Prescriptive Residential Energy Conservation Requirements

TABLE N1101.1(1)
PRESCRIPTIVE ENVELOPE REQUIREMENTS [a]

Building Component	Standard Base Case: Required Performance	Standard Base Case: Equiv. Value [b]	Log Homes Only: Required Performance	Log Homes Only: Equiv. Value [b]
Wall insulation-above grade	U-0.060	R-21 [c]	[d]	[d]
Wall insulation-below grade [e]	F-0.565	R-15	F-0.565	R-15
Flat ceilings [f]	U-0.031	R-38	U-0.025	R-49
Vaulted ceilings [g]	U-0.042	R-38[g]	U-0.027	R-38A[h]
Underfloors	U-0.028	R-30	U-0.028	R-30
Slab edge perimeter	F-0.520	R-15	F-0.520	R-15
Heated slab interior [i]	n/a	R-10	n/a	R-10
Windows [j]	U-0.35	U-0.35	U-0.35	U-0.35
Window area limitation [k]	n/a	n/a	n/a	n/a
Skylights [l]	U-0.60	U-0.60	U-0.60	U-0.60
Exterior doors [m]	U-0.20	U-0.20	U-0.54	U-0.54
Exterior doors w/>2.5 ft^2 glazing [n]	U-0.40	U-0.40	U-0.40	U-0.40
Forced air duct insulation	n/a	R-8	n/a	R-8

a As allowed in Section N1104.1, thermal performance of a component may be adjusted provided that overall heat loss does not exceed the total resulting from conformance to the required *U*-value standards. Calculations to document equivalent heat loss shall be performed using the procedure and approved *U*-values contained in Table N1104.1(1).

b R-values used in this table are nominal, for the insulation only in standard wood framed construction and not for the entire assembly.

c Wall insulation requirements apply to all exterior wood framed, concrete or masonry walls that are above grade. This includes cripple walls and rim joist areas. R-19 Advanced Frame or 2 x 4 wall with rigid insulation may be substituted if total nominal insulation *R*-value is 18.5 or greater.

d The wall component shall be a minimum solid log or timber wall thickness of 3.5 inches (90 mm).

e Below-grade wood, concrete or masonry walls include all walls that are below grade and does not include those portions of such wall that extend more than 24 inches above grade.

f Insulation levels for ceilings that have limited attic/rafter depth such as dormers, bay windows or similar architectural features totaling not more than 150 square feet (13.9 m^2) in area may be reduced to not less than R-21. When reduced, the cavity shall be filled (except for required ventilation spaces).

g The maximum vaulted ceiling surface area shall not be greater than 50 percent of the total heated space floor area unless area has a U-factor no greater than U-0.031. The U-factor of 0.042 is representative of a vaulted scissor truss. A 10-inch deep rafter vaulted ceiling with R-30 insulation is U-0.033 and complies with this requirement, not to exceed 50 percent of the total heated space floor area.

h A=advanced frame construction, which shall provide full required insulating value to the outside of exterior walls.

i Heated slab interior applies to concrete slab floors (both on and below grade) that incorporate a radiant heating system within the slab. Insulation shall be installed underneath the entire slab.

j. Sliding glass doors shall comply with window performance requirements. Windows exempt from testing in accordance with NF1111.2 Item 3 shall comply with window performance requirements if constructed with thermal break aluminum or wood, or vinyl, or fiberglass frames and double-pane glazing with low-emissivity coatings of 0.10 or less. Buildings designed to incorporate passive solar elements may include glazing with a U-factor greater than 0.35 by using Table N1104.1(1) to demonstrate equivalence to building envelope requirements.

k Reduced window area may not be used as a trade-off criterion for thermal performance of any component.

l Skylight area installed at 2% or less of total heated space floor area shall be deemed to satisfy this requirement with vinyl, wood, or thermally broken aluminum frames and double-pane glazing with low-emissivity coatings. Skylight U-factor is tested in the 20 degree overhead plane per NFRC standards.

m A maximum of 28 square feet (2.6 m^2) of exterior door area per dwelling unit can have a U-factor of 0.54 or less.

n Glazing that is either double pane with low-e coating on one surface, or triple pane shall be deemed to comply with this U-0.40 requirement.

TABLE N1101.1(2)
ADDITIONAL MEASURES (select one) [a]

	Measure
1	High efficiency HVAC system: Gas-fired furnace or boiler with minimum AFUE of 90%[a], or Air-source heat pump with minimum HSPF of 8.5 or Closed-loop ground source heat pump with minimum COP of 3.0
2	High efficiency duct sealing: Certified performance tested duct systems [b] or All ducts and air handler are contained within building envelope [a]
3	High efficiency building envelope: Replace corresponding Table N1101.1(1) components with all of the following: Wall above grade – U-0.047 / R-19+R-5 continuous, and Vaulted ceilings – U-0.033 / R-30A[c, d], and Flat ceilings – U-0.025 / R-49, and Windows – U-0.32
4	Zonal electric, ductless furnace or ductless heat pumps: 75 percent of permanently installed lighting fixtures as CFL or linear fluorescent or a min efficacy of 40 lumens per watt, or Windows – U-0.32, or Flat ceilings – U-0.025 / R-49 and vaulted ceilings – U-0.033 / R-30A or Exterior walls – U-0.047 / R-19+R-5 continuous
5	High efficiency ceilings & windows/lighting: Replace corresponding Table N1101.1(1) components with all of the following: Vaulted ceilings – U-0.033 / R-30A[c, d], and Flat ceilings – U-0.025 / R-49, and Windows – U-0.32, and 75 percent of permanently installed lighting fixtures as CFL or linear fluorescent or a min efficacy of 40 lumens per watt
6	High efficiency ceilings & windows / water heating: Replace corresponding Table N1101.1(1) components with all of the following: Vaulted ceilings – U-0.033 / R-30A[c, d], and Flat ceilings – U-0.025 / R-49, and Windows – U-0.32, and Natural gas/propane, on-demand water heating with min EF of 0.80
7	High efficiency water heating / lighting: Natural gas/propane, on-demand water heating with min EF of 0.80 75 percent of permanently installed lighting fixtures as CFL or linear fluorescent or a min. efficacy of 40 lumens per watt
8	Solar photovoltaic: Minimum 1 Watt / sq ft. conditioned floor space [e]
9	Solar water heating: Minimum of 40 ft^2 of gross collector area [f]

[a] Furnaces located within the building envelope shall have sealed combustion air installed. Combustion air shall be ducted directly from the outdoors.

[b] Documentation of Performance Tested Ductwork shall be submitted to the Building Official upon completion of work. This work shall be performed by a contractor that is certified by the Oregon Department of Energy's (ODOE) Residential Energy Tax Credit program and documentation shall be provided that work demonstrates conformance to ODOE duct performance standards.

[c] A=advanced frame construction, which shall provide full required ceiling insulation value to the outside of exterior walls.

[d] The maximum vaulted ceiling surface area shall not be greater than 50 percent of the total heated space floor area unless vaulted area has a U-factor no greater than U-0.026.

[e] Solar electric system size shall include documentation indicating that Total Solar Resource Fraction is not less than 75%.

[f] Solar water heating panels shall be Solar Rating and Certification Corporation (SRCC) Standard OG-300 certified and labeled, with documentation indicating that Total Solar Resource Fraction is not less than 75%.

This pamphlet is one in a series that describes residential energy conservation requirements of the Oregon Residential Specialty Code and Structural Specialty Code. Other pamphlets in this series may be downloaded from Oregon Department of Energy web site at http://egov.oregon.gov/ENERGY/CONS/Codes/cdpub.shtml or local building departments or from Oregon Building Codes Division.

Actual requirements

Table N1101.1(1) specifies the measure required performance as an overall U-factor (or F-factor). It also list an *insulation only* R-value for that assembly when it is installed within standard wood frame construction.

A non-typical construction may have an equivalent U-factor and not comply (have a lower value) with insulation R-value. An example of this would be a 2-by-4 wall with R-15 batt insulation and continuous exterior R-3 rigid insulation is U-0.058. While the "insulation R-value is only R-18, the overall U-factor is 0.058 and complies with the 0.060 performance requirement.

The following text is excerpted from Chapter 11 of the 2008 Oregon Residential Specialty Code

N1101.1 General. The provisions of this chapter regulate the exterior envelope; the design, construction and selection of heating, ventilating and air-conditioning systems, lighting and piping insulation, required for the purpose of effective conservation of energy within a building or structure governed by this code.

All conditioned spaces within residential buildings shall comply with Table N1101.1(1) and one additional measure from Table N1101.1(2).

Exceptions:

1. Application to existing buildings shall comply with Section N1101.2.
2. Application to additions shall comply with Section N1101.3.

N1107.2 High-efficiency interior lighting systems. A minimum of fifty percent of the permanently installed lighting fixtures shall be compact or linear fluorescent, or a lighting source that has a minimum efficacy of 40 lumens per input watt. Screw-in compact florescent lamps comply with this requirement.

The building official shall be notified in writing at the final inspection that a minimum of fifty percent of the permanently installed lighting fixtures are compact or linear fluorescent, or a minimum efficacy of 40 lumens per input watt.

Note: *Fifty percent of the permanently installed lighting fixtures includes fixtures in the garage and attached to the outside of the building.*

Information presented in this publication supports the Oregon Residential Specialty Code. This publication does not include all code requirements. Refer to the code and check with your code official for additional requirements. If information in this publication conflicts with code or your local officials, follow requirements of code and your local officials.

For more information about the residential energy code, call the Building Codes Division at (503) 378-4133 or the Oregon Dept of Energy (503) 378-4040 in Salem or toll-free, 1-800-221-8035.

This publication was prepared by Alan Seymour, Energy Code Analyst, Oregon Department of Energy for the Oregon Building Codes Division. Funding was provided by Northwest Energy Efficiency Alliance.

Building Codes Division

Working with Oregonians to ensure safe building construction while supporting a positive business climate.

OREGON DEPARTMENT OF ENERGY

Contains recycled materials

Oregon Residential Energy Code

April 2008 • No. 2

Additional Measures *Required Options*

This pamphlet is one in a series that describes residential energy conservation requirements of the Oregon Residential Specialty Code and Structural Specialty Code. Other pamphlets in this series may be downloaded from Oregon Department of Energy web site at http://egov.oregon.gov/ENERGY/CONS/Codes/cdpub.shtml or local building departments or from Oregon Building Codes Division.

Directions for selecting options

Prior to selecting one of the nine measures/options from Table N1101.1(2), one must either comply with the building envelope requirements of Tables N1101.1(1) or N1104.1(1).

If you are demonstrating building envelope compliance using Table N1104.1(1), other combinations of building envelope measures may be used to show that this combination achieves the performance standard of the Standard Base Case.

You must carefully select an additional measure from Table N1101.1(2) when using Table N1104.1(1). It is simpler to select an additional measure that does not contain a building envelope improvement. If you select an additional measure that requires building envelope improvements, that improvement must be used as the Standard base case value, in lieu of that value. In addition to the modified calculation, any non-envelope measure must be installed.

See publication #12, *How to Do Residential Thermal Performance Calculations Using Table N1104.1(2)* for examples of how to incorporate building envelope Additional Measures into Table N1104.1(1) calculations.

1	High efficiency HVAC system: Gas-fired furnace or boiler with minimum AFUE of 90%[a], or Air-source heat pump with minimum HSPF of 8.5 or Closed-loop ground source heat pump with minimum COP of 3.0

Measure 1: High efficiency HVAC system

This option requires one of three different type of high efficiency (above code performance) HVAC systems.

The **gas-fired furnace** includes natural gas and propane furnaces. 90% AFUE is a minimum performance value; this unit may exceed this performance requirement.

78% AFUE is the minimum code requirement for gas-fired furnaces.

The **gas-fired boiler** includes natural gas and propane boilers. 90% AFUE is a minimum performance value; this unit may exceed this performance requirement.

80% AFUE is the minimum code requirement for gas-fired boilers. 75% AFUE is the minimum code requirement for gas-fired steam boilers.

Footnote a states that furnaces and boilers located within the building envelope shall have sealed combustion air installed. Combustion air must be ducted directly from the outdoors.

Air-source heat pump must have a minimum HSPF of 8.5; this unit may exceed this performance requirement.

7.7 HSPF and 13.0 SEER is the minimum code requirement for heat pumps.

Closed-loop ground source heat pumps must have a minimum efficiency of 3.0 COP.

Code does not have a minimum code efficiency requirement for closed-loop ground source heat pumps.

2	High efficiency duct sealing: Certified performance tested duct systems [b] or All ducts and air handler are contained within building envelope [a]

Measure 2: High efficiency duct sealing

This option requires one of two different methods of improving HVAC duct efficiency (above code performance).

All **HVAC ducts** must be **certified** that **performance tested** through a process that demonstrates compliance with the Oregon Department of Energy's Residential Energy Tax Credit duct performance standards. Documentation of this work being done to these standards must be provided top the Building Official upon completion of work.

Footnote b states that documentation of Performance Tested Ductwork shall be submitted to the Building Official upon completion of work. This work shall be performed by a contractor that is certified by the Oregon Department of Energy's (ODOE) Residential Energy Tax Credit program and documentation shall be provided that work demonstrates conformance to ODOE duct performance standards.

All ducts and air handler are located within the building envelope (conditioned space). Air handler shall have sealed combustion air installed. Combustion air must be ducted directly from the outdoors.

3	High efficiency building envelope: Replace corresponding Table N1101.1(1) components with all of the following: Wall above grade – U-0.047 / R-19+R-5 continuous, and Vaulted ceilings – U-0.033 / R-30A[c, d], and Flat ceilings – U-0.025 / R-49, and Windows – U-0.32

Measure 3: High efficiency building envelope

This option requires that **all** four building envelope measures exceed the Standard base case: wall insulation, vaulted and flat ceiling insulation, and windows.

Above grade wall insulation (including walls between the house and garage) performance requirement is U-0.047, which consists of R-24 (total) insulation in standard wood frame construction.

While R-19 batt insulation with R-5 rigid exterior insulation equals R-24, it does not comply unless the rigid insulation is applied in a "continuous" manner. Often, R-19 + R-5 (one-inch thick insulation) is only installed where exterior structural sheathing (one half-inch thickness) is not required. A sheet of one half-inch thick rigid insulation (R-2.5) is installed over the structural panel.

The overall U-factor of the above described R-19 + R-5 wall is not U-0.047 and does not comply. If the R-19 batt insulation is replaced with R-21 insulation, the overall U-factor will comply.

Vaulted ceilings must have a minimum performance of U-0.033 or R-30 insulation in advance framed wood construction. A two-by-ten wood rafter with high density batt insulation is U-0.033. A standard wood scissors truss with R-30 (U-0.046) or R-38 (U-0.042) **does not comply** with this requirement. An *advance framed* wood scissors truss with R-30 insulation (U-0.32) complies with this requirement.

The area of vaulted ceiling at U-0.033 is limited to 50 percent of the total heated space floor area. The area in excess of 50 percent must be insulated to U-0.025. See Table N1104.1(2) for default U-factors of assemblies that meet U-0.025.

Flat ceilings must have a minimum performance of U-0.025 or R-49 insulation in standard wood framed construction.

Windows, including sliding glass doors (SGD) must have a maximum U-0.32 value.

4	Zonal electric, ductless furnace or ductless heat pumps: 75 percent of permanently installed lighting fixtures as CFL or linear fluorescent or a min efficacy of 40 lumens per watt, or Windows – U-0.32, or Flat ceilings – U-0.025 / R-49 and vaulted ceilings – U-0.033 / R-30A or Exterior walls – U-0.047 / R-19+R-5 continuous

Measure 4: Zonal electric, ductless furnace, or ductless heat pumps

This option requires that **one** of the following bulleted measures is installed. Only homes, or dwelling units with either zonal electric (hydronic, zoned hot water does not qualify), ductless furnace, or ductless heat pump qualify for this option. The applicant may have one of these types of heat sources and choose to select a different option if they desire to do so.

- A minimum of **75 percent of the permanently installed lighting fixtures** must be either compact fluorescent, linear fluorescent, or have a minimum efficacy of 40 lumens per watt.

Note: *75 percent of the permanently installed lighting fixtures includes fixtures in the garage and attached to the outside of the building. Screw-in compact fluorescent lamps may be used in incandescent fixtures. Fixtures must be able to accept screw-in lamps and lamps must be the appropriate type for the application.*

Recessed down lights take a special compact fluorescent lamp as well as fixtures located outdoors or in cold areas such as the garage and those controlled by a dimmer.

- **Windows, including sliding glass doors** (SGD) must have a maximum U-0.32 value.

