

Chapter 1: Compliance

[101]

Who Must Comply?

All new residential construction must comply with both the Washington State Energy Code and the Ventilation Code.

Exceptions. Exempt from envelope requirements but needing to comply with other Code provisions are:

[101.3.1.1]

- Buildings with peak design energy usage for space conditioning less than 1 watt (3.4 Btu/hour) per square foot of floor area. May apply to garage, shop, or similar part of building.

[101.3.1.2]

- Buildings neither heated nor cooled by a non-renewable energy source (for the purposes of the Code, wood heat is not considered renewable, and must comply).

[101.3.1.3]

- Greenhouses isolated from any conditioned space and not intended for occupancy.

[101.3.2.1 -
101.3.2.8]

Additions and remodeling to existing buildings must comply. See pages 1-15 through 1-18 for specific conditions.

Three Compliance Approaches

The Code allows three possible approaches to demonstrate compliance:

[101.2]

Prescriptive Approach. Follows prescribed building component efficiency levels. [WSEC Chapter 6]

Component Performance Approach. Compares building envelope heat loss rates of the proposed house design to a Code-defined reference house. [WSEC Chapter 5]

System Analysis Approach. Compares an estimate of annual building energy use of the proposed house design to that of a Code-defined reference house. [WSEC Chapter 4]

You must meet the requirements of only *one* approach to comply.

All three compliance options require that the project meet requirements concerning heating systems, water heating and ventilation systems. These requirements are detailed in other chapters of this Guide.

[502.2.1] Buildings constructed using log walls must use "other" fuels to apply the exception noted in Section 502.21 UA Calculations.

[502.2.2] **The WSEC defines two fuel types:**

Electric Resistance. Includes baseboard units, radiant units, boilers, and forced air units using more than 1kW per dwelling unit or 1 watt/ft.², whichever is greater. This applies whether units are primary or secondary sources of heat.

Other. Includes all gas, wood, oil, and propane heating systems, unless electric resistance is used as a secondary heating system (see above), and **all heat pump** heating systems.

The prescriptive approach does not distinguish between fuel types. All fuels have the same requirements for building envelope.

Climate Zones

[302.3]

The WSEC divides the state into two Climate Zones, shown in Figure 1-1.

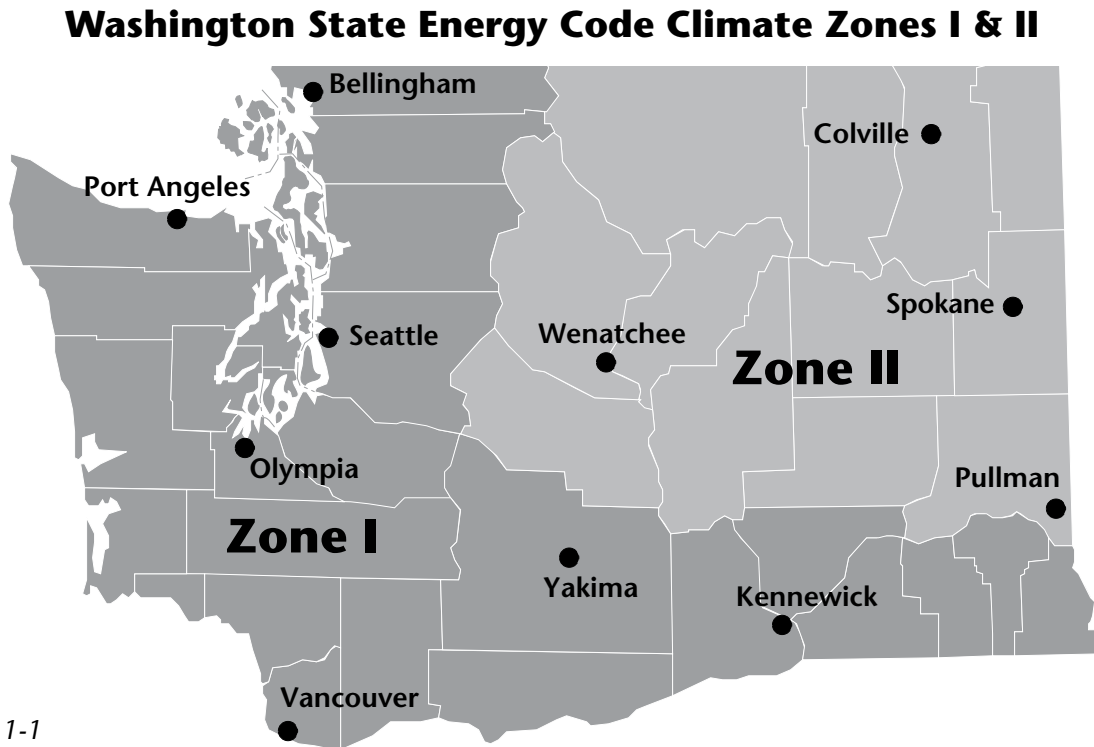


Figure 1-1

Prescriptive Approach

The Easiest Way

The prescriptive approach dictates the minimum insulation level required for each building component. Each component must meet or exceed the listed performance value to qualify.

