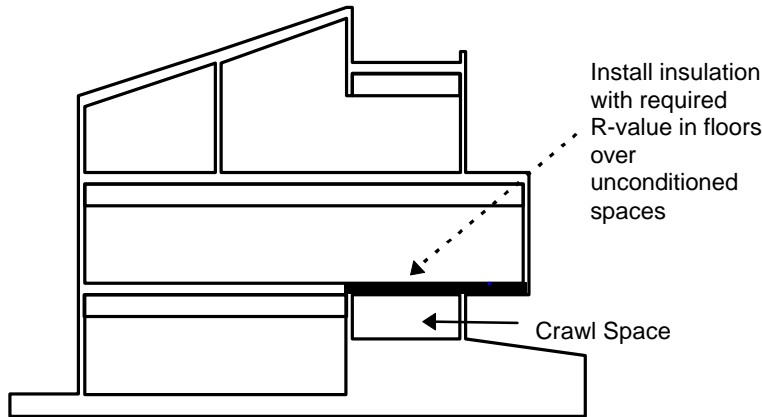
Location of Roof Insulation

All roof components with the same R-value and construction class may be combined and entered as a single component on the certificate.

Floors

Your design complies with the floor insulation requirement if the proposed floor insulation has an R-value equal to or greater than that in the prescriptive package. Floor insulation requirements apply where the underside of a floor is exposed to the outdoors or unconditioned space.

To demonstrate compliance, enter the R-value of the insulation to be installed in each floor component in the *Proposed R-Value* column on the *Envelope Compliance Certificate*. R-values for floors represent cavity insulation, spray-on insulation, and insulating sheathing (depending on the package selected).

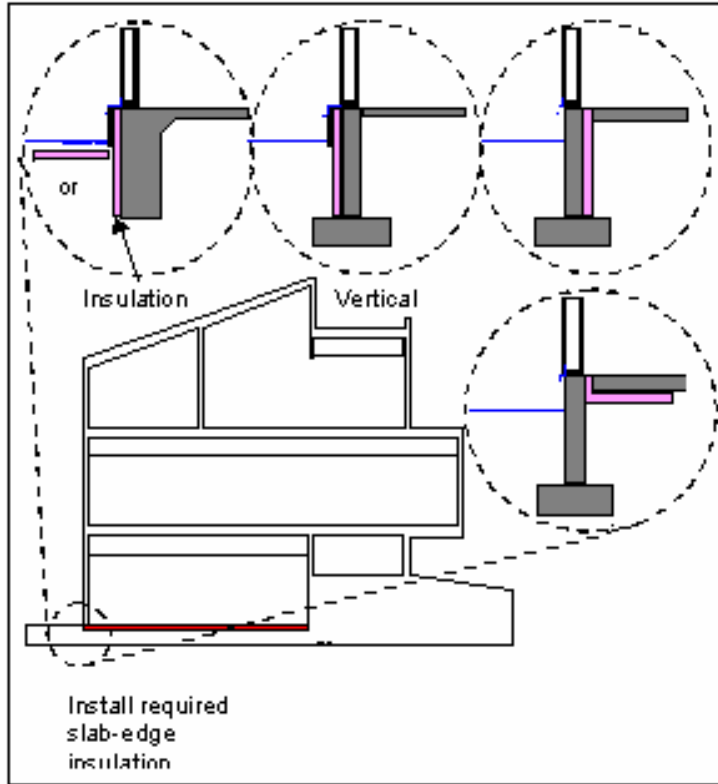


Location of Raised-Floor Insulation

All floor components with the same R-values and construction class may be combined and entered as a single component on the certificate.

Slab-On-Grade

In some cases, the edges of concrete slab floors must be insulated. The following diagram shows several common ways to effectively insulate a slab edge.