- **Flat ceilings** must have a minimum performance of U-0.025 or R-49 insulation in standard wood framed construction.

Vaulted ceilings must have a minimum performance of U-0.033 or R-30 insulation in advance framed wood construction. A two-by-ten wood rafter with high density batt insulation is U-0.033. A standard wood scissors truss with R-30 (U-0.046) or R-38 (U-0.042) **does not comply** with this requirement. An *advance framed* wood scissors truss with R-30 insulation (U-0.32) complies with this requirement.

The area of vaulted ceiling at U-0.033 is limited to 50 percent of the total heated space floor area. The area in excess of 50 percent must be insulated to U-0.025. See Table N1104.1(2) for default U-factors of assemblies that meet U-0.025.

- **Above grade wall insulation** (including walls between the house and garage) performance requirement is U-0.047, which is based on R-19 batt plus R-5 continuous rigid (R-24 total) insulation in standard wood frame construction.

While R-19 batt insulation with R-5 rigid exterior insulation equals R-24, it does not comply unless the rigid insulation is applied in a "continuous" manner. Often, R-19 + R-5 (one-inch thick insulation) is only installed where exterior structural sheathing (one half-inch thickness) is not required. A sheet of one half-inch thick rigid insulation (R-2.5) is installed over the structural panel.

The overall U-factor of the above described R-19 + R-5 wall is not U-0.047 and does not comply. If the R-19 batt insulation is replaced with R-21 insulation, the overall U-factor will comply.

5	High efficiency ceilings & windows/lighting: Replace corresponding Table N1101.1(1) components with all of the following: Vaulted ceilings – U-0.033 / R-30A[c, d], and Flat ceilings – U-0.025 / R-49, and Windows – U-0.32, and 75 percent of permanently installed lighting fixtures as CFL or linear fluorescent or a min efficacy of 40 lumens per watt

Measure 5: High efficiency ceilings, windows and lighting

This option requires that **all** of the following measures are installed.

Vaulted ceilings must have a minimum performance of U-0.033 or R-30 insulation in advance framed wood construction. A two-by-ten wood rafter with high density batt insulation is U-0.033. A standard wood scissors truss with R-30 (U-0.046) or R-38 (U-0.042) **does not comply** with this requirement. An *advance framed* wood scissors truss with R-30 insulation (U-0.32) complies with this requirement.

The area of vaulted ceiling at U-0.033 is limited to 50 percent of the total heated space floor area. The area in excess of 50 percent must be insulated to U-0.025. See Table N1104.1(2) for default U-factors of assemblies that meet U-0.025.

Flat ceilings must have a minimum performance of U-0.025 or R-49 insulation in standard wood framed construction.

Windows, including sliding glass doors (SGD) must have a maximum U-0.32 value.

A minimum of **75 percent of the permanently installed lighting fixtures** must be either compact fluorescent, linear fluorescent, or have a minimum efficacy of 40 lumens per watt.

Note: *75 percent of the permanently installed lighting fixtures includes fixtures in the garage and attached to the outside of the building. Screw-in compact fluorescent lamps may be used in incandescent fixtures. Fixtures must be able to accept screw-in lamps and lamps must be the appropriate type for the application.*

Recessed down lights take a special compact fluorescent lamp as well as fixtures located outdoors or in cold areas such as the garage and those controlled by a dimmer.

6	High efficiency ceilings & windows / water heating: Replace corresponding Table N1101.1(1) components with all of the following: Vaulted ceilings – U-0.033 / R-30A[c, d], and Flat ceilings – U-0.025 / R-49, and Windows – U-0.32, and Natural gas/propane, on-demand water heating with min EF of 0.80

Measure 6: High efficiency ceilings, windows and water heating

This option requires that **all** of the following measures are installed.

Vaulted ceilings must have a minimum performance of U-0.033 or R-30 insulation in advance framed wood construction. A two-by-ten wood rafter with high density batt insulation is U-0.033. A standard wood scissors truss with R-30 (U-0.046) or R-38 (U-0.042) **does not comply** with this requirement. An *advance framed* wood scissors truss with R-30 insulation (U-0.32) complies with this requirement.

The area of vaulted ceiling at U-0.033 is limited to 50 percent of the total heated space floor area. The area in excess of 50 percent must be insulated to U-0.025. See Table N1104.1(2) for default U-factors of assemblies that meet U-0.025.

Flat ceilings must have a minimum performance of U-0.025 or R-49 insulation in standard wood framed construction.

Windows, including sliding glass doors (SGD) must have a maximum U-0.32 value.

On-demand, tank-less, gas-fired water heater must have a minimum EF of 0.80.

7	High efficiency water heating / lighting: Natural gas/propane, on-demand water heating with min EF of 0.80 75 percent of permanently installed lighting fixtures as CFL or linear fluorescent or a min. efficacy of 40 lumens per watt

Measure 7: High efficiency water heating and lighting

This option requires that **all** of the following measures are installed.

On-demand, tank-less, gas-fired water heater must have a minimum EF of 0.80.

A minimum of **75 percent of the permanently installed lighting fixtures** must be either compact fluorescent, linear fluorescent, or have a minimum efficacy of 40 lumens per watt.

Note: *75 percent of the permanently installed lighting fixtures includes fixtures in the garage and attached to the outside of the building. Screw-in compact fluorescent lamps may be used in incandescent fixtures. Fixtures must be able to accept screw-in lamps and lamps must be the appropriate type for the application.*

Recessed down lights take a special compact fluorescent lamp as well as fixtures located outdoors or in cold areas such as the garage and those controlled by a dimmer.

8	Solar photovoltaic: Minimum 1 Watt / sq ft. conditioned floor space [e]

Measure 8: Solar photovoltaic

This option requires a solar photovoltaic system size to include documentation indicating that Total Solar Resource Fraction is not less than 75%.

Total Solar Resource Fraction is the fraction of usable solar energy that is received by the solar panel/collector throughout the year. This accounts for the impacts due to external shading, collector tilt and collector orientation.

9	Solar water heating: Minimum of 40 ft^2 of gross collector area [f]

Measure 9: Solar water heating

This option requires a solar water heating panels shall be Solar Rating and Certification Corporation (SRCC) Standard OG-300 certified and labeled, with documentation indicating that Total Solar Resource Fraction is not less than 75%.

Total Solar Resource Fraction is the fraction of usable solar energy that is received by the solar panel/collector throughout the year. This accounts for the impacts due to external shading, collector tilt and collector orientation.

Information presented in this publication supports the Oregon Residential Specialty Code. This publication does not include all code requirements. Refer to the code and check with your code official for additional requirements. If information in this publication conflicts with code or your local officials, follow requirements of code and your local officials.

For more information about the residential energy code, call the Building Codes Division at (503) 378-4133 or the Oregon Dept of Energy (503) 378-4040 in Salem or toll-free, 1-800-221-8035.

This publication was prepared by Alan Seymour, Energy Code Analyst, Oregon Department of Energy for the Oregon Building Codes Division. Funding was provided by Northwest Energy Efficiency Alliance.

Building Codes Division

Working with Oregonians to ensure safe building construction while supporting a positive business climate.

OREGON DEPARTMENT OF ENERGY

Contains recycled materials

Oregon Residential Energy Code

April 2008 • No. 3

Windows, Doors and Skylights

This pamphlet is one in a series that describes residential energy conservation requirements of the Oregon Residential Specialty Code and Structural Specialty Code. Other pamphlets in this series may be downloaded from Oregon Department of Energy web site at http://egov.oregon.gov/ENERGY/CONS/Codes/cdpub.shtml or local building departments or from Oregon Building Codes Division.

Prescriptive window and skylight requirements

Since windows and skylights can be the biggest heat losers in the building shell code sets U-factor standards and establishes minor limitations on window and skylight area.

Table N1101.1(1) lists the Standard Base Case and a Log Home case. The window U-factor requirement for Standard Base Case is 0.35.

When skylight area is 2 percent or less of heated space floor area, is deemed-to-satisfy when constructed as follows: Vinyl, or wood, or thermally broken aluminum frames and double-pane glazing with low-emissivity coatings. Skylights in excess of 2 percent of the heated floor area must have a U-factor no less than U-0.60. Skylights shall be tested in the 20 degree overhead plane per NFRC standards.

Window and skylight area limits

The code does not limit window area.

Skylight area is unlimited for skylights with tested U-factors of 0.60 or less. Otherwise, skylight area is limited to 2 percent or less of heated space floor area when constructed of material as described above. If a higher U-factor skylight is used, performance calculations using Table N1104.1(1) must be submitted to show code compliance. The pamphlet *How* to *Do Residential Thermal Performance Calculations Using Table N1104.1(1)* explains the performance calculation procedure.

Calculating skylight area limits

To calculate the 2 percent deemed-to-satisfy skylight area a, multiply the heated space floor area by 0.02. For example, what is the 2 percent deemed-to-satisfy skylight area of a home with 2,300 square feet of heated space floor area?

$$2{,}300 \times 0.02 = 46 \text{ square feet}$$

If skylight area of this home exceeds 46 square feet, skylight U-factor in excess or 46 square feet shall be 0.60. Alternately, a thermal performance calculation (Table N1104.1(1)) could be used to demonstrate compliance.

Window and skylight U-factor

"U-factor" is established in tests that measure rate of heat transfer through an entire window or skylight assembly, including the glass, the edge spacer and frame material.

U-factors are the inverse of R-values: R-value equals 1/U-factor. Thus, lower the U-factor, higher the R-value. Low U-factors mean slower rates of heat transfer and better resistance to heat loss.

Window and skylight U-factors should be indicated on the plan section drawing, in the window schedule or in written specifications accompanying the plan.

Window exceptions

Single pane glazing for decorative or unique architectural features may not exceed 1 percent of floor area. Multi-glazed decorative or unique glazing may qualify as a decorative or unique architectural feature. Examples include door sidelights and transoms, glazing within a door and any unique glazing such as stained glass.

Garden windows also are included in this category. Use their rough opening area to determine allowable exempted area.

Skylights and conventional windows, including but not limited to horizontal sliders, double-hung and picture windows, are not considered decorative or unique architectural features.

Disregard 1 percent decorative or unique architectural feature, exempted glazing when using thermal performance calculations. A note on the blueprints and calculations should indicate which windows are being exempted and their area.

Prescriptive door requirements

In the energy code, exterior doors are divided into two categories: an exempt door and all other exterior doors.

The default U-factor for an untested, unglazed door is 0.54. An untested, unglazed 1-3/4 inch foam insulated core door with a thermal break is assigned a default U-factor of 0.20.

Exterior doors

A maximum of 28 square feet of exterior door area per dwelling unit can have a U-factor of 0.54 or less. The log home case allows less efficient doors (all at U-0.54) to maintain the design character of a log home.

Sliding glass doors are classified as windows and must have the same U-factor that is required for windows.

Door U-factors should be shown on plan section drawings, in the door schedule or in written specifications accompanying the drawings.

Hinged doors with >2.5 ft^2 glazing

Doors that contain more than 2.5 square feet of glazing must comply with an overall U-factor of 0.40. Glazing in these doors will be deemed-to-satisfy code that is either: 1) double pane with low-e coating on one pane; or 2) triple pane glazing

Hinged doors with $\le$2.5 ft^2 glazing

Glazed areas that are 2.5 square feet in area in a door may be exempted as decorative or unique architectural features. The remaining area of the wood door is assigned either: 1) U-0.54 for untested, solid wood doors; or 2) U-0.20 for foam core, insulated doors with a thermal break.

How to find window and skylight U-factor information

Product literature

The code requires tested, rather than calculated U-factors. Product literature available from window suppliers and distributors may contain suitable energy performance information. Make sure cited U-factors were established using the following standard testing procedures:

- NFRC (National Fenestration Rating Council) Procedure for Determining Fenestration Product Thermal Performance.

Product literature listing U-factors determined by this testing procedure may be used to verify window or skylight values.

Figure 1
SAMPLE NFRC WINDOW LABEL

Labels

All windows must have labels affixed to the glass so they can be read from the interior of the building. Labels will state the U-factor as shown in Figure 1 or similar.

Window U-Factors

U-factors for almost all manufactured windows, skylights and glazed doors are available through the NFRC web site at http://www.nfrc.org/.

Site built windows

Windows that are manufactured in limited quantities and site built windows (as defined in NF1110) can comply with prescriptive values specified in Tables N1112.4(1) and N1112.4(2) of the *Oregon Residential Specialty Code*.

Using product literature to determine door U-factors

Product literature is a source for door U-factor information. Look for tested values using NFRC Thermal Performance Test procedures. An unglazed, untested door is assigned a U-factor of 0.54. An untested, unglazed 1-3/4 inch foam insulated core door with a thermal break is assigned a default U-factor of 0.20.

Air leakage standards for windows, skylights, and doors

Air leakage through.a door or window is measured in cubic feet per minute (dm) per linear foot of sash crack, or dm per square foot of door area. Air leakage rates must be tested using ASTM E-283, "Standard Test Methods for Rate of Air Leakage through Exterior Windows, Curtain Walls and Doors." The air leakage test must be conducted under a 25 mph wind condition.

The energy code specifies the following air leakage standards:

Windows:	0.37 dm per foot of sash crack
Swinging doors:	0.37 dm per square foot of door area
Sliding doors:	0.37 dm per square foot of door area

Many doors, windows and skylights on the market are tighter than code requires.

On-site air leakage control

The energy code specifies caulking and sealing between the window, door or skylight unit and the rough opening to limit air leakage between the manufactured unit and the building frame.

Information presented in this publication supports the Oregon Residential Specialty Code. This publication does not include all code requirements. Refer to the code and check with your code official for additional requirements. If information in this publication conflicts with code or your local officials, follow requirements of code and your local officials.

For more information about the residential energy code, call the Building Codes Division at (503) 378-4133 or the Oregon Dept of Energy (503) 378-4040 in Salem or toll-free, 1-800-221-8035.

This publication was prepared by Alan Seymour, Energy Code Analyst, Oregon Department of Energy for the Oregon Building Codes Division. Funding was provided by Northwest Energy Efficiency Alliance.

Building Codes Division
Working with Oregonians to ensure safe building construction while supporting a positive business climate.

OREGON DEPARTMENT OF ENERGY

Contains recycled materials

Wall Insulation

This pamphlet is one in a series that describes residential energy conservation requirements of the Oregon Residential Specialty Code and Structural Specialty Code. Other pamphlets in this series may be downloaded from Oregon Department of Energy web site at http://egov.oregon.gov/ENERGY/CONS/Codes/cdpub.shtml or local building departments or from Oregon Building Codes Division.

Prescriptive wall insulation requirements

Wall performance requirement for the Standard Base Case in Table N1101.1(1), is U-0.060. This translates to R-21 insulation installed in a standard wood frame wall.

When code specifies required R-value it is for the insulation only. Any insulation product or combination of products that meets the installed R-value requirement is acceptable.

Minimum wall insulation that can be installed is R-15 (U-0.080). Residential thermal performance calculations are required to use less than R-21 (U-0.060) wall. This procedure is described in the pamphlet *How to Do Residential Thermal Performance Calculations Using Table N1104.1(1)*. Section drawings or written specifications that accompany the plans must identify wall insulation R-value.

R-21 Wall Options

R-21 high-density batts are 5-1/2 inches thick. They fit into a 2x6 frame without being compressed. Standard density R-19 batts are 6-1/4 inch thick. They must be compressed into 2x6 framing. Compression reduces insulation R-value. R-21 is available in faced and unfaced batts. See the pamphlet *R-Value Codes for Unfaced Batt Insulation* for help identifying R-values of unfaced products.

R-21 can also be achieved by other means. Blown-in batt systems can achieve R-21 in a 2x6 frame. Blown-in batt systems combine loose fill insulation and sometimes incorporating an adhesive. Insulation is retained by netting that is stretched and stapled over the face of the wall studs. The adhesive sets up and prevents loose fill from sagging over time. 6-1/2 inch structural, insulated, foam core panels also meet or exceed the R-21 standard.

Combinations of batts and foam board panels can achieve R-21 or better. A conventional wood framed R-21 wall assembly has a U-factor of 0.060. Any wall assembly with an overall U-factor of 0.060 or less is acceptable. Consult the default U-factor table in the pamphlet *How to Do Residential Thermal Performance Calculations Using Table N1104.1(1)* for approved U-factors. For example, an R-13 conventional frame wall with an R-5 insulation sheathing has a U-factor of 0.058, which complies with the U-factor requirement. An R-19 advanced frame wall is also considered equivalent to the R-21 requirement.