[601.1]

The two prescriptive tables reproduced on pages 1-5 and 1-6 are taken from Chapter 6 of the WSEC. To select the correct table, simply determine your Climate Zone.

How To Use The Prescriptive Tables

Example House:

- Location: Olympia
- Occupancy: R-3, Single Family
- Conditioned floor area (measured to outside of exterior walls): 1000 ft.²
- Glazing area (measured window rough openings): 200 ft²
- Glazing to floor area ratio: 200/1000 = 20%

Process:

- Zone Map (Figure 1-1) identifies Olympia as Zone 1.
- Single Family (R-3) may use the prescriptive approach.
- 20 percent glazing area limits us to Option IV, unlimited glazing

[602.6] Glazing in doors and skylights are treated like any other window. When a door contains over 50 percent glass, the entire rough opening is included in the glazing area.

If a portion of the glazing area is over the allowable U-factor, and a portion is under, you may use an area weighted average U-factor to show compliance with your prescriptive option. To determine the average U-factor, find the corresponding glazing area for each distinct U-factor. Multiply the U-factor by the corresponding glazing area. Add together the U x A for each distinct U-factor, and divide by the total glazing area.

Example of Area Weighted U-Factor Calculation

Window #1 area 10 ft ² U = .37	U x A = 3.70
Window #2 area 15 ft ² U = .32	U x A = 4.80
<hr/> Total area 25 ft ²	Total U x A = 8.50

Area weighted average 8.50/25 = 0.34

WSEC Table 6-1
**Prescriptive Requirements^{0,1} for Group R Occupancy
 Climate Zone 1**

Option	Glazing Area ¹⁰ : % of floor	Glazing U-factor		Door ⁹ U-factor	Ceiling ²	Vaulted Ceiling ³	Wall ¹² Above Grade	Wall•int ⁴ Below Grade	Wall•ext ⁴ Below Grade	Floor ⁵	Slab ⁶ on Grade
		Vertical	Overhead ¹¹								
I.	10%	0.32	0.58	0.20	R-38	R-30	R-15	R-15	R-10	R-30	R-10
II. *	15%	0.35	0.58	0.20	R-38	R-30	R-21	R-21	R-10	R-30	R-10
III.	25% Group R-1 and R-2 Occupancies Only	0.40	0.58	0.20	R-38 / U=0.031	R-30 / U=0.034	R-21 / U=0.057	R-15	R-10	R-30 / U=0.029	R-10
IV.	Unlimited Group R-3 and R-4 Occupancies Only	0.35	0.58	0.20	R-38	R-30	R-21	R-21	R-10	R-30	R-10
V.	Unlimited Group R-1 and R-2 Occupancies Only	0.35	0.58	0.20	R-38 / U=0.031	R-30 / U=0.034	R-21 / U=0.057	R-15	R-10	R-30 / U=0.029	R-10

* Reference Case

0. Nominal R-values are for wood frame assemblies only or assemblies built in accordance with Section 601.1.
1. Minimum requirements for each option listed. For example, if a proposed design has a glazing ratio to the conditioned floor area of 13%, it shall comply with all of the requirements of the 15% glazing option (or higher). Proposed designs which cannot meet the specific requirements of a listed option above may calculate compliance by Chapters 4 or 5 of this Code.
2. Requirement applies to all ceilings except single rafter or joist vaulted ceilings complying with Note 3. "Adv" denotes Advanced Framed Ceiling.
3. Requirement applicable only to single rafter or joist vaulted ceilings where both (a) the distance between the top of the ceiling and the underside of the roof sheathing is less than 12 inches and (b) there is a minimum 1-

4. Below grade walls shall be insulated either on the exterior to a minimum level of R-10, or on the interior to the same level as walls above grade. Exterior insulation installed on below grade walls shall be a water resistant material, manufactured for its intended use, and installed according to the manufacturer's specifications. See Section 602.2.
5. Floors over crawl spaces or exposed to ambient air conditions.
6. Required slab perimeter insulation shall be a water resistant material, manufactured for its intended use, and installed according to manufacturer's specifications. See Section 602.4.
7. Int. denote standard framing 16

8. This wall insulation requirement denotes R-19 wall cavity insulation plus R-5 foam sheathing.
9. Doors, including all fire doors, shall be assigned default U-factors from Table 10.6C.
10. Where a maximum glazing area is listed, the total glazing area (combined vertical plus overhead) as a percent of gross conditioned floor area shall be less than or equal to that value. Overhead glazing with U-factor of U=0.40 or less is not included in glazing area limitations.
11. Overhead glazing shall have U-factors determined in accordance with NFRC 100 or as specified in Section 502.1.5.
12. Log and solid timber walls with a minimum average thickness of 3.5" are exempt from this insulation requirement [see page 1-10 for detail].