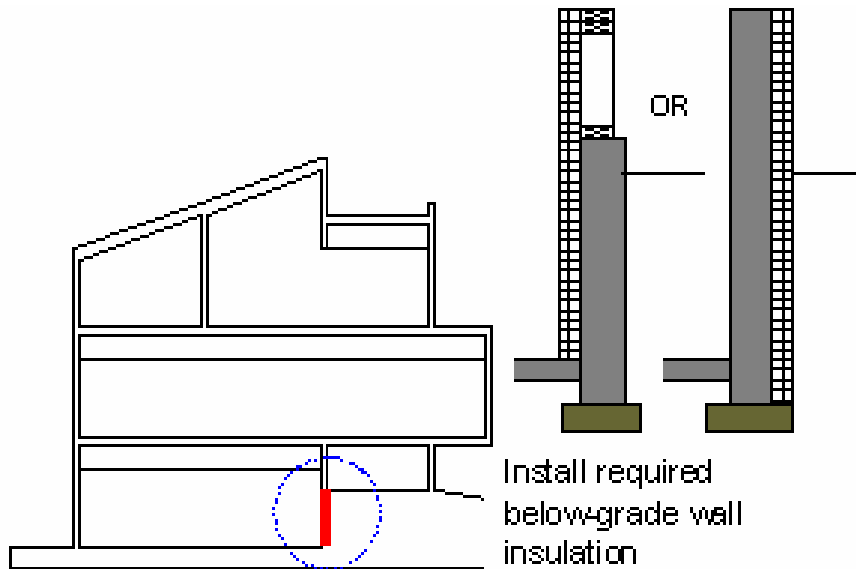


Location of Slab-Edge Insulation

Slab-edge insulation may be installed vertically or horizontally on the inside or outside of foundation walls. If installed vertically, it must extend downward from the top of the slab to the top of the footing (or 48 in., whichever is less). If installed horizontally, it must cover the slab edge and then extend horizontally (to the interior or exterior) for a minimum distance of 40 in.

Below-Grade Walls

In some cases, basement walls must be insulated. For purpose of this requirement, a wall is considered to be below grade when at least 85% of its surface area is in direct contact with the earth. The insulation must extend 10 ft below finish grade or to the level of the below-grade floor (i.e., the lowest floor), whichever is less. Your design complies with the basement wall insulation requirement if the proposed insulation has an R-value equal to or greater than that in the prescriptive package.



Location of Basement Wall Insulation

To demonstrate compliance, enter the R-value of the insulation to be installed in the basement wall component in the *Proposed R-Value* column on the *Envelope Compliance Certificate*. R-values for basement walls represent cavity insulation or insulating sheathing (depending on the package selected).

All basement wall components with the same R-value and construction class may be combined and entered as a single component on the certificate.

Completing Envelope Compliance Certificate

These instructions explain the information to include in the Envelope Compliance Certificate, identify the appropriate contact or reference if you have questions, and provide *EZ* tips for completing the certificate. A sample certificate is also provided. The instructions have numbered circles that correspond to those on the sample certificate. For code enforcement officials, *EZ* tips for plan check and field inspection are included at the end of this guide.

General Guidelines

For Documentation Authors: Provide all information in unshaded sections, entering "NA" if a particular requirement is not applicable; submit the completed certificate to the authority having jurisdiction with the building permit application package.

For Plan Checkers: Verify that proposed values listed on the certificate are consistent with the plans and specifications and with the requirements of this guide or the code.

For Field Inspectors: Inspect and approve building construction against each requirement in Section 3 of the certificate.

Prequalifying Project Design

Before using the *Envelope Compliance Certificate*, determine if your proposed design is qualified to use the *COMcheck-EZ* manual method to demonstrate compliance.

To determine if your design qualifies, calculate the WWR for the design using the following equation. If the design WWR exceeds 50%, or the prescriptive path cannot be followed in its entirety, a nonprescriptive code approach must be used. The *COMcheck-EZ* software provides an optional way to demonstrate compliance through a system performance path. Refer to the *COMcheck-EZ Software Compliance Guide* for instructions on using the software.

Gross Fenestration Area) Gross Exterior Wall Area X 100 = Design WWR%

Low Fenestration (WWR 0%-10%)

Medium Fenestration (WWR 10%-25%)

High Fenestration (WWR 25%-40%)

Very High Fenestration (WWR 40%-50%)