Foam board systems achieve their equivalent efficiency by providing a thermal break to heat loss through the building frame. Advanced framing reduces heat loss through the frame by eliminating all but structural lumber and by insulating headers, corners, and partition intersections.

Because of compression, two R-11 batts (full loft equals 7 inches) in a 2x6 cavity (5-1/2 inches) and does not meet the required R-21 standard.

Advanced framing can save resources (money) as well as energy and are considered a *best practice*. See the pamphlet *Advanced Framing for Walls and Ceilings* for more information.

Drawings that follow illustrate ways of meeting energy code requirements.

U-0.047 (R-24) wall options

U-0.047 wood framed walls are commonly constructed using a combination of batts and rigid foam board insulation such as R-19 batt with one inch of continuous R-5 extruded polystyrene foam board insulation.

Other innovative wall construction methods such as certain Structural Insulated Panels (SIPs) and Insulated Concrete Forms (ICF) are construction methods to achieve U-0.047.

Log walls

Log homes built to that case are required to have solid log or timber walls at least 3-1/2 inches thick. Log homes complying with energy code using Table N1104.1(1) Thermal Performance Calculations must also be compared to an R-21 wall standard. If conventional wood framed walls are incorporated into the log home, such as gable-end walls, they must be insulated to R-21 or an equivalent to U-0.060 for other types of construction.

Walls separating heated from unheated spaces

When people think wall insulation, they usually focus on walls at the building perimeter. However, walls away from the perimeter may also divide heated from unheated space and thus require insulation.

A common example is the wall between the heated house and unheated garage. Rooms with vaulted ceilings may have high walls that divide heated space from unheated attics. Sidewalls in skylight wells divide heated from unheated space. Pony walls may divide rooms from unheated attics or crawl spaces. Tri-level homes may have walls that divide heated spaces from attics or crawl spaces. Stairwell walls may divide a heated stair from an unheated garage or basement.

All walls that separate heated from unheated space must meet exterior wall R-value requirements.

Insulation installation

Code requires insulation to be installed flush to the inside (warm) surface of wall, in so far as practical. Face stapling is not required but is preferred and considered a *best practice*. The intent of code is to avoid unnecessary compression during installation. When insulation achieves full loft in the stud cavity, it blocks air paths around the batt that could reduce its effectiveness. Voids, short cuts, crammed-in long cuts and gaps in the insulation job also reduce effective R-value. Splitting batts around wiring and plumbing and cutting-in batts around outlet boxes reduce compression and voids within insulated cavities.

Wall vapor retarders

To protect insulation from interior moisture, a one perm (or less) vapor retarder must be installed on the warm side of insulation. Facing on faced batts meets this requirement. When unfaced or blown-in-batts are used, an independent vapor retarder must be installed. Rated wall coverings such as vapor retarder paint/primer may be used to finish drywall and provide the vapor retarder.

See the pamphlet *Moisture Control Measures in the Oregon Residential Energy Code* for a list of perm ratings for common building materials.

Specify the type of wall vapor retarder on the blueprint section drawing or in written specifications attached to plans.

Figure 1

R-21 Wall insulation examples

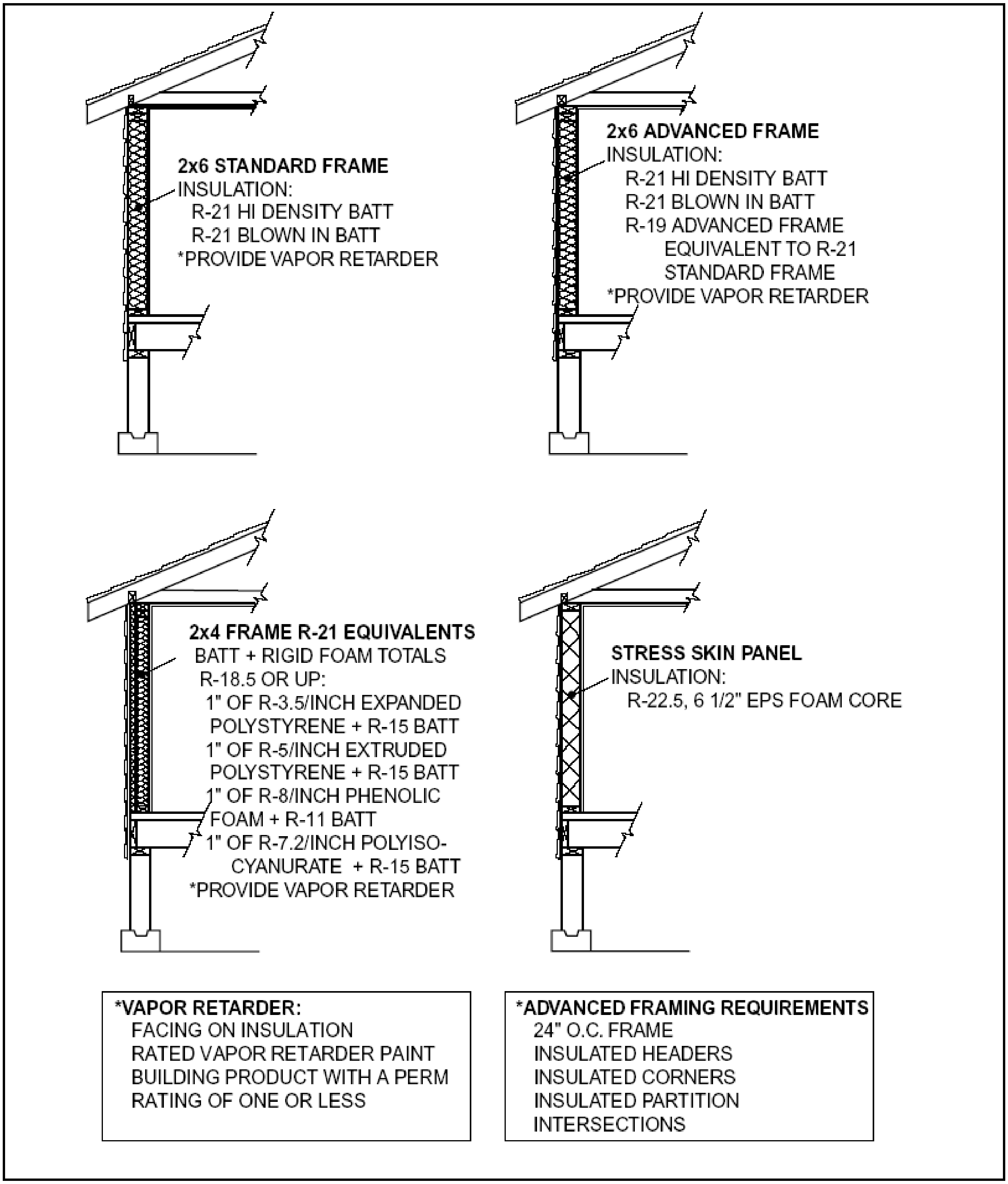
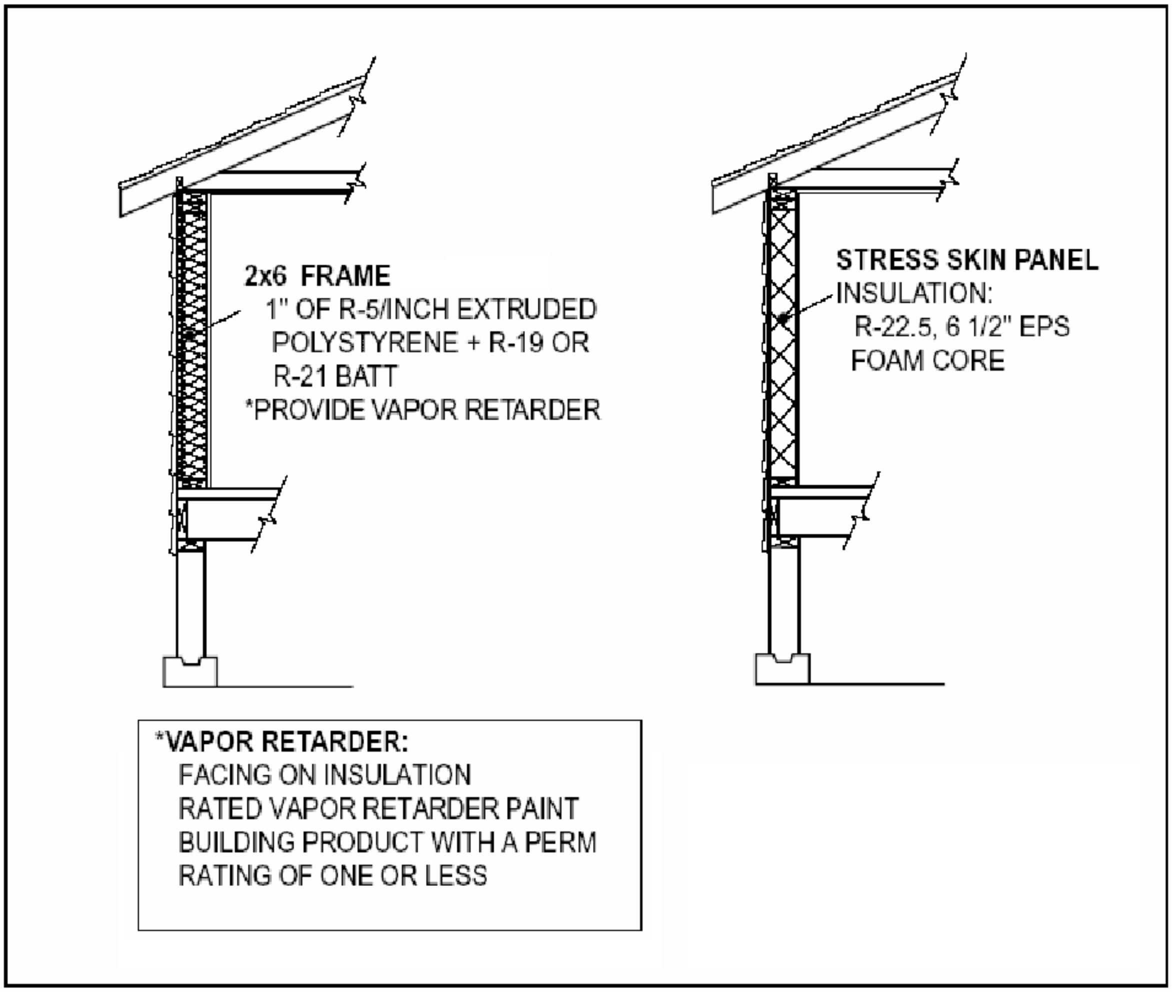


Figure 2
U-0.047 Wall insulation examples



Information presented in this publication supports the Oregon Residential Specialty Code. This publication does not include all code requirements. Refer to the code and check with your code official for additional requirements. If information in this publication conflicts with code or your local officials, follow requirements of code and your local officials.

For more information about the residential energy code, call the Building Codes Division at (503) 378-4133 or the Oregon Dept of Energy (503) 378-4040 in Salem or toll-free, 1-800-221-8035.

This publication was prepared by Alan Seymour, Energy Code Analyst, Oregon Dept of Energy for the Oregon Building Codes Division. Illustrations are by Gene Stevenson. Funding was provided by Northwest Energy Efficiency Alliance.

Building Codes Division

Working with Oregonians to ensure safe building construction while supporting a positive business climate.

OREGON DEPARTMENT OF ENERGY

Contains recycled materials

Underfloor Insulation

This pamphlet is one in a series that describes residential energy conservation requirements of the Oregon Residential Specialty Code and Structural Specialty Code. Other pamphlets in this series may be downloaded from Oregon Department of Energy web site at http://egov.oregon.gov/ENERGY/CONS/Codes/cdpub.shtml or local building departments or from Oregon Building Codes Division.

Prescriptive requirements for underfloor insulation

Table 1101.1(1), Prescriptive Envelope Requirements, lists required floor insulation levels. This table specifies R-30 for standard wood frame construction.

The code specifies required R-values, not products. Any insulation product or combination of insulation products that meets installed R-value requirements installed to there nominal thickness is acceptable. Section drawings or written specifications that accompany the plans must identify floor insulation R-value.

High density R-30 batts, 8 inches thick, are acceptable when installed within a 4 x 8-inch nominal wood post and beam flooring system.

Batt insulation install within cavities that are deeper than insulation, such as a 14-inch I-beam, must be installed in substantial contact with underside of sub-flooring.

Installation guidelines

Insulation must be installed flush against the warm surface. Batts achieve the stated R-value only when installed at full loft. Support systems keep insulation in place without compressing it. Support systems include lath nailed to the underside of floor joists, criss-crossed string or wire webbing hung on nails at the bottom of joist systems, and lath laid across furring lumber nailed to foundation post supports or wire hangers. Figure 1 shows support system examples.

Installing deeper batts in post and beam floors may require special measures to keep crawl space vents clear. Baffles can be used to keep vent openings clear. Or vents can be installed lower in the stem wall, so they floor cavities, splitting the batt above and below so they are not blocked by insulation. When plumbing is in plumbing run is usually best.

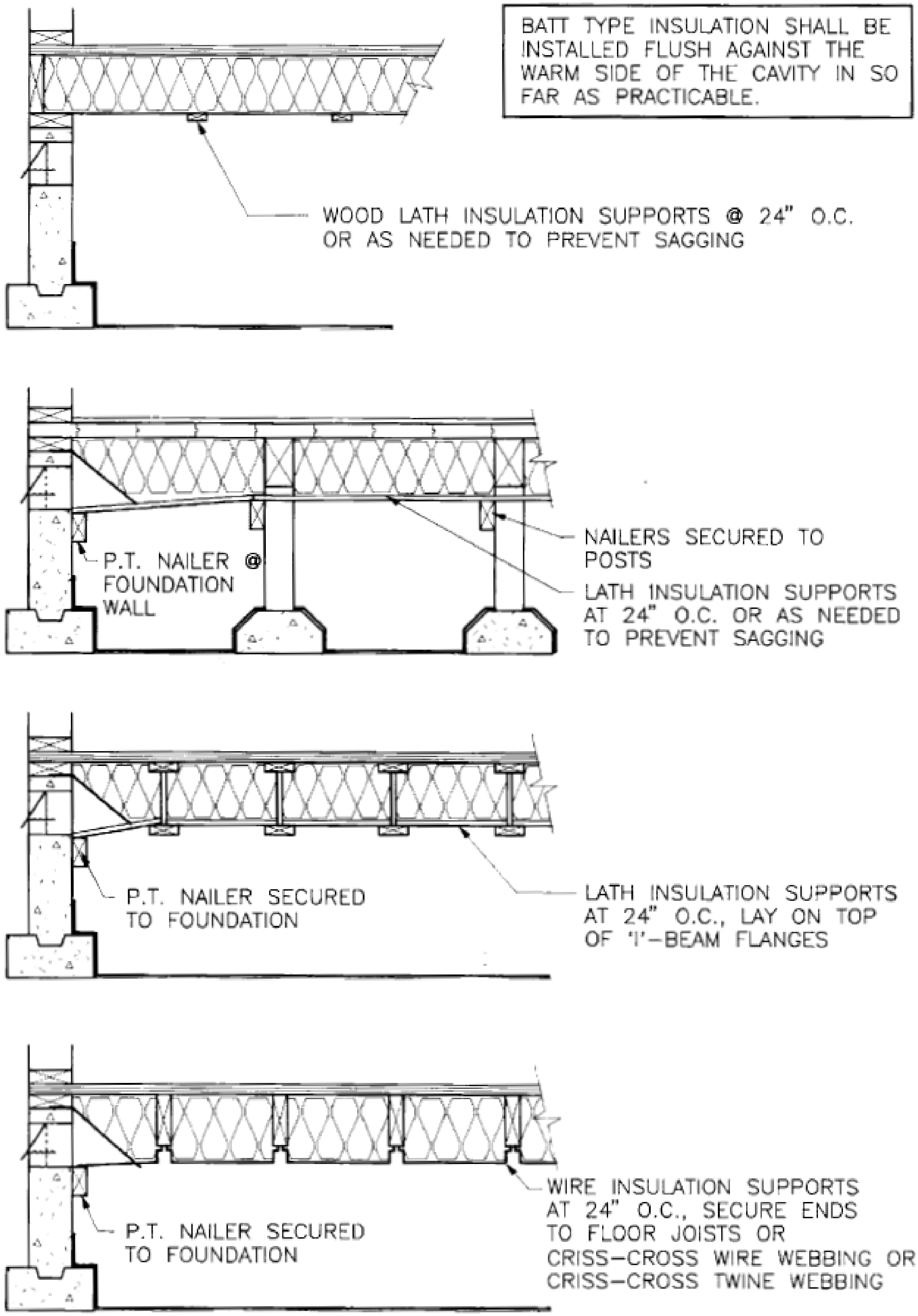
While actual lumber dimension for a nominal 8-inch thick beam is ~7.5 inches in thickness, this is a better installation than R-25 batt insulation when installed in a similar 4 x 8 post and beam floor system. The wire or string used to attach R-30 batt will cause minimum compression while achieving a tighter fit within the cavity in comparison to R-25 batt insulation.