WSEC Table 6-2

**Prescriptive Requirements^{0,1} for Group R Occupancy
Climate Zone 2**

Option	Glazing Area ¹⁰ : % of floor	Glazing U-factor		Door ⁹ U-factor	Ceiling ²	Vaulted Ceiling ³	Wall ¹² Above Grade	Wall•int ⁴ Below Grade	Wall•ext ⁴ Below Grade	Floor ⁵	Slab ⁶ on Grade
		Vertical	Overhead ¹¹								
I.	12%	0.35	0.58	0.20	R-38	R-30	R-21 int ⁷	R-21	R-12	R-30	R-10
II. *	15%	0.35	0.58	0.20	R-38	R-30	R-19 + R-5 ⁸	R-21	R-12	R-30	R-10
III.	17%	0.32	0.58	0.20	R-38	R-30	R-19 + R-5 ⁸	R-21	R-12	R-30	R-10
IV.	25% Group R-1 and R-2 Occupancies Only	0.35	0.58	0.20	R-38 / U=0.031	R-30 / U=0.034	R-21 int ⁷ / U=0.054	R-15	R-12	R-30 / U=0.029	R-10 / F=0.54
V.	Unlimited Group R-3 and R-4 Occupancies Only	0.35	0.58	0.20	R-38	R-30	R-19+ R-5 ⁸	R-21	R-12	R-30	R-10
VI.	Unlimited Group R-1 and R-2 Occupancies Only	0.30	0.58	0.20	R-38 / U=0.031	R-30 / U=0.034	R-21 int ⁷	R-21	R-12	R-30	R-10
VII.	Unlimited Group R-1 and R-2 Occupancies Only	0.32	0.58	0.20	R-38 / U=0.031	R-30 / U=0.034	R-21 int ⁷ / U=0.054	R-15	R-12	R-30 / U=0.029	R-10 / F=0.54

* Reference Case

- 0. Nominal R-values are for wood frame assemblies only or assemblies built in accordance with Section 601.1.
- 1. Minimum requirements for each option listed. For example, if a proposed design has a glazing ratio to the conditioned floor area of 13%, it shall comply with all of the requirements of the 15% glazing option (or higher). Proposed designs which cannot meet the specific requirements of a listed option above may calculate compliance by Chapters 4 or 5 of this Code.
- 2. Requirement applies to all ceilings except single rafter or joist vaulted ceilings complying with Note 3. "Adv" denotes Advanced Framed Ceiling.
- 3. Requirement applicable only to single rafter or joist vaulted ceilings where both 9a) the distance between the top of the ceiling and the underside of the roof sheathing is less than 12 inches and (b)

- there is a minimum 1-inch vented airspace above the insulation. other single rafter or joist vaulted ceilings shall comply with the "ceiling" requirements. This option is limited to 500 square feet of ceiling area for any one dwelling unit.
- 4. Below grade walls shall be insulated either on the exterior to a minimum level of R-12, or on the interior to the same level as walls above grade. Exterior insulation installed on below grade walls shall be a water resistant material, manufactured for its intended use, and installed according to the manufacturer's specifications. See Section 602.2.
- 5. Floors over crawl spaces or exposed to ambient air conditions.
- 6. Required slab perimeter insulation shall be a water resistant material, manufactured for its intended use, and installed according to manufacturer's specifications. See Section 602.4.

- 7. Int. denote standard framing 16 inches on center with headers insulated with a minimum of R-10 insulation.
- 8. This wall insulation requirement denotes R-19 wall cavity insulation plus R-5 foam sheathing.
- 9. Doors, including all fire doors, shall be assigned default U-Factors from Table 10-6C.
- 10. Where a maximum glazing area is listed, the total glazing area (combined vertical plus overhead) as a percent of gross conditioned floor area shall be less than or equal to that value. Overhead glazing with U-Factor of U = 0.40 or less is not included in glazing area limitations.
- 11. Overhead glazing shall have U-Factors determined in accordance with NFRC 100 or as specified in Section 502.1.5.
- 12. Log and solid timber walls with a minimum average thickness of 3.5" are exempt from this insulation requirement.

Single Rafter Joist

[Table 6-1, 6-2, 5-1 footnote 3]

Footnote of Tables 6-1, 6-2, 5-1 limit the use of R-30 single rafter joist as follows:

Footnote 3. Requirement applicalbe only to single rafter or joist vaulted ceilings where both (a) the distance between the top of the ceiling and the underside of the roof sheathing is less than 12 inches and (b) there is a minimum 1-inch vented airspace above the insulation. Other single rafter or joist vaulted ceilings shall comply with the "ceiling" requirements. This option is limited to 500 square feet of ceiling area for any one dwelling unit.

If there is room in the joist for R-38 insulation, R-38 is required. This applies to all single rafter joist 13 inches or greater in depth.