Floor vapor retarders

A one perm vapor retarder is required on the warm side of insulation to protect it from indoor moisture sources. The floor vapor retarder is **NOT** the same as the crawl space ground moisture barrier. The ground moisture barrier protects insulation and framing from moisture sources in the ground.

In joist and panel floor systems, glue in exterior grade plywood and strand board floor panels is rated at one perm or less, so the subfloor panel doubles as the vapor retarder. When the vapor retarder is part of the subfloor, unfaced batts can be used.

Figure 1:
Floor insulation suspension system examples



Two-by decking floor systems requires an independent vapor retarder. Often the vapor retarder requirement is met by laying asphalt-impregnated kraft paper or other rated building paper above decking and below finish floor underlayment.

Foam core panels do not require separate vapor retarders.

Floor vapor retarders should be shown on the plan section drawing or identified in written specifications accompanying the plans.

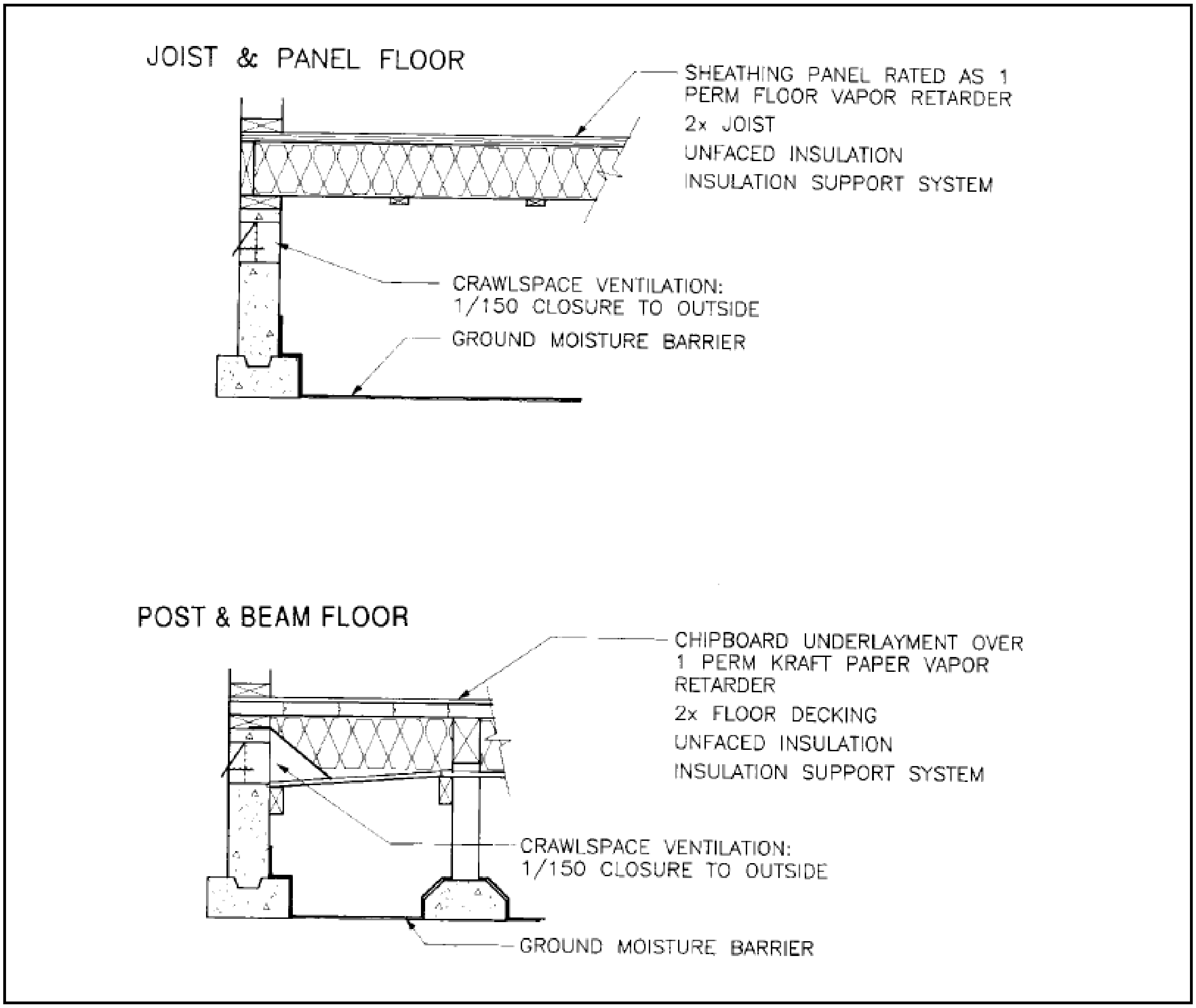
Crawl space ventilation and ground cover

Ventilation requirements in other parts of Residential Code and Structural Code require ventilation of crawl spaces to avoid moisture damage to the floor and insulation.

One square foot of net free vent area is required for each 150 square feet of crawl space area. Vent placement must assure good cross-ventilation.

A ground cover is also required. See the pamphlet *Moisture Control Measures in the Oregon Residential Energy Code* for details.

Figure 2:
Floor insulation examples



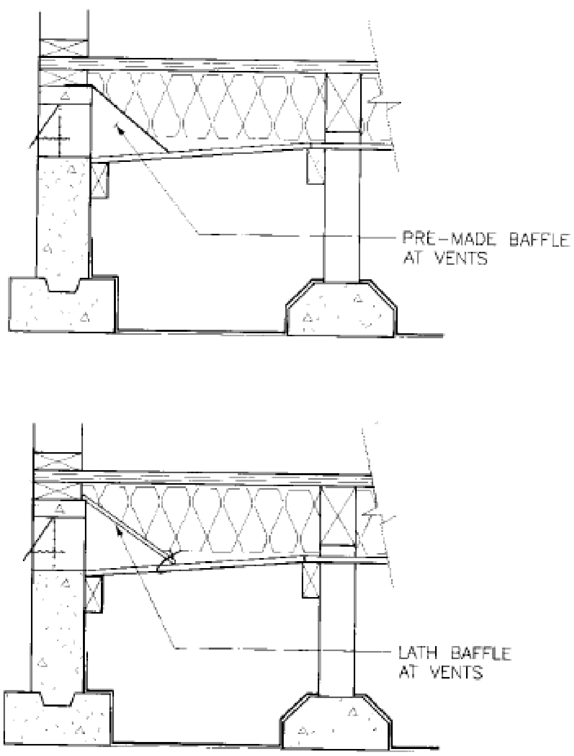
Perimeter crawl space insulation vs. underfloor insulation

Perimeter crawl space insulation is not allowed. Perimeter systems have been found to be thermally inferior to underfloor systems and to pose potential indoor air quality and health and safety problems. Underfloor systems avoid these problems. There is an alternative system described in Interpretive Ruling 96-12 that mitigates these concerns.

Impact of underfloor insulation on crawl space utilities

If possible, plumbing runs should be on the warm side of floor insulation. If this is not possible, plumbing insulation is good insurance against pipe freezing when the temperature dips below zero. Higher levels of floor insulation make this doubly important. Pipes near foundation vents are usually required to be protected in accordance with plumbing code.

Figure 3:
Keeping air vents free of floor insulation



Information presented in this publication supports the Oregon Residential Specialty Code. This publication does not include all code requirements. Refer to the code and check with your code official for additional requirements. If information in this publication conflicts with code or your local officials, follow requirements of code and your local officials.

For more information about the residential energy code, call the Building Codes Division at (503) 378-4133 or the Oregon Dept of Energy (503) 378-4040 in Salem or toll-free, 1-800-221-8035.

This publication was prepared by Alan Seymour, Energy Code Analyst, Oregon Department of Energy for the Oregon Building Codes Division. Illustrations are by Gene Stevenson. Funding was provided by Northwest Energy Efficiency Alliance.

Building Codes Division

Working with Oregonians to ensure safe building construction while supporting a positive business climate.

OREGON DEPARTMENT OF ENERGY

Contains recycled materials

Flat Ceiling Insulation

This pamphlet is one in a series that describes residential energy conservation requirements of the Oregon Residential Specialty Code and Structural Specialty Code. Other pamphlets in this series may be downloaded from Oregon Department of Energy web site at http://egov.oregon.gov/ENERGY/CONS/Codes/cdpub.shtml or local building departments or from Oregon Building Codes Division.

Prescriptive requirements for flat ceiling insulation

Table 1104.1(1), Prescriptive Envelope Requirements lists the required flat ceiling R-value. Flat ceiling insulation R-value in standard wood frame construction for Standard Base Case is R-38 and R-49 for Log Homes.

The code specifies required R-values, not products. Any insulation product or combination of insulation products that meets the installed R-value requirement is acceptable when installed at its nominal thickness.

Section drawings or written specifications that accompany the plans must identify ceiling insulation R-value.

R-38 ceiling insulation

Flat ceiling R-values are most often achieved by blowing in loose-fill fiberglass, cellulose or rock wool. Sometimes two R-19 batts are cross-layered to achieve R-38 or one R-38 batt is used. For help determining R-value of unfaced batts, see the pamphlet *R-Value Codes for Unfaced Batt Insulation*. Blown-in insulation may be used when the roof pitch is 4/12 or greater and there is at least 44 inches of headroom at the ridge.

R-49 ceiling insulation options

Some of the Additional Measure packages specified in Table N1101.1(2) require R-49 flat ceiling insulation. Blown-in loose fill insulation is the most common way to achieve R-49. Sometimes cross-layered R-30 and R-19 batts are used. Figure 1 shows typical attic insulation details.

Achieving required R-value with loose fill

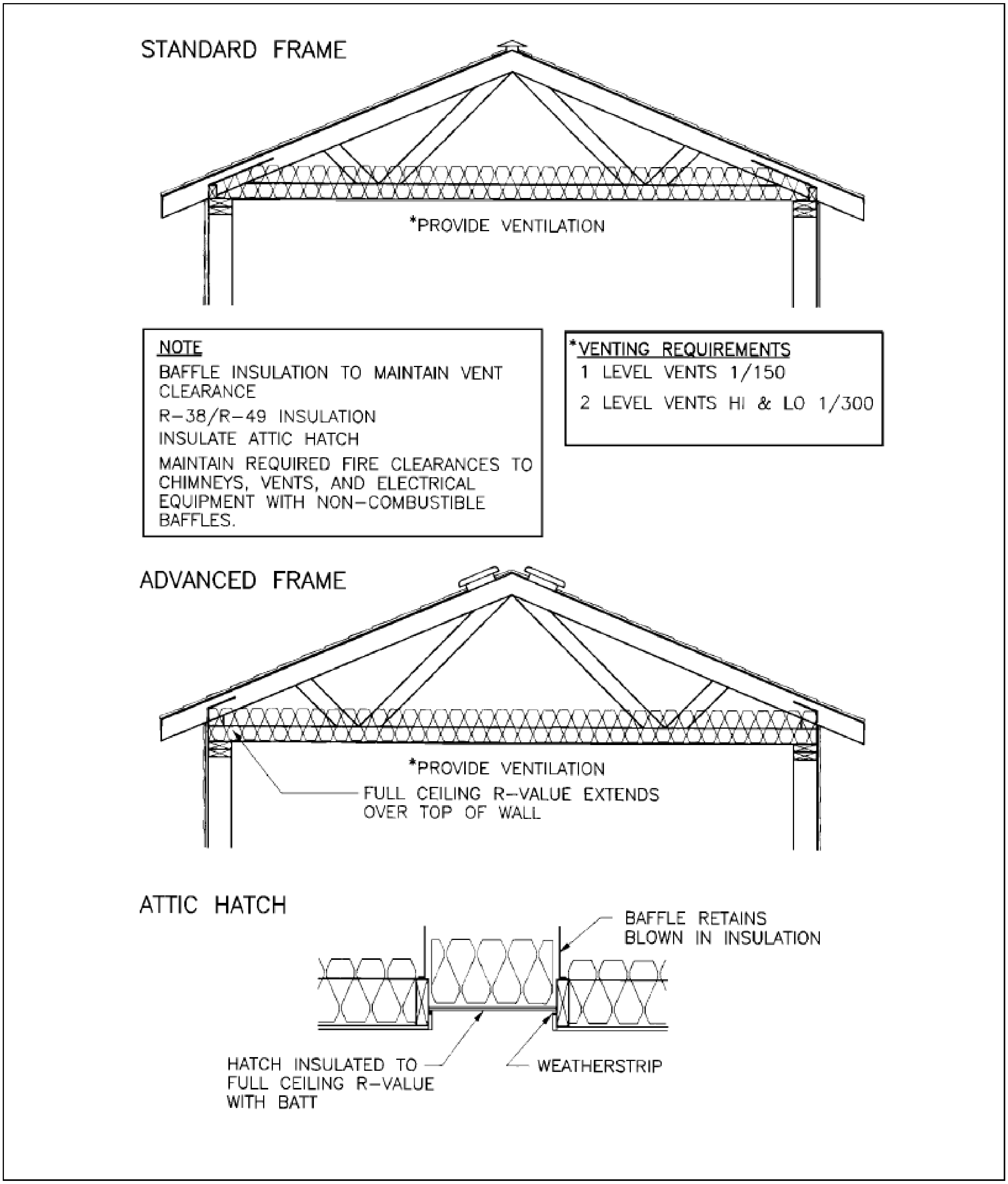
To achieve the required R-value with loose fill insulation no matter what the product a certain number of pounds of insulation must be installed per square foot of ceiling surface. Otherwise, insulation will settle and its R-value will be less than required.

Each manufacturer of loose fill insulation indicates on the bag label pounds per square foot density required for that particular product to achieve stated R-values. The label also indicates how many bags per 1,000 square feet must be installed to yield required density.

Insulation depth is a less reliable indicator of installed R-value because an installer may “fluff” loose-fill insulation as its being blown in place. The insulation may meet required thickness without having the required density.

To verify that required density has been installed, weigh a sample of insulation taken from a square foot of ceiling area. Or check the bag count by calculating the ceiling area, dividing by 1,000 square feet and multiplying by the number of bags per 1,000 square feet.

Figure 1:
Typical attic insulation details



For example, the ceiling area is 2,300 square feet and the manufacturer's label says it takes 20 bags per 1,000 square feet to achieve R-38. How many bags should the installer use?

$2{,}300 \div 1{,}000 = 2.3$

$2.3 \times 20 = 46$

Forty-six bags are needed to achieve the density required for R-38.

Keeping loose fill out of vent openings

The energy code requires that retainers or baffles be used to deflect ventilation air above insulation and to keep attic ventilation paths open. Treated cardboard baffles are often used to retain loose fill. Baffles should be in place at the framing inspection. Without baffles, insulation may restrict attic ventilation or wind may blow loose fill away from the vent area, creating an uninsulated bare spot in front of the vent.

Deeper layers of insulation require longer baffles to retain insulation properly.

Vapor retarders in ceilings with attics above them

Oregon code requires vapor retarders in floors and walls, but does not require vapor retarders in ceilings with vented attic space above them.

Rated vapor retarder paint often serves as the ceiling vapor retarder. Polyethylene is another option. If polyethylene is used, the ceiling must be insulated right after the ceiling drywall is hung. That way, moisture released in the home during mudding, taping, texturing, and painting will not condense on a cold vapor retarder and cause water damage to the ceiling.

Ventilation in attics

The attic ventilation requirement is one square foot of net free vent area per 150 square feet of ceiling. This is often abbreviated as 1/150. If half the vents are placed low, at the eaves, and half the vents are placed high, at the ridge or gable end, the vent to ceiling ratio may be reduced to 1/300. Consult the pamphlet *Moisture Control Measures in the Oregon Residential Energy Code* for more information on attic ventilation.

Fire clearances

Baffles may be needed to keep insulation away from flues, metal chimneys, gas vents, or fixtures that require clearances or ventilation for fire safety. New recessed lights installed in new or existing construction must be IC- (insulation cover-) rated and airtight. The IC rating indicates that it is safe to cover the fixture with insulation.