R-30 single rafter joist now limited to 500 square feet of roof area. Additional rafter area must use R-38 insulation. A take off noting rafter area will be required for all R-30 rafter systems.

Figure 1-2 shows typical insulation requirements for single rafter joist. If the table notes R-38, then R-38 is required.

**Footnote 3, Table 6-1 or 6-2
Prescriptive Rafter Insulation Based on Fiberglass Batts**

Nominal	Actual	Max Depth with 1 inch Ventilation	First 500 SF R-Value	Over 500 SF R-Value
2 x 10	9 1/4"	8 1/4"	R-30 HD ²	Note ¹
2 x 12	11 1/4"	10 1/4"	R-30	R-38 HD ²
2 x 14	13 1/4"	13 1/4"	R-38	R-38
I-Joist	9 1/2"	8 1/2"	R-30 HD ²	Note ¹
I-Joist	11 7/8"	10 7/8"	R-30	R-38 HD ²
I-Joist	14"	13"	R-38	R-38
I-Joist	16"	15"	R-38	R-38

Note¹ – Upsize joist or provide an alternative method meeting U-.027.

HD² – Refers high density fiberglass batt or equivalent.

Figure 1-2

Component Performance Approach

[502.1]

Calculations Required

If none of the prescriptive options are suitable for your house design, you may be able to show compliance using the component performance approach. This process allows trading off the thermal efficiency of one component for another; for example, more attic insulation may allow less wall insulation.

To calculate energy performance, you must determine each building component's area and U-factor (default U-factors for common building practices are listed in Chapter 10 of the WSEC and summarized in Chapter 10 of this Guide). Multiply the U-factor for each component by the component area. That gives a component UA. Add component UAs to find overall UA for the proposed building.

The overall UA must be compared to a target value based on WSEC specifications, found in WSEC Table 5-1. The overall target UA is calculated by multiplying the component areas from the proposed design by prescribed U-factors from the Code. Glazing in the reference calculation is limited to 15 percent of the conditioned floor area. The proposed overall UA must be less than or equal to the target UA to show compliance.

To choose the correct target from WSEC Table 5-1, identify the Climate Zone for the home.

The WSU Extension Energy Program developed spread sheets that simplify the component performance calculations. They are discussed in more detail at the end of this chapter.

WSEC Table 5-1

Target Component Values for Group R Occupancy

Component	Climate Zone	
	1	2
Glazing % Floor Area	15%	15%
Vertical Glazing U-Factor		
Group R-1 and R-2	U = 0.400	U = 0.400
Group R-3 and R-4	U = 0.350	U = 0.350
Overhead Glazing U-Factor	U = 0.58	U = 0.58
Doors	U = 0.200 (R-5)	U = 0.200 (R-5)
Ceilings		
Attic	U = 0.031 (R-38)	U = 0.031 (R-38)
Single Rafter / Joist Vaulted ³	U = 0.034 (R-30)	U = 0.034 (R-30)
Walls ^{1,2}	U = 0.057 (R-21)	U = 0.044 (R-19A + R-5)
Floors	U = 0.029 (R-30)	U = 0.029 (R-30)
Slab on Grade	F = 0.54 (R-10)	F = 0.54 (R-10)
Below Grade Interior		
Wall R-Value	R-19	R-19
2' Depth: Walls	U = 0.043	U = 0.043
Slab	F = 0.69	F = 0.69
3.5' Depth: Walls	U = 0.041	U = 0.041
Slab	F = 0.64	F = 0.64
7' Depth: Walls	U = 0.037	U = 0.037
Slab	F = 0.57	F = 0.57
Below Grade Exterior		
Wall R-Value	R-10	R-12
2' Depth: Walls	U = 0.070	U = 0.061
Slab	F = 0.60	F = 0.60
3.5' Depth: Walls	U = 0.064	U = 0.057
Slab	F = 0.57	F = 0.57
7' Depth: Walls	U = 0.056	U = 0.050
Slab	F = 0.42	F = 0.42

1. Log and solid timber walls that have a minimum average thickness of 3.5" in spaces with space heating by "other fuels" are exempt from wall target UA and proposed UA calculations.

2. "A" means advanced framing. For more information, see Section 1005.2.