If ceiling insulation levels are being increased as part of a remodel, the insulation installer may find existing recessed lights that are not IC-rated. If a light is not IC-rated, a non-combustible baffle is required to maintain a three-inch fire clearance between the light and insulation. Baffles must be non-combustible and be at least as high as the finished insulation level.

Consult the pamphlet *Recessed Lights and the Oregon Residential Energy Code* for more information on recessed light requirements.

Consult the National Fire Protection Association (1 Battery March Park, P.O. Box 9101, Quincy, MA 02269-9101; 1-800-344-3555) for information about proper fire clearances.

Attic hatch

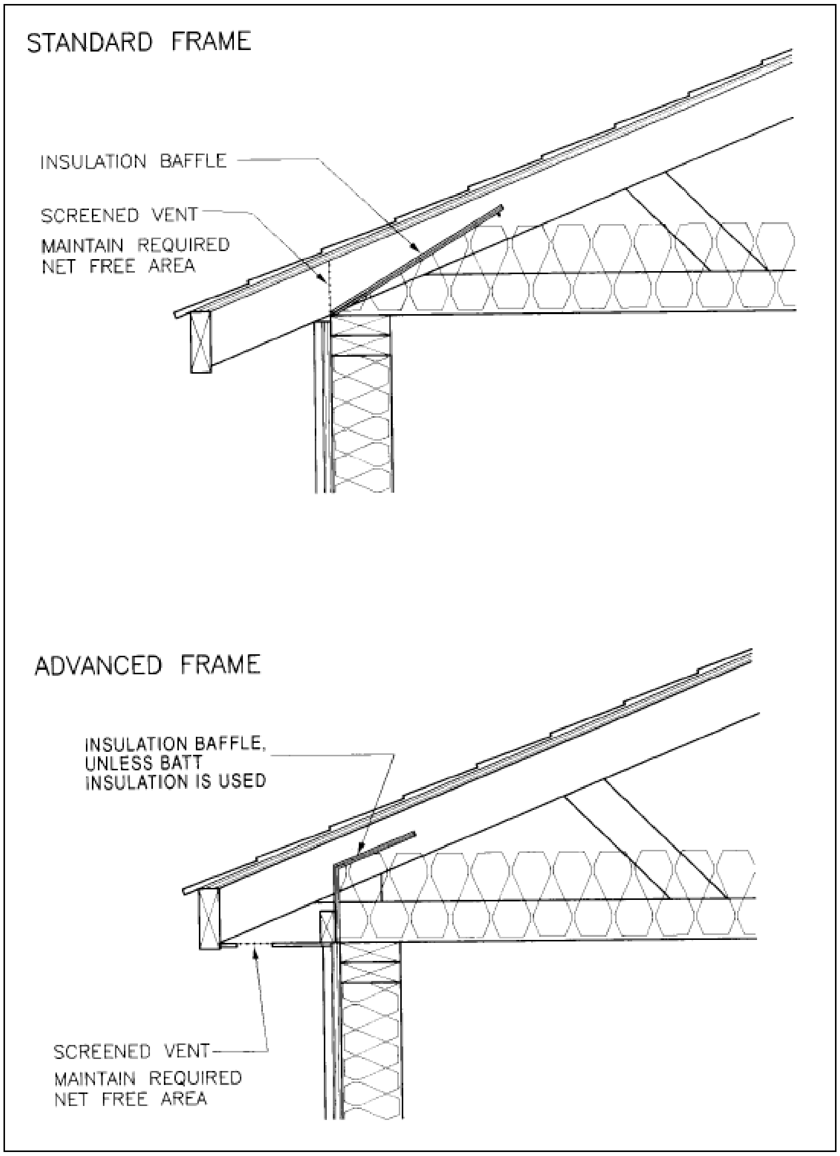
If the attic hatch is in an insulated ceiling, a baffle is required to keep insulation away from the hatch opening. The attic hatch is part of the ceiling. It must be insulated to the same level as the ceiling. Typically, pieces of batt insulation or rigid foam are used. Weatherstripping must be used to prevent air leakage from the heated space to the attic.

Attic storage areas and furnaces in attics

Furnaces and other equipment can be installed in attics, if requirements of M1305 in the Oregon Residential Specialty Code are met. Attic equipment and passageways are not allowed to compress the ceiling insulation. A 22x30 inch passageway must be available above the insulation. The furnace must be installed above the insulation, and the 22-inch walkway from the access hole to the furnace must be above the insulation.

Attic storage areas and passageways to storage areas are not allowed to compress the ceiling insulation.

Figure 2:
Soffit vent baffles



Information presented in this publication supports the Oregon Residential Specialty Code. This publication does not include all code requirements. Refer to the code and check with your code official for additional requirements. If information in this publication conflicts with code or your local officials, follow requirements of code and your local officials.

For more information about the residential energy code, call the Building Codes Division at (503) 378-4133 or the Oregon Dept of Energy (503) 378-4040 in Salem or toll-free, 1-800-221-8035.

This publication was prepared by Alan Seymour, Energy Code Analyst, Oregon Department of Energy for the Oregon Building Codes Division. Illustrations are by Gene Stevenson. Funding was provided by Northwest Energy Efficiency Alliance

Building Codes Division

Working with Oregonians to ensure safe building construction while supporting a positive business climate.

OREGON DEPARTMENT OF ENERGY

Contains recycled materials

Insulation Requirements for Vaulted Ceilings

This pamphlet is one in a series that describes residential energy conservation requirements of the Oregon Residential Specialty Code and Structural Specialty Code. Other pamphlets in this series may be downloaded from Oregon Department of Energy web site at http://egov.oregon.gov/ENERGY/CONS/Codes/cdpub.shtml or local building departments or from Oregon Building Codes Division.

Prescriptive requirements for vaulted ceiling insulation

Any ceiling is considered a vault when the ceiling slope is 2/12 or greater. Table N1101.1(1), Prescriptive Envelope Requirements, list required R-value for vaulted ceilings within standard wood frame construction. The Standard Base Case vaulted ceiling insulation R-value is R-38. The U-factor of 0.042 is representative of R-38 insulation installed within a standard scissors truss. A 10-inch deep wood rafter vaulted ceiling with R-30 insulation is U-0.033 and complies with this requirement and is classified as an R-30A (Advanced Framing). Other additional measure packages may require R-30A insulation.

Vaulted ceiling area is restricted. Vaulted ceiling area may not exceed 50 percent of total heated space floor area. If vaulted ceiling area exceeds 50 percent of the heated floor area, the area in excess of 50 percent must be insulated to U-0.031. Typically the entire vaulted ceiling would be insulated to R-38. Compliance could be demonstrated using Table 1104.1(1) thermal performance calculations. To determine vault area, multiply vault length by its width, measured along the slope to the ridge.

To provide design flexibility, footnote f to Table 1101.1(1) indicates ceilings that have attic/rafter depth such as dormers, bay windows, and similar architectural features may have insulation reduced to R-21, as long as total area for all vaults in the residence does not exceed 150 square feet.

The code specifies required R-values, not products. Any insulation product or combination of insulation products that meets the installed R-value requirement at nominal thickness is acceptable.

Section drawings or written specifications that accompany the plans must identify vault insulation R-value.

R-30 vaulted ceiling insulation options

Faced batts or unfaced batts (incorporating a vapor retarder paint on the surface) are typically used to insulate single rafter vaults. Loose fill may be used in vaults with attic space above (scissors truss) where the roof pitch is 4/12 or greater and there is at least 44 inches of headroom at the ridge. Loose fill is not recommended when the slope of the interior ceiling exceeds 3/12 because loose fill tends to slip down the slope towards the eaves.

High density R-30 batts are available approximately 8-1/2 inches thick. They allow for R-30 insulation and ventilation in 2x10 framing. Standard density R-30 batts are 9-1/2 inches thick. They completely fill a 2x10 cavity. To get ventilation in the same cavity with a standard R-30 batt, 2x12 framing lumber is needed.

Most 10-1/4 inch thick foam core panels meet or exceed the U-0.42 vault requirement.

In conjunction with the appropriate roofing material, air impermeable spray-on insulation may be used in vaulted ceilings. A vapor retarder is still required unless the installed material has a perm rating ot1.0 or less at installed thickness.

Figure 1:
Vault insulation examples

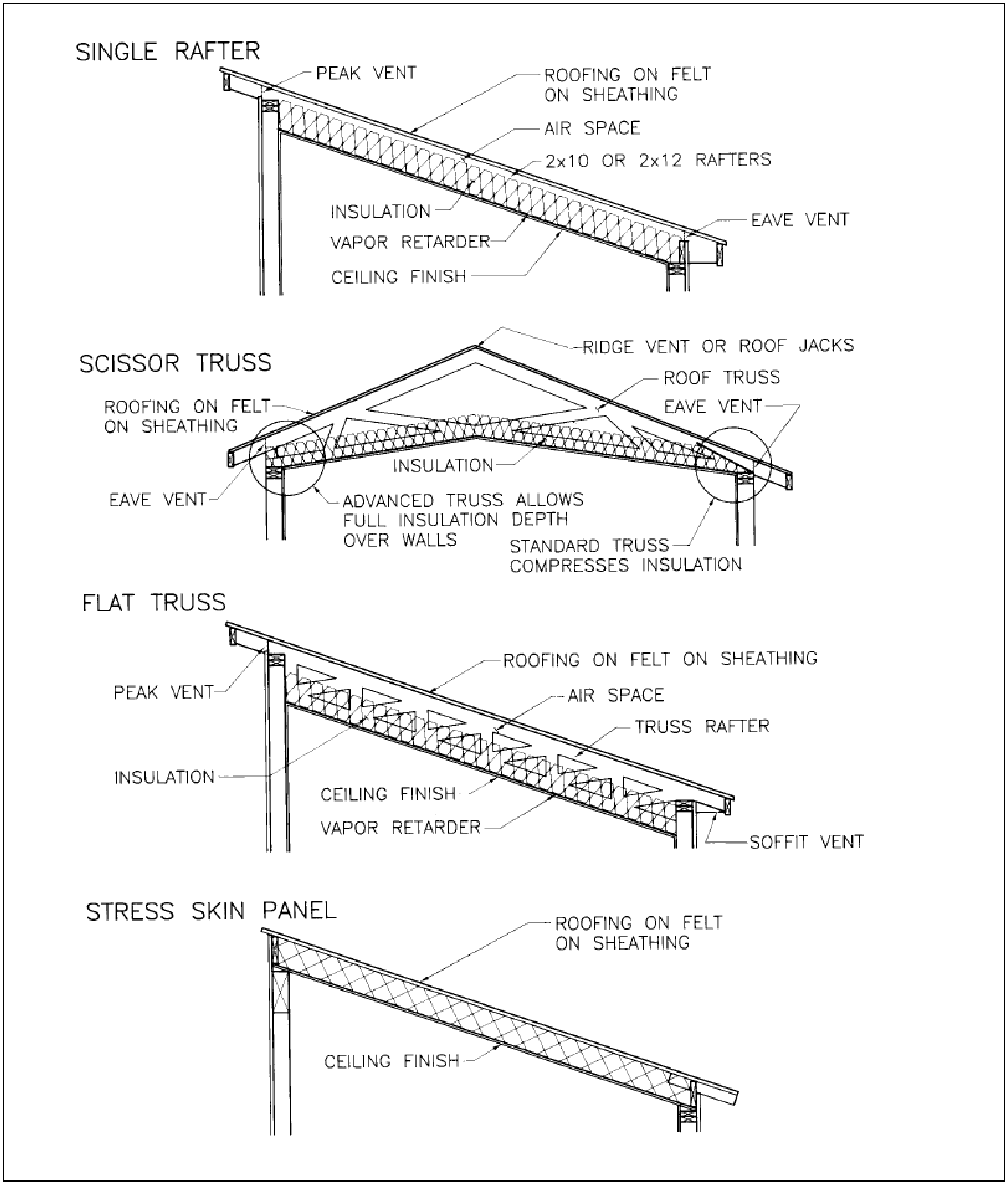


Figure 2:
Vault ventilation details

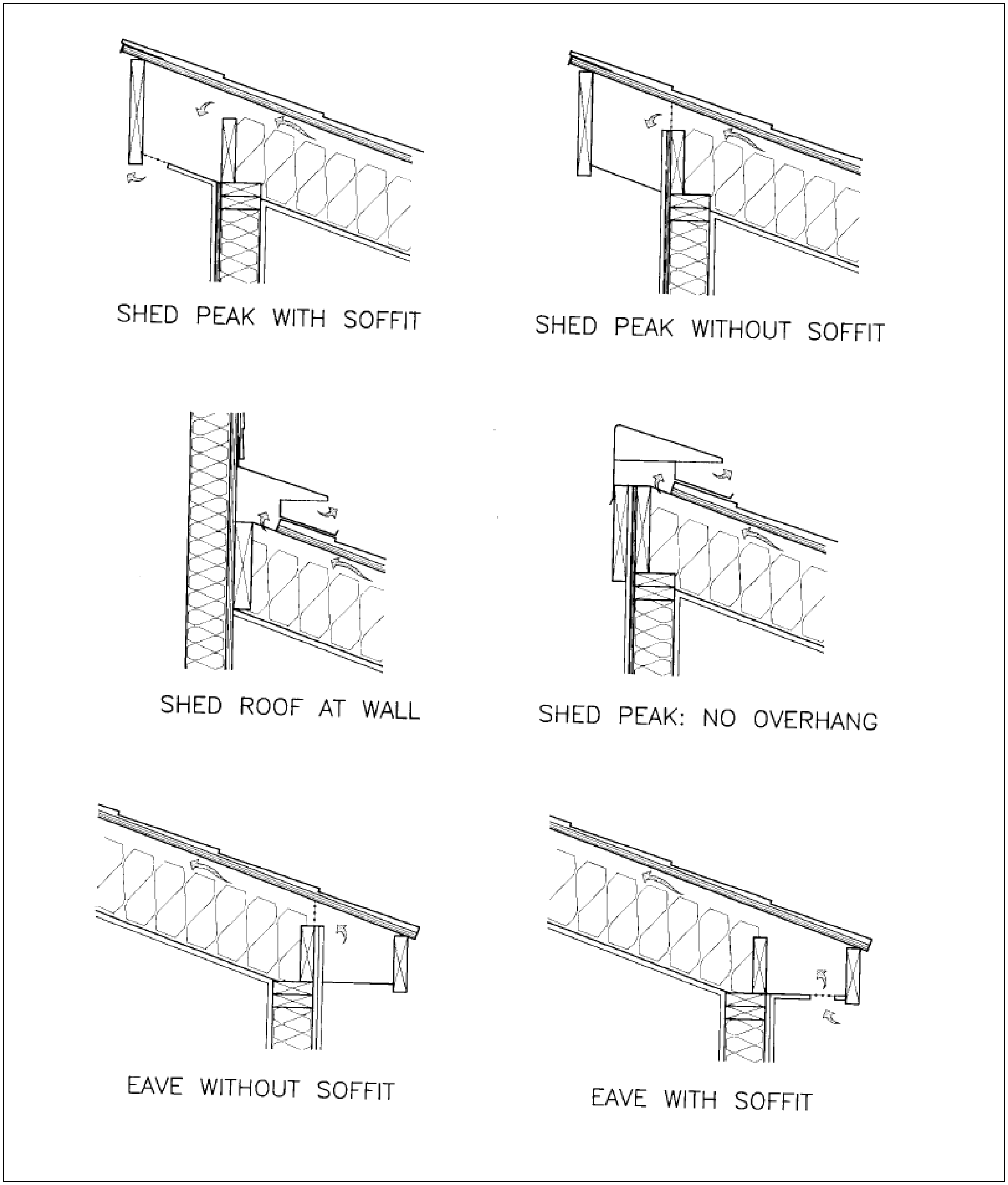
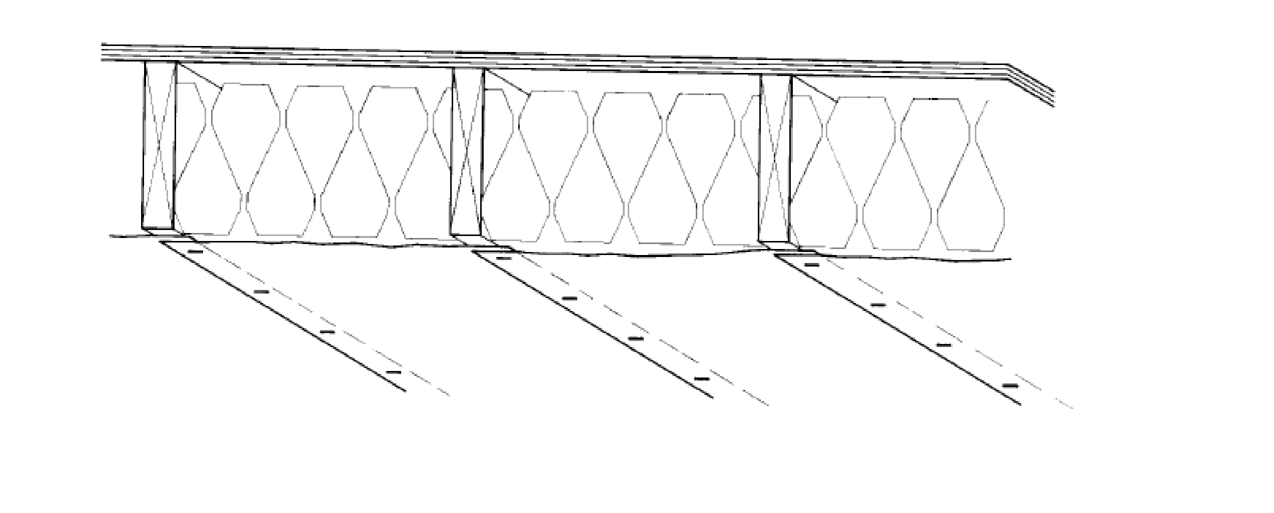


Figure 3:
Face stapling at vaults



U-0.031 vaulted ceiling insulation

One way to obtain U-0.031 in vaults is to provide advance frame scissors truss (raise heel or cantilevered) framing. Advanced scissors trusses can generally meet the 44-inch headroom requirement and allow plenty of room for insulation and ventilation. When this framing is used with ceiling slopes of 3/12 or less, loose fill insulation is typically used.

High density R-38 batts approximately 10 inches thick may be installed in 2x12 vaults, leaving space for ventilation above the batt.

Most 10-1/4-inch thick foam core panels meet the U-0.031 requirement.

Ventilation of vaulted ceilings

When vaulted ceiling ventilation is required per Oregon Structural or Residential Specialty Codes ventilation for enclosed attics or rafters may be required. The 1/150 rule for flat ceilings also applies to vaults: 1 square foot of net free vent area is required for each 150 square feet of vaulted area. If half the vent area is located high, at the ridge, and half is located low, at the eaves, the vent to ceiling ratio may be reduced to 1/300. Some jurisdictions only allow high/low venting in single rafter vaults.

Figure 2 shows vault ventilation details. Section drawings or written specifications that accompany the plans must show vault ventilation details.

Vapor retarders in vaulted ceilings

In ceilings with attic spaces above them, such as scissors truss ceilings, no vapor barrier is required. Attic spaces are defined as spaces with at least 44-inches of clear headroom at the roof ridge.

When vaults have no ventilated attic space above, a 1.0 perm vapor retarder is required. It helps protect the vault from moisture sources inside the home. A *best practice* for maintaining integrity of the vapor retarder is to lap and staple flanges of foil-faced insulation at the ceiling framing members. Section drawings or written specifications that accompany the plans must identify the 1.0 perm vapor retarder.

Recessed light restrictions in vaults

To avoid fire hazards and to minimize moisture penetration and heat loss into vaulted areas, only *AIRTIGHT* “IC-rated” (insulation cover) recessed lights are allowed in vaults. For more information, see the pamphlet *Recessed Lights and the Oregon Residential Energy Code.*

For more information about the residential energy code, call the Building Codes Division at (503) 378-4133 or the Oregon Dept of Energy (503) 378-4040 in Salem or toll-free, 1-800-221-8035.

This publication was prepared by Alan Seymour, Energy Code Analyst, Oregon Department of Energy for the Oregon Building Codes Division. Illustrations are by Gene Stevenson. Funding was provided by Northwest Energy Efficiency Alliance.

Building Codes Division

Working with Oregonians to ensure safe building construction while supporting a positive business climate.

OREGON DEPARTMENT OF ENERGY

Oregon Residential Energy Code April 2008 • No. 8

Basement Wall Insulation Requirements

This pamphlet is one in a series that describes residential energy conservation requirements of the Oregon Residential Specialty Code and Structural Specialty Code. Other pamphlets in this series may be downloaded from Oregon Department of Energy web site at http://egov.oregon.gov/ENERGY/CONS/Codes/cdpub.shtml or local building departments or from Oregon Building Codes Division.

Prescriptive insulation requirements for basement walls

All basement walls are required to be insulated to R-15.

The code also refers to basement walls as "below grade walls." Insulation for below-grade walls must extend from the bottom of the above-grade subfloor to the top of the below-grade finished floor. The entire wall, including the rim joist area, must be insulated.

The energy code specifies required R-values, not specific types of product. Any insulation product or combination of insulation products that meets the installed R-value requirement is acceptable. Only R-values and F-factors for the Standard Base Case may be used.

Basement wall insulation requirements apply only to *heated* basements. For *unheated* basements, the floor between the home and basement must meet floor insulation requirements. If heating is later installed in an unheated basement, wall insulation must be added. Uncovered basement walls should be insulated with fire-rated faced batts, not unrated kraft-faced batts.

Section drawings or written specifications that accompany the plans must indicate basement wall R-value.

R-15 basement wall insulation options

Typically, the R-15 basement wall insulation requirement is met by framing an interior finish wall and installing R-15 high density batt insulation. The wall frame may be 2x4 or 2x3. To keep insulation dry, the wall frame should be held in place from the concrete below grade wall so insulation does not contact concrete. Exterior insulation placement and combinations of batts and rigid foam board insulation are also acceptable. If insulation is applied to the wall exterior, it should be approved for below-grade use and protected from damage above grade.

Figures 1 and 2 show basement wall insulation options for exterior and interior insulation details. Note that rim joists must be insulated.

Moisture protection for basement walls

Requirements for foundation drainage and damp-proofing are part of the Oregon Residential and Structural Specialty Codes. Drawings show footing drains, damp-proofing details and energy code requirements. Other drainage systems may also be used.

The 1-perm rated, interior vapor retarder is optional, not required. A *best practice* would be to use either an unfaced batt or forgiving vapor retarder such as kraft-faced batts, avoid polyethylene, or provide an airspace between interior surface of insulation and finished wallboard.

Figure 1:
Interior basement wall insulation detail

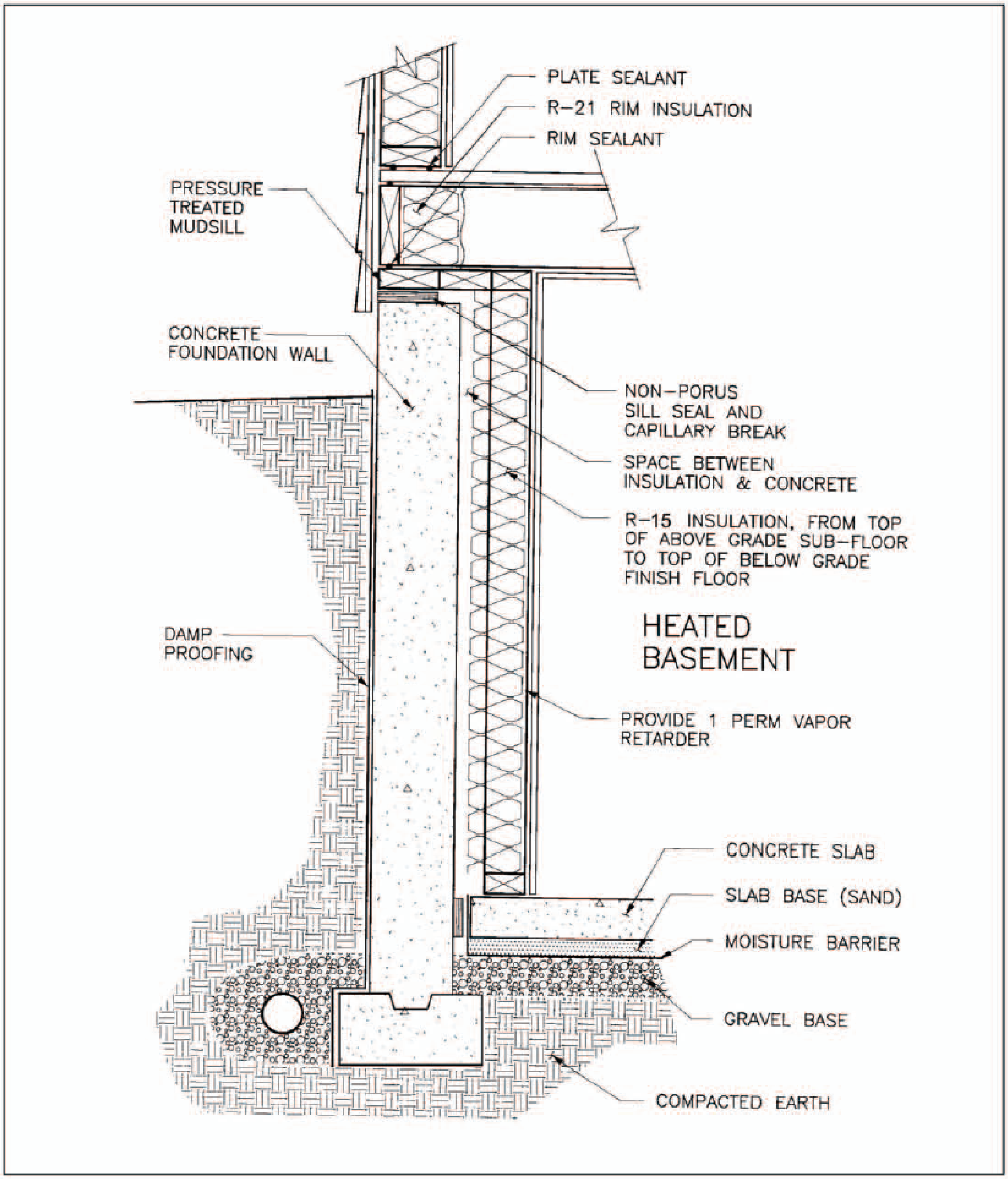
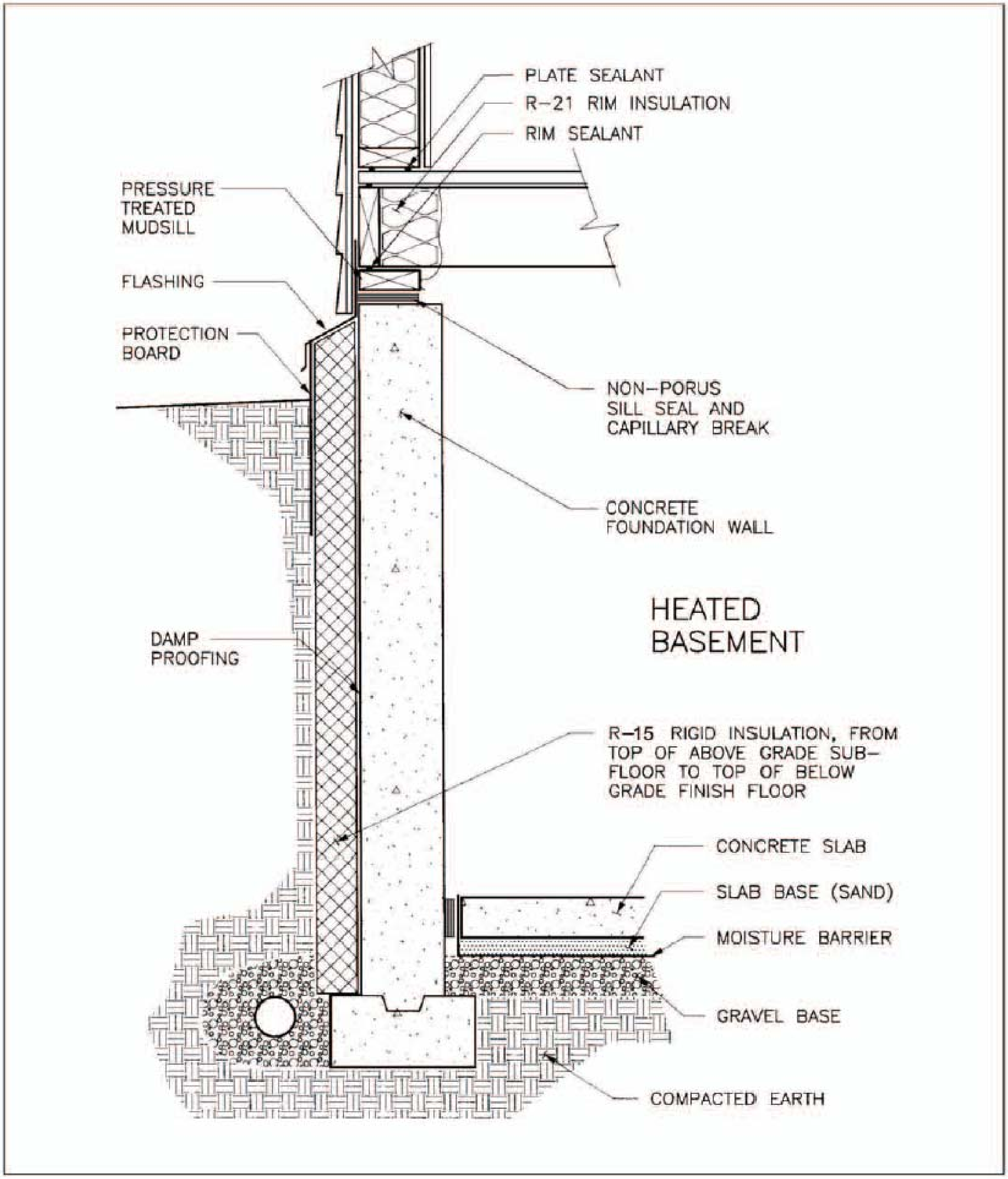


Figure 2:
Exterior basement wall insulation detail



Information presented in this publication supports the Oregon Residential Specialty Code. This publication does not include all code requirements. Refer to the code and check with your code official for additional requirements. If information in this publication conflicts with code or your local officials, follow requirements of code and your local officials.

For more information about the residential energy code, call the Building Codes Division at (503) 378-4133 or the Oregon Dept of Energy (503) 378-4040 in Salem or toll-free, 1-800-221-8035.

This publication was prepared by Alan Seymour, Energy Code Analyst, Oregon Department of Energy for the Oregon Building Codes Division. Illustrations are by Gene Stevenson. Funding was provided by Northwest Energy Efficiency Alliance.

Building Codes Division

Working with Oregonians to ensure safe building construction while supporting a positive business climate.

OREGON DEPARTMENT OF ENERGY

Contains recycled materials

Slab Floor Edge Insulation

This pamphlet is one in a series that describes residential energy conservation requirements of the Oregon Residential Specialty Code and Structural Specialty Code. Other pamphlets in this series may be downloaded from Oregon Department of Energy web site at http://egov.oregon.gov/ENERGY/CONS/Codes/cdpub.shtml or local building departments or from Oregon Building Codes Division.

Prescriptive requirements for slab floor edge insulation

All residences require R-15 insulation for slab on grade floors in heated areas. Section drawings or written specifications that accompany the plans must show slab insulation details.

The energy code specifies required R-values, not specific products. Any insulation product or combination of insulation products that meets the installed R-value requirement and is approved for below grade use is acceptable. If a prescriptive path is used for code compliance, only the R- and F-factors in that prescriptive path may be used.

R-15 is most typically achieved by installing three inches of rigid extruded polystyrene foam board (blue board, pink board, or green board with an insulation value of R-5 per inch). If expanded polystyrene (white bead board with an insulation value of R-3.5 per inch) is used, approximately 4-1/2 inches of material is needed to achieve R-15.

For floating slabs, insulation must be placed from the top of the slab down for a total of 24 inches, or from the top down to the bottom of the slab and horizontally back under the slab for a total of 24 inches. For monolithic slabs, insulation must extend from the top of the slab down 24 inches or to the bottom of the thickened edge, whichever is applicable.

Above-grade protection must be provided for insulation installed on the exterior side of the slab or foundation.

Figures 1 and 2 show insulation placement and protection details.

“Heated” slab insulation

When a slab is heated – such as with a hydronic heating system – in addition to slab edge insulation, the entire under slab must be insulated to R-10.

Which slab edges get insulated?

When people think about slab edge insulation, they typically focus on edges at the outside perimeter of a building. They forget about other slab edges that also may be at junctures between conditioned and unconditioned spaces.

Figures 3 and 4 show details for insulating between conditioned and unconditioned slabs, between conditioned and unheated crawl spaces, and at the building perimeter.

Slab moisture protection

The code does not require vapor retarders for slab floor insulation.

Code does require a ground moisture barrier beneath the slab. The moisture barrier prevents concrete from wicking ground moisture into the living space.