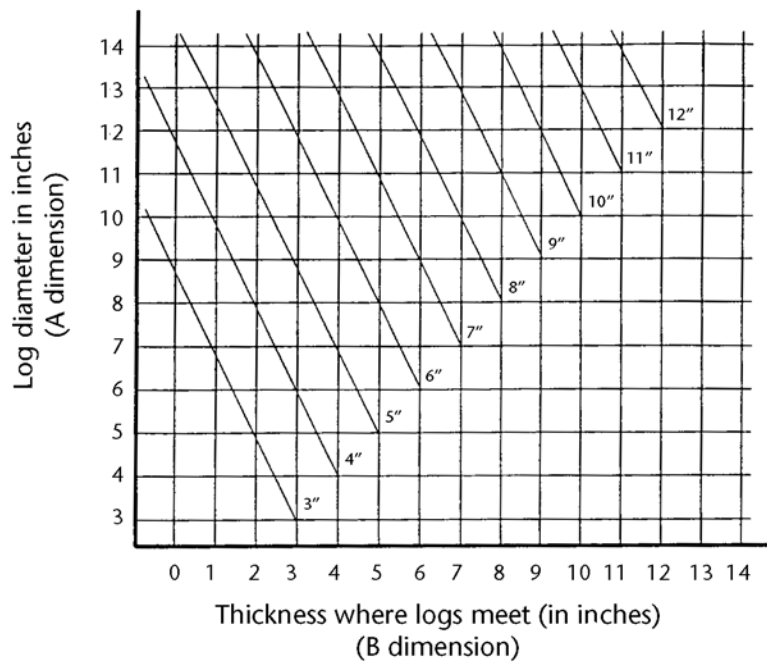
3. Requirement applicable only to single rafter or joist vaulted ceilings where both (a) the distance between the top of the ceiling and the underside of the roof sheathing is less than 12 inches and (b) there is a minimum 1-inch vented airspace above the insulation. Other single rafter or joist vaulted ceilings shall comply with the "ceiling" requirements. This option is limited to 500 square feet of ceiling area for any one dwelling unit.

Log Walls

Footnote 12 of Tables 6-1 and 6-2 and Footnote 1 of Table 5-1 provide an exemption for log walls with a minimum average thickness of 3.5". The home must be heated with "other fuels" to qualify for this exception.

Figure 1-3 provides a method for determining average thickness, based on the log diameter, and the thickness of where two logs meet.

Average Thickness For Round Log Walls



Example:
A = 11"
B = 5"



From chart:
Average thickness = 7"

Figure 1-3

Systems Analysis

Computer Simulation Recommended

[402.1.2]

The System Analysis Approach requires a calculation of the annual energy use of the proposed design. If the calculation demonstrates that the proposed design uses less heating energy than the Code defined target home, it meets the envelope requirements of the Code.

The calculation must be done as described in Chapter 4 of the Code. It must account for local weather data, air infiltration, heating system efficiencies, solar gains, and internal gains including occupancy loads, as well as the building shell insulation. The envelope requirements for the home are based on the component performance target UA. For other systems, refer to WSEC Chapter 4.

When your design includes high efficiency heating equipment, or solar gain and thermal mass, systems analysis may allow trades between other components. The calculation is complex, however, and should be done using a computer program that is capable of documenting all of the building system interactions. This may require the help of a design professional.

WSEC Chapter 8 suggests software that may be used for systems analysis. The WSU Extension Energy Program suggests that users interested in demonstrating compliance using the systems analysis approach use one of the many variations of DOE-2 software. Additional information on documenting code compliance is included at the end of this chapter.

Systems Analysis

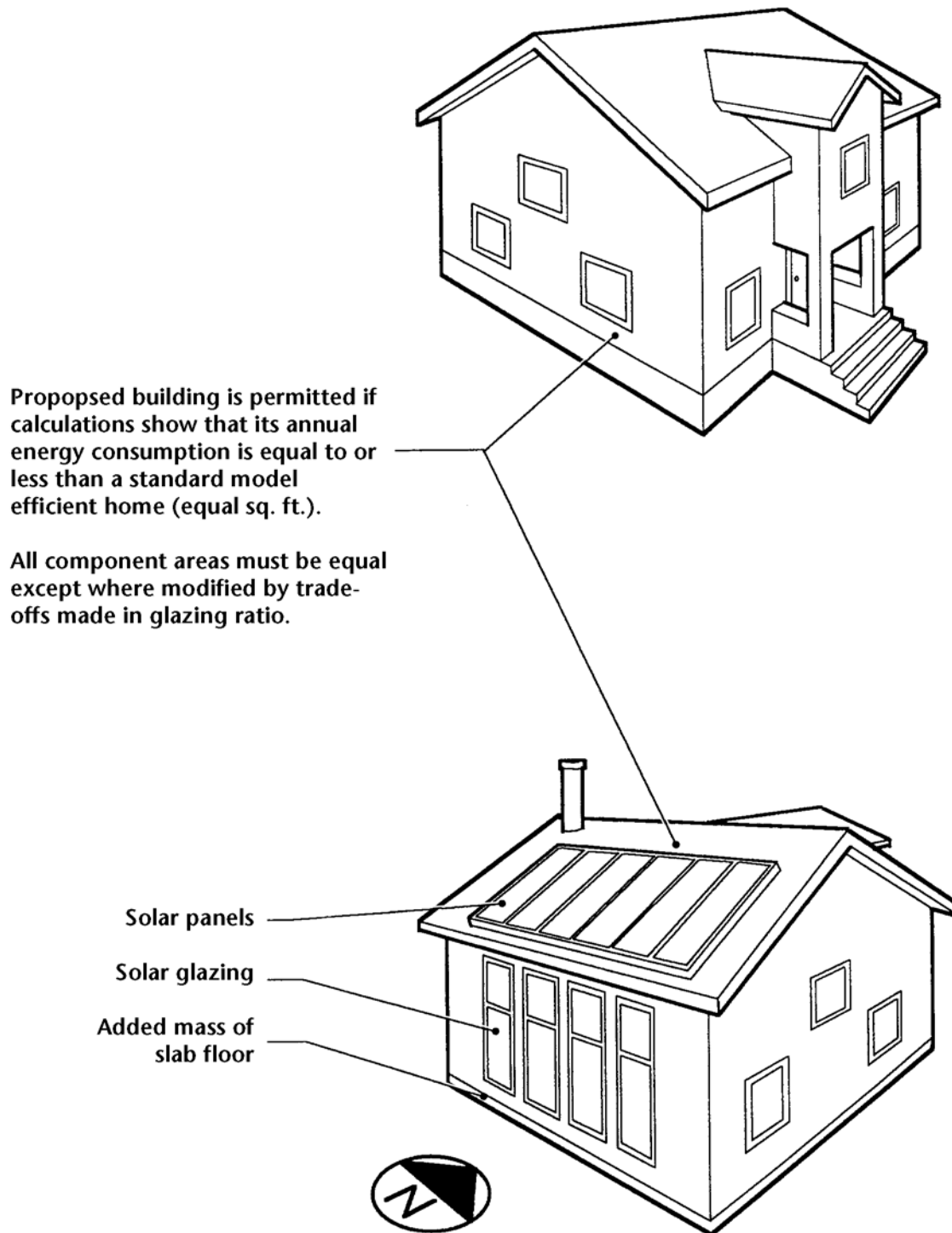


Figure 1-4

Ventilation and Indoor Air Quality

Regardless of the compliance approach used to meet the WSEC, *all homes* must also comply with the provisions of the VIAQ Code. This Code requires:

- [V302.3] Spot and whole-house ventilation in all residential construction.
- [V502] Radon mitigation measures for all crawl spaces and crawl-space plenum systems.
- [V401.1] Structural building materials with low levels of formaldehyde emissions.
- [V402.2] Combustion air supply for all solid fuel appliances.
- [V501.2.2] **Seven counties in the state** (Clark, Ferry, Okanogan, Pend Oreille, Skamania, Spokane, and Stevens) are considered at higher risk for radon and must meet additional prescriptive radon measures (see Figure 1-5). The additional measures include: sub-slab gravel, radon vent stack and sealing below-grade walls and floor.

Higher Risk Radon Counties

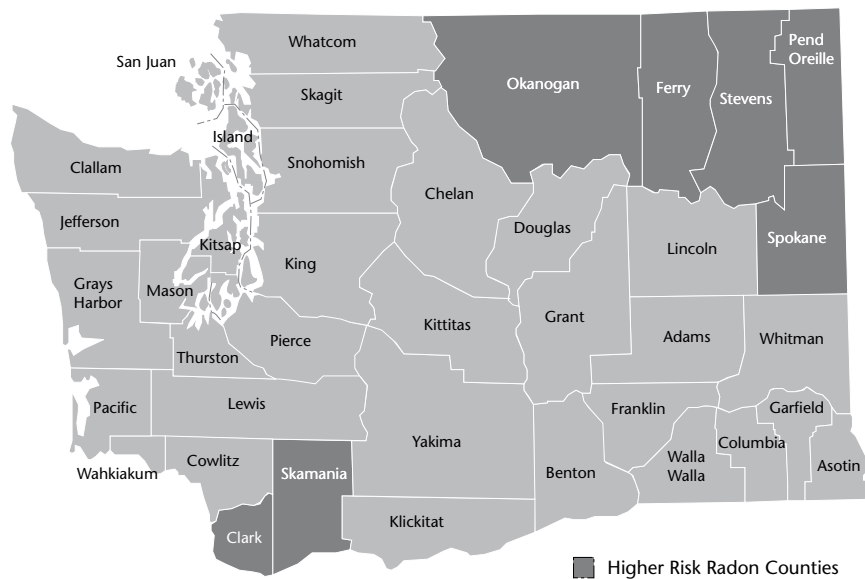


Figure 1-5

In 2006, Washington state adopted the International Residential Code *Appendix F, Radon Control Methods*. This appendix applies to one and two family dwellings only. All other Group R construction must meet the radon resistive construction requirements of the VIAQ.

The Washington state amendments to the International Residential Code, Section AF101.1, prohibits the use of the unvented crawl spaces in high risk Radon counties (Clark, Ferry, Okanogan, Pend Oreille, Skamania, Spokane, and Stevens). For all other counties, when unvented crawl spaces are constructed, Radon mitigation system in compliance with Appendix F is required.