Figures 1 and 2 show ground moisture barrier placement. Sand over the moisture barrier is considered a *best practice* that allows concrete to cure more evenly.

Figure 1:
Monolithic slab on grade insulation details

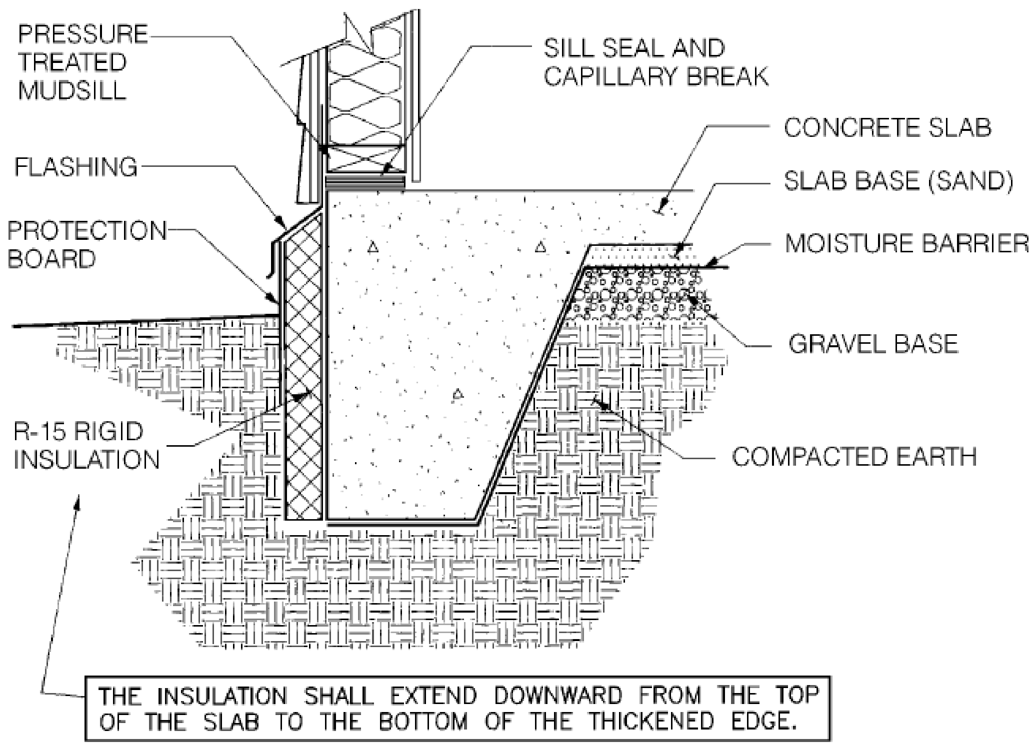


Figure 2:
Floating slab on grade insulation details

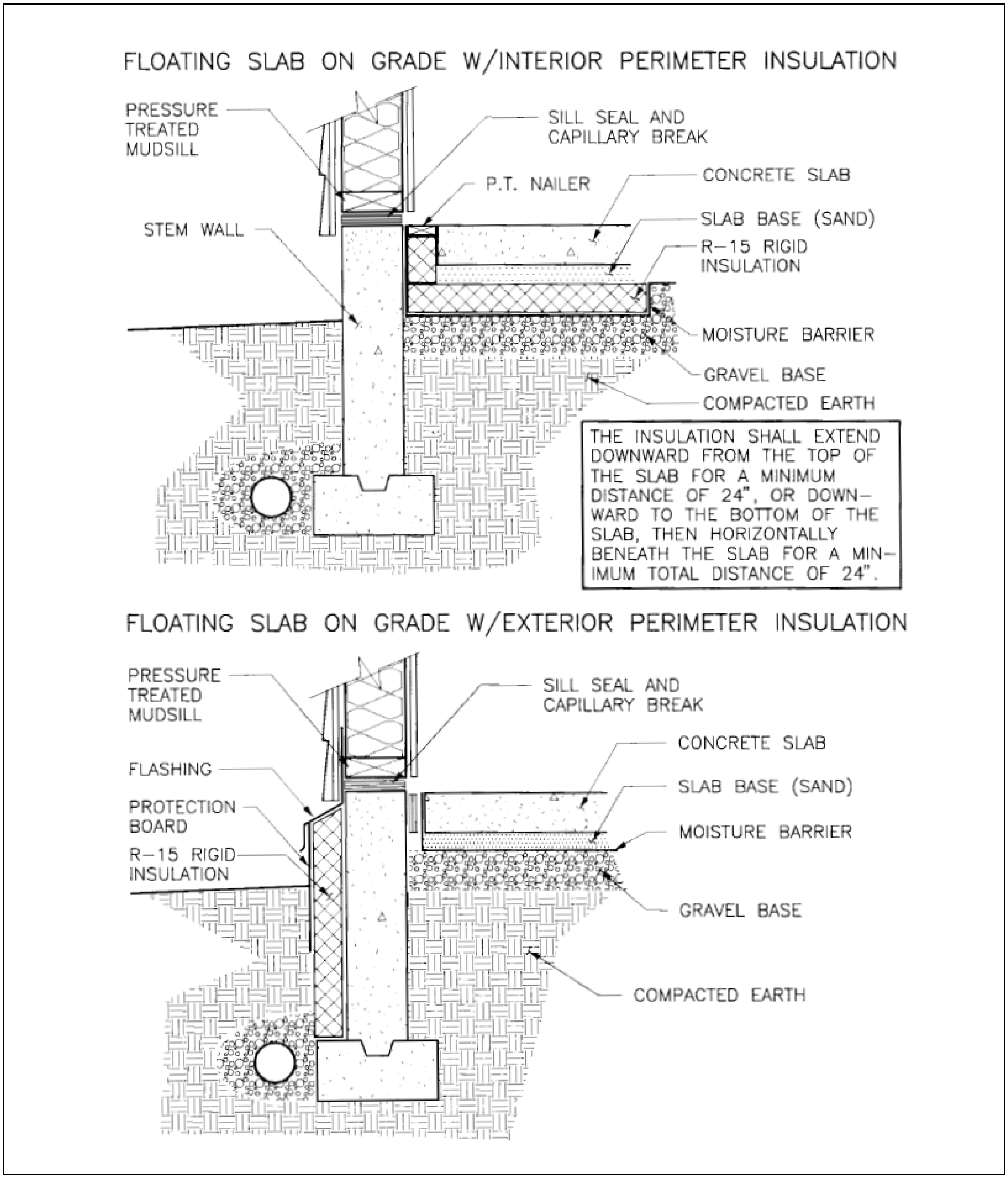


Figure 3:
Thermal break between slabs of heated and unheated floor spaces

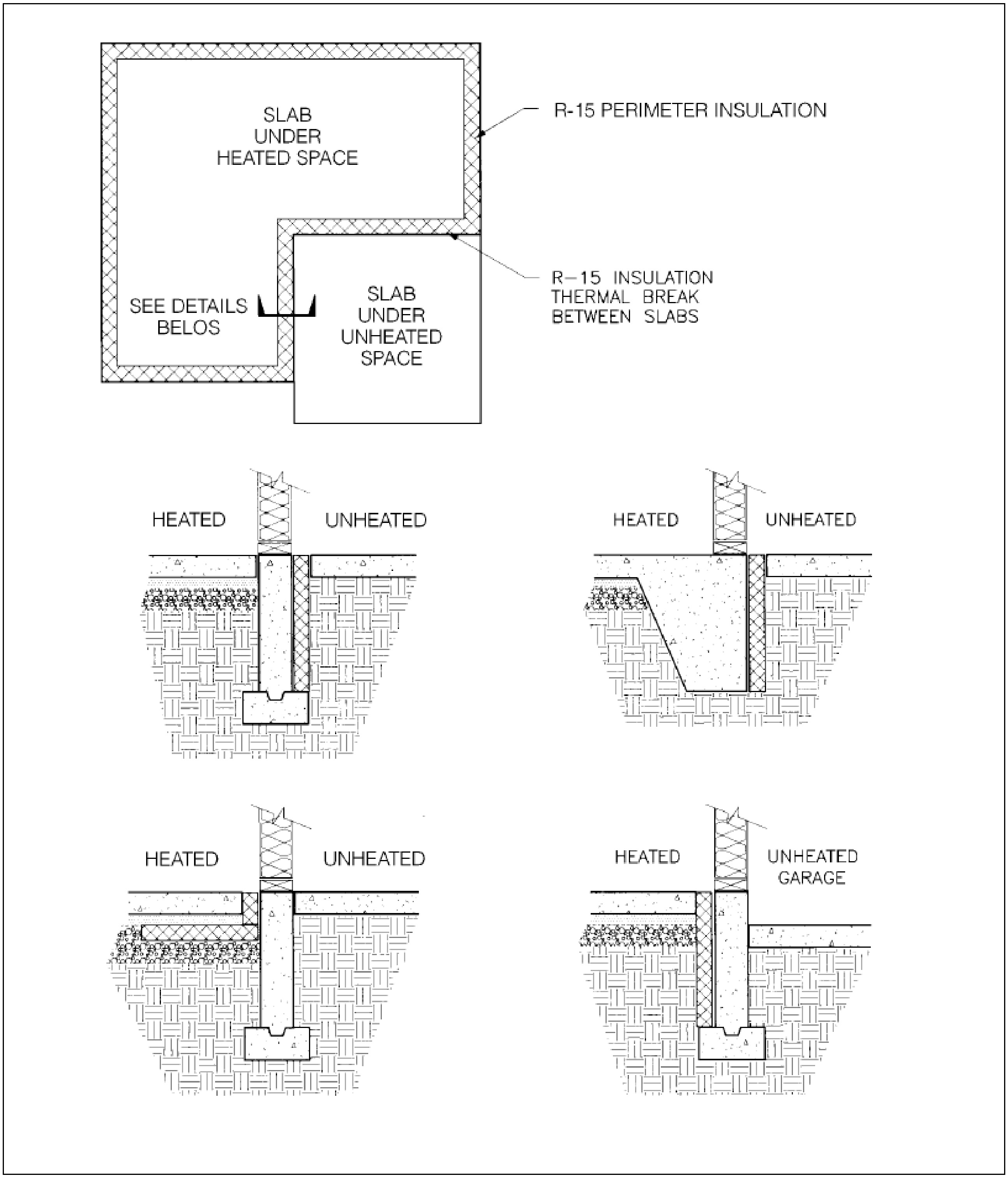
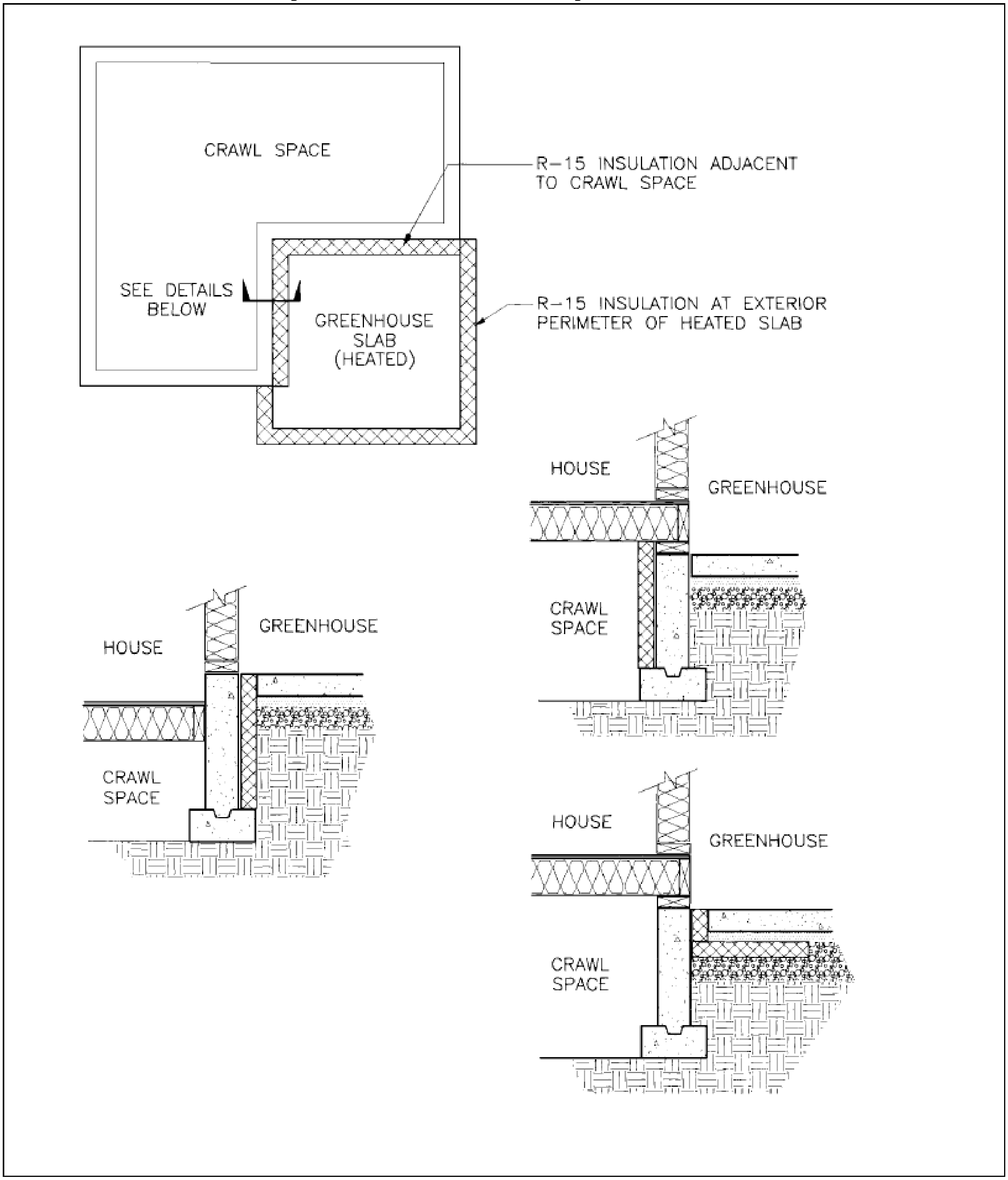


Figure 4:
Thermal break between heated space slabs and unheated crawl spaces



Information presented in this publication supports the Oregon Residential Specialty Code. This publication does not include all code requirements. Refer to the code and check with your code official for additional requirements. If information in this publication conflicts with code or your local officials, follow requirements of code and your local officials.

For more information about the residential energy code, call the Building Codes Division at (503) 378-4133 or the Oregon Dept of Energy (503) 378-4040 in Salem or toll-free, 1-800-221-8035.

This publication was prepared by Alan Seymour, Energy Code Analyst, Oregon Department of Energy for the Oregon Building Codes Division. Illustrations are by Gene Stevenson. Funding was provided by Northwest Energy Efficiency Alliance.

Building Codes Division

Working with Oregonians to ensure safe building construction while supporting a positive business climate.

OREGON DEPARTMENT OF ENERGY

Contains recycled materials

Table 1104.1(1): Residential Thermal Performance Calculations

TABLE N1104.1(1)
RESIDENTIAL THERMAL PERFORMANCE CALCULATIONS

BUILDING COMPONENTS [b]	Standard base case [a]			Proposed alternative			
	Areas [c]	U-factor	Areas x U	R-value[d]	Areas[c]	U-factor [e]	Areas x U
Flat ceilings Vaulted ceilings [f] Conventional wood-framed walls Underfloor Slab edge		0.031 0.042 0.060 0.028 (perimeter ft. =) F=0.52 [g]					
Windows Skylights <2%[h] Skylights >2%[h]		0.35 0.75 0.60					
Exterior doors [i] Doors with >2.5 ft^2 glazing		0.20 0.40					
		CODE UA =				**Proposed UA [j] =**	

a Base path 1 represents Standard Base Case from Table N1101.1(1).

b Performance trade-offs are limited to those listed in column 1. Heat plant efficiency, duct insulation levels, passive and active solar heating, air infiltration and similar measures including those not regulated by code may not be considered in this method of calculation.

c Areas from plan take-offs. All areas must be the same for both Standard Base Case and Proposed Alternate. The vaulted ceiling surface area for Standard Base Case must be the actual surface area from the plan take-off not to exceed 50 percent of the total heated space floor area. Any areas in excess of 50 percent for Base Case must be entered at U-0.031 (R-38) with "Flat Ceilings" area.

d Minimum Component Requirements: Walls R-15; Floors R-21; Flat Ceilings R-38; Vaults R-21; Below-Grade Wood, Concrete or Masonry Walls R-15; Slab Edge R-10; Duct Insulation R-8. R-values used in this table are nominal, for the insulation only and not for the entire assembly. Window and skylight *U*-values shall not exceed 0.65 (CL65). Door *U*-values shall not exceed 0.54 (Nominal R-2). A maximum of 28 square feet (2.6 m^2) of exterior door area per dwelling unit can have a U-factor of 0.54 or less and shall not be included in calculations.

e *U*-values for wood frame ceilings, walls and floor assemblies shall be as specified in Table N1104.1(2). *U*-values for other assemblies, which include steel framing, brick or other masonry, stucco, etc., shall be calculated using standard ASHRAE procedures.

f Vaulted area, unless insulated to R-38, U-0.031**,** may not exceed 50 percent of the total heated space floor area.

g F=The heat loss coefficient, BTU/hr./ft.^{2}/^{o}F. per foot of perimeter.

h Whenever skylight area for Proposed Alternative exceeds 2 percent of the total heated space floor area, enter 2 percent of area under Standard Base Case at U-0.75 then the remaining area under Standard Base Case at U-0.60. For Proposed Alternative skylights, enter the actual skylight area and U-factor of those to be installed in residence.

i A maximum of 28 square feet (2.6 m^2) of exterior door area per dwelling unit can have a U-factor of 0.54 or less. Default U-factor for an unglazed wood door is 0.54**.**

j Proposed UA must be less than or equal to Code UA.

TABLE N1104.1(2)— APPROVED DEFAULT U-FACTORS

FLAT CEILINGS[a]		
Insulation	**Type**	**U-Factor**
R-38	Conventional framing	0.031
R-38	=>8/12 roof pitch	0.028
R-38	Advance framing[c]	0.026
R-49	Conventional framing	0.025
R-49	=>8/12 roof pitch	0.024
R-49	Advance framing[c]	0.020
VAULTED CEILINGS[a]		
Insulation	**Type**	**U-Factor**
R-21	Rafter framings	0.047
R-30	Rafter framing	0.033
R-38	Rafter framing	0.027
R-21	Scissors truss	0.055
R-30	Scissors truss	0.046
R-38	Scissors truss	0.042
R-49	Scissors truss	0.039
R-30	Advance scissors truss[c]	0.032
R-38	Advance scissors truss[c]	0.026
R-49	Advance scissors truss[c]	0.020
EPS FOAM CORE PANEL VAULTED CEILINGS		
Insulation	**Type**	**U-Factor**
R-29	8-1/4” EPS foam core panel	0.037
R-37	10-1/4” EPS foam core panel	0.030
R-44	12-1/4” EPS foam core panel	0.025
FLOORS[a]		
Insulation	**Type**	**U-Factor**
R-21	Underfloor	0.035
R-25	Underfloor	0.032
R-30	Underfloor	0.028
SLAB-ON-GRADE		
Insulation	**Type**	**F-Factor[f]**
R-10	Slab edge	0.54
R-15	Slab edge	0.52
EPS FOAM CORE PANEL EXTERIOR WALLS		
Insulation	**Type**	**U-Factor**
R-14.88	4-1/2” EPS foam core panel	0.065
R-22.58	6-1/4” EPS foam core panel	0.045
R-29.31	8-1/4” EPS foam core panel	0.035

EXTERIOR WALLS[a]			
Insulation	**Insulation Sheathing**	**Framing**	**U-Factor**
R-15	0	Conventional framing	0.080
R-15	0	Intermediate framing[b]	0.075
R-19	0	Conventional framing	0.065
R-19	0	Intermediate framing[b]	0.063
R-19	0	Advance framing[d]	0.061
R-21	0	Conventional framing	0.060
R-21	0	Intermediate framing[b]	0.058
R-21	0	Advance framing[d]	0.055
R-11	3.5[e]	Conventional framing	0.069
R-11	5[e]	Conventional framing	0.063
R-11	7[e]	Conventional framing	0.055
R-11	3.5[e]	Advance framing[d]	0.067
R-11	5[e]	Advance framing[d]	0.061
R-11	7[e]	Advance framing[d]	0.054
R-13	3.5[e]	Conventional framing	0.064
R-13	5[e]	Conventional framing	0.058
R-13	7[e]	Conventional framing	0.052
R-13	3.5[e]	Advance framing[d]	0.062
R-13	5[e]	Advance framing[d]	0.056
R-13	7[e]	Advance framing[d]	0.050
R-15	3.5[e]	Conventional framing	0.060
R-15	5[e]	Conventional framing	0.055
R-15	7[e]	Conventional framing	0.049
R-15	3.5[e]	Advance framing[d]	0.057
R-15	5[e]	Advance framing[d]	0.052
R-15	7[e]	Advance framing[d]	0.047
R-19	3.5[e]	Conventional framing	0.052
R-19	5[e]	Conventional framing	0.047
R-19	7[e]	Conventional framing	0.043
R-19	3.5[e]	Advance framing[d]	0.049
R-19	5[e]	Advance framing[d]	0.045
R-19	7[e]	Advance framing[d]	0.041
R-21	3.5[e]	Conventional framing	0.048
R-21	5[e]	Conventional framing	0.044
R-21	7[e]	Conventional framing	0.040
R-21	3.5[e]	Advance framing[d]	0.044
R-21	5[e]	Advance framing[d]	0.042
R-21	7[e]	Advance framing[d]	0.038

[a] *U*-factors are for wood frame construction. *U*-factors for other assemblies which include steel framing, brick or other masonry, stucco, etc., shall be calculated using standard ASHRAE procedures.

[b] Intermediate framing consists of wall studs placed at a minimum 16 inches on-center with insulated headers. Voids in headers shall be insulated with rigid insulation having a minimum R-value of 4 per one-inch (w/m^3-k) thickness.

[c] Advanced framing construction for ceilings as defined in Section 1104.6

[d] Advanced framing construction for walls as defined in Section 1104.5.1

[e] Insulation sheathing shall be rigid insulation material, installed continuously over entire exterior or interior of wall (excluding partition walls).

[f] *F*-Factor is heat loss coefficient in Btu/hr/F° per lineal foot of concrete slab perimeter.

Information presented in this publication supports the Oregon Residential Specialty Code. This publication does not include all code requirements. Refer to the code and check with your code official for additional requirements. If information in this publication conflicts with code or your local officials, follow requirements of code and your local officials.

For more information about the residential energy code, call the Building Codes Division at (503) 378-4133 or the Oregon Dept of Energy (503) 378-4040 in Salem or toll-free, 1-800-221-8035.

This publication was prepared by Alan Seymour, Energy Code Analyst, Oregon Department of Energy for the Oregon Building Codes Division. Funding was provided by Northwest Energy Efficiency Alliance.

Building Codes Division

Working with Oregonians to ensure safe building construction while supporting a positive business climate.

OREGON DEPARTMENT OF ENERGY

Contains recycled materials

How to Do Residential Thermal Performance Calculations Using Table N1104.1(1)

This pamphlet is one in a series that describes residential energy conservation requirements of the Oregon Residential Specialty Code and Structural Specialty Code. Other pamphlets in this series may be downloaded from Oregon Department of Energy web site at http://egov.oregon.gov/ENERGY/CONS/Codes/cdpub.shtml or local building departments or from Oregon Building Codes Division.

Homes may comply with building envelope requirements of the residential energy code through either prescriptive building envelope (Table N1101.1(1)) or thermal performance calculations (Table N1104.1(1)). When following either of Tables N1101.1(1) or N1104.1(4), an additional measure must still be selected from Table N1101.1(2), Additional Measures.

Other combinations of measures may be used if thermal performance calculations show that the combination achieves the performance standard of the Standard Base Case. You must carefully select an additional measure from Table N1101.1(2).

You must carefully select an additional measure from Table N1101.1(2). It is simpler to perform this calculation if you select an additional measure that does not contain a building envelope improvement. If you select an additional measure that requires building envelope improvements, that improvement must be used as the Standard base case value, in lieu of that value. In addition to the modified calculation, any non-envelope measure must be installed.

Untested windows, doors and skylights may be used. In general, prescriptive paths require use of tested products. Builders who want to use certain products that are not yet tested can use thermal performance calculations to demonstrate code compliance. Certain untested products are assigned conservative default U-factors (rates of heat transfer per square foot). Other parts of the package are adjusted to compensate for conservative performance estimates of untested components.

Thermal performance calculations should be submitted on a copy of Table N1104.1(1), as shown in this pamphlet. Use of a standard format expedites review of the calculations by the code official.

How Table N1104.1(1) works

In a thermal performance calculation, a component U-factor is multiplied by total area (A) of the component in square feet. The result of this calculation is the "UA." The UA indicates rate of heat transfer through total component area. Totaling rates of heat transfer for listed building components gives a "UA total," or a heat transfer rate for all items that affect building envelope code compliance.

In Table N1104.1(2), building heat loss is first calculated as if the building was built using measures in the Standard Base Case from Table N1101.1(1). On Table N1104.1(1) worksheet this is called "Standard base case." The heat loss total is called "Code UA." Next, the UA is calculated for alternate conservation measures under consideration by the builder or designer. On the worksheet this is called the "Proposed alternative." The heat loss rate is called "Proposed UA."

If Proposed UA is equal to or less than Code UA, proposed measures meet energy code performance standards. If the Proposed alternative doesn't initially qualify, the builder or designer improves conservation levels in one or more building components until it complies.

TABLE N1104.1(1)
RESIDENTIAL THERMAL PERFORMANCE CALCULATIONS

BUILDING COMPONENTS [b]	Standard base case [a]			Proposed alternative			
	Areas [c]	U-factor	Areas x U	R-value[d]	Areas[c]	U-factor [e]	Areas x U
Flat ceilings Vaulted ceilings [f] Conventional wood-framed walls Underfloor Slab edge		0.031 0.042 0.060 0.028 (perimeter ft. =) F=0.52 [g]					
Windows Skylights <2%[h] Skylights >2%[h]		0.35 0.75 0.60					
Exterior doors [i] Doors with >2.5 ft^2 glazing		0.20 0.40					
		CODE UA =				**Proposed UA [j] =**	

a Base path 1 represents Standard Base Case from Table N1101.1(1).

b Performance trade-offs are limited to those listed in column 1. Heat plant efficiency, duct insulation levels, passive and active solar heating, air infiltration and similar measures including those not regulated by code may not be considered in this method of calculation.

c Areas from plan take-offs. All areas must be the same for both Standard Base Case and Proposed alternative. The vaulted ceiling surface area for Standard Base Case must be the actual surface area from the plan take-off not to exceed 50 percent of the total heated space floor area. Any areas in excess of 50 percent for Base Case must be entered at U-0.031 (R-38) with "Flat Ceilings" area.

d Minimum Component Requirements: Walls R-15; Floors R-21; Flat Ceilings R-38; Vaults R-21; Below-Grade Wood, Concrete or Masonry Walls R-15; Slab Edge R-10; Duct Insulation R-8. R-values used in this table are nominal, for the insulation only and not for the entire assembly. Window and skylight *U*-values shall not exceed 0.65 (CL65). Door *U*-values shall not exceed 0.54 (Nominal R-2). A maximum of 28 square feet (2.6 m^2) of exterior door area per dwelling unit can have a U-factor of 0.54 or less and shall not be included in calculations.

e *U*-values for wood frame ceilings, walls and floor assemblies shall be as specified in Table N1104.1(2). *U*-values for other assemblies, which include steel framing, brick or other masonry, stucco, etc., shall be calculated using standard ASHRAE procedures.

f Vaulted area, unless insulated to R-38, U-0.031**,** may not exceed 50 percent of the total heated space floor area.

g F=The heat loss coefficient, BTU/hr./$ft.^2/^oF$. per foot of perimeter.

h Whenever skylight area for Proposed alternative exceeds 2 percent of the total heated space floor area, enter 2 percent of area under Standard Base Case at U-0.75 then the remaining area under Standard Base Case at U-0.60. For Proposed alternative skylights, enter the actual skylight area and U-factor of those to be installed in residence.

i .A maximum of 28 square feet (2.6 m^2) of exterior door area per dwelling unit can have a U-factor of 0.54 or less. Default U-factor for an unglazed wood door is 0.54**.**

j Proposed UA must be less than or equal to Code UA.

The process starts with determining areas (in square feet) of each building component. Then Code UA and Proposed UA are calculated using guidelines in this pamphlet and in footnote c to Table N1104.1(1). The U-factor column for Standard base case on Table N1104.1(1) worksheet lists U-factors for calculating Code UA. Proposed alternative U-values are listed in Table N1104.1(2) Approved Default U-Factors that follows Table N1104.1(1) and is reproduced on pages 7-8 of this pamphlet.

Minimum component requirements

Thermal performance calculations allow trading of lower energy performance of one component for higher energy performance of another. However, the Proposed alternative must at least meet the minimum component requirement listed in footnote c to Table N1104.1(2). U-factors for minimum component R-values are specified in Table N1104.1(2) "Approved Default U-Factors" that follows Table N1104.1(2).

Standard base path area limits apply to Table N1104.1(1) calculations

Standard base case contains component limitations: R-30 vaulted ceilings are limited to 50 percent of heated space floor area and skylights (U-0.61 to U-0.75) are limited to 2 percent of heated floor space. These component limits must be observed when calculating Standard base case in Table N1104.1(1). A maximum of 28 square feet of exterior door area per dwelling unit can have a U-factor of 0.54 or less and shall not be included in calculations; Footnote c in Table N1104.1(1) and this pamphlet explain how component area limits are modeled in Standard base case calculation. Example calculation worksheets are on pages 8-11 of this pamphlet.

Calculating component areas

The first step in using Table N1104.1(1) is to find actual areas of each component:

Flat ceilings

Ceiling area equals length multiplied by width. Use outside dimensions and round to the nearest whole square foot. Deduct skylight area and use "net ceiling area."

Minimum component requirement is R-38, or U-0.031.

Vaulted ceilings

Ceiling area equals length multiplied by width of the ceiling surface. Measure vault length along the slope to the peak. Deduct skylight area and use "net vault area."

Minimum component requirement is R-21, or U-0.047.

U-0.042 (R-38) vault area limit in Standard Base Case calculation: For Standard base case, enter area of the R-38 (U-0.042) vault, not to exceed 50 percent of heated floor space. Enter the actual U-factor for this assembly. U-factor for a standard R-38 scissors truss is U-0.042. U-factor for a rafter vaulted ceiling with R-30 insulation is typically U-0.033.

Include excess vault area (area that is greater than 50 percent of heated space floor area) with "Flat Ceilings." For Proposed alternative, enter actual area of vaulted ceiling under "Vaulted Ceilings." If there are two or more vaulted ceilings with different U-values, enter each vaulted ceiling UA on separate lines for the Proposed alternative calculation.

Opaque (solid) walls

Wall area equals length multiplied by height, using outside dimensions and rounding to the nearest whole square foot. For triangular walls at vaults and gable ends, area equals base multiplied by height divided by two. Subtract area of windows and exterior doors from total opaque wall area. Use this "net wall area" for the performance calculation.

Minimum component requirement is R-15, or U-0.080.

Account for all walls that divide heated and unheated spaces. Remember to include walls between house and garage, vault end walls, skylight wells, pony walls, knee walls, and stairway walls that may divide heated and unheated spaces.

Windows & Sliding Glass Doors (SGD)

For rectangular windows, area equals width multiplied by height. Since window U-factors include heat loss through the frame, use rough opening dimensions to calculate window area. Round to the nearest whole square foot. For whole circles, area equals π (3.14) multiplied by radius (r) squared ($A = \pi r^2$). For half-round windows, figure whole circle area and divide by two. For triangular windows, area equals base multiplied by height divided by two.

Deduct window and SGD area from gross wall area.

Minimum component requirement is U-0.65, or a class 65 window – typically a double-glazed window with a thermally-improved metal frame.

For site-assembled windows, use default U-factors from Table NF1112.4(1).

1 percent unique glazing exemption: Glazing area equal to 1 percent of heated space floor area may be exempt from meeting window U-factor standards if it is a "unique architectural glazing feature." That includes door sidelights, stained glass, glass contained in a door, garden windows and other decorative glass. Skylights and conventional window configurations that include but are not limited to horizontal sliders, double-hung and picture windows are not eligible as unique architectural features. Do not include unique exempted glazing in thermal performance calculations. A note accompanying calcul-ations should indicate which windows were exempted and exempted window area.

Skylights

Skylight area equals rough opening dimension: length multiplied by width. Deduct skylight area from gross flat or vaulted ceiling area.

2 percent skylight area limit in the Standard Base Case calculation: For Standard base case, actual