Additions and Remodeling

[101.3.2.1-8,
V103.1.1-2]

Additions and remodeling to a home must meet requirements of the WSEC and the VIAQ Code.

Table 1-1

Remodeling Requirements

Replacement of:	Requirement
Combustion Furnace	Minimum AFUE 78%.
Heat Pump	Minimum HSPF 7.7
Water Heater	Meet 1987 National Appliance Energy Conservation Act (NAECA). Set to 120° F.
Electric Water Heaters	R-10 insulated pad in unconditioned space or on uninsulated slabs.
Solid Fuel Combustion Devices	Direct connection of outside combustion air. Tight fitting doors. See exceptions Chapter 9.
Window Replacement	Required U-factor – 0.35
Insulation Walls & Ceilings	Exposed cavities must be filled to the requirements of Table 6-1 or 6-2, or have an average UA that complies with the requirements of Table 5-1. Where structural elements limit the level of insulation that can be applied to less than the code requirements, the cavities must be filled. Roof decks must be insulated to the requirement of the code if a complete roof tear-off is part of the work.
[101.3.2.5]	

There are a few exceptions (historical buildings and other special cases) when the WSEC and VIAQ Code may not be fully enforced. Check with your local jurisdiction.

Table 1-2

Additions Requirements

Size	Code Compliance for Additions
Under 500 ft. ²	Must meet spot ventilation regulations. Whole house ventilation not required.
Over 500 ft. ²	Whole house and spot ventilation requirement.
Under 750 ft. ²	Addition can comply with the WSEC either by prescriptive approach, or by using tradeoffs with existing building for WSEC compliance.*
Over 750 ft. ²	Addition must show full WSEC compliance as a stand alone project.

**See component performance approach.*

The need to perform complicated tradeoffs for additions was reduced considerably with the introduction of unlimited glazing options in the prescriptive approach. Consider the prescriptive approach first.

Note:

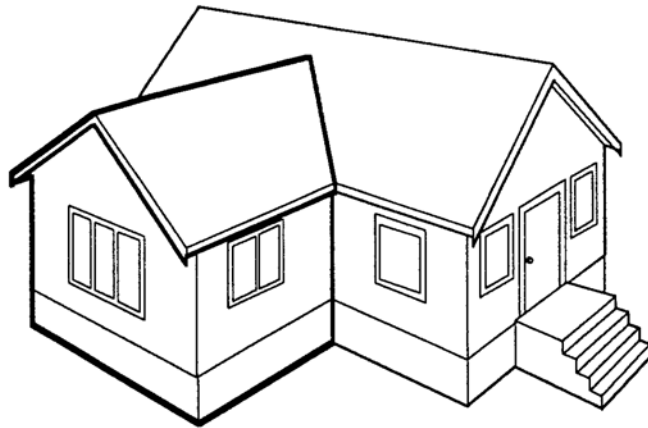
Radon protection is required in additions that call for construction of foundations, crawl-spaces, slabs or basements, and is not required where these features are not in the design.

All additions of any size must meet VIAQ specifications for formaldehyde and solid fuel combustion appliances.

[V501.1]

Energy Code Requirements for Additions

If an addition complies with the energy code... no change is required in the existing building.



A non-complying addition <750 sq. ft. is permitted if improvements made to existing building (increasing ceiling insulation) to compensate for a non-complying addition.

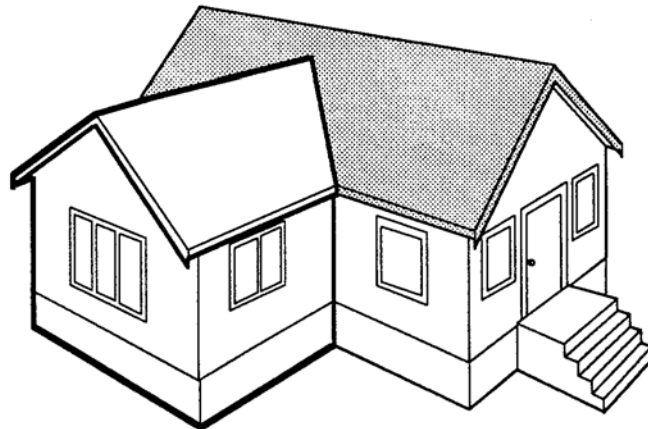
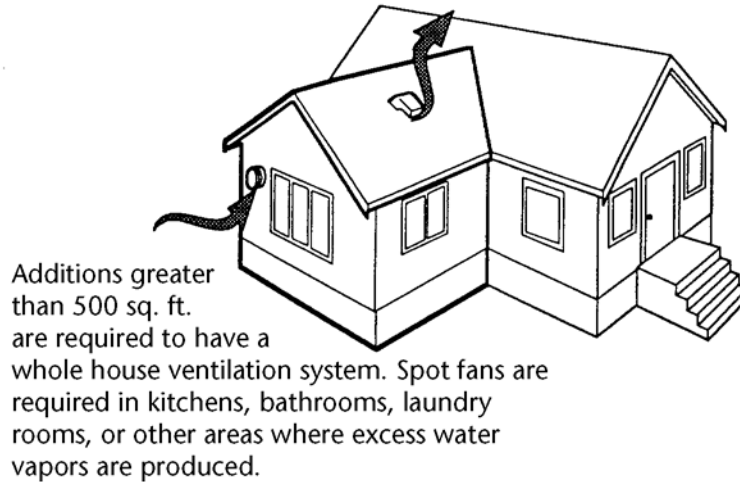


Figure 1-6

Ventilation and Indoor Air Quality Code Requirements for Additions



Radon Requirements for Additions

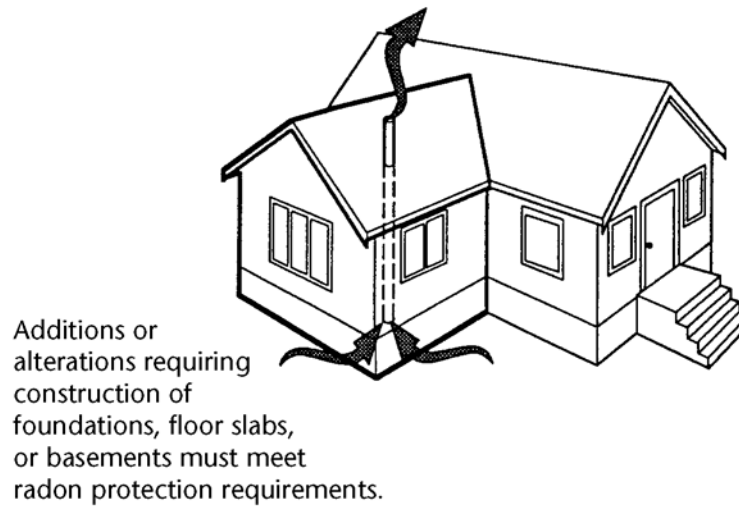


Figure 1-7

Documenting Code Compliance

To obtain a building permit you will be required to provide the local building department with a description of the Energy and Ventilation Code compliance approach that will be used. This will include details on the plans and documentation required to demonstrate compliance with the code requirements. This will typically include energy code compliance forms, and a description of the chosen ventilation systems.

Plans and Specifications

The codes requires that sufficient detail be included on the plan set to assure that the energy code requirements are implemented during construction. This *Builder's Field Guide* book includes many examples of insulation and air sealing details. A similar level of detail should be included as part of the plan set. A few examples of areas needing good details follow.

Framing:

- Show framing with sufficient depth to accommodate the required insulation.
- Detail header insulation when insulated headers are required.

Roof Ventilation:

- Show minimum 1" air space in single rafter joist systems. Provide details for ventilation openings top and bottom on all roof sections.

Slab Insulation:

- Detail insulation integration with the foundation and floor system. Show insulation protection when installed on the exterior. Show the thermal break on the vertical edge of below grade heated slabs.

Vapor Retarder:

- Indicate the type and location of vapor retarders.

Air Sealing:

- Detail difficult areas, including attic knee walls, cantilevered floor systems, mechanical and plumbing chases, etc.

Ducts:

- Provide framing details with specific space for major duct runs.

The Prescriptive Approach

For the Washington State Energy Code, the prescriptive approach is the simplest method of code compliance. The WSU Extension Energy Program has created an Excel[®] spreadsheet to help you provide documentation with the prescriptive building envelope sections of the code. This worksheet also helps you provide documentation required to meet the heating system sizing requirements of IRC section M1401.3. To select the correct worksheet, you will need know the building occupancy type and climate zone. The worksheet is available from the WSUEEP website at www.energy.wsu.edu/code/

Component Performance Approach

The WSU Extension Energy Program developed a package of Excel[®] worksheets designed to document the qualification of building designs by the component performance approach described in Chapter 5 of the WSEC.

There are two worksheets: The **CPLibrary** contains all of the component descriptions in Chapter 10 of the WSEC. The **CPworksheet** includes the compliance forms for all building types and climate zones. Both workbooks can be downloaded as a set from the WSU Extension Energy Program website: www.energy.wsu.edu/code/

Systems Analysis Approach

The WSU Extension Energy Program no longer provides software that supports a systems analysis approach. Select a DOE-2 based software package for this type of analysis. Use the WSUEEP component performance worksheet to develop a target and proposed building envelope as required by the code. Then load this information into a DOE-2 product and perform the systems analysis.

For a complete list of DOE-2 compliant software available from the Simulation Research Group at Lawrence Berkeley National Laboratory in Berkeley, California, visit their website at <http://gundog.lbl.gov>

The Simulation Research Group specializes in creating building energy simulation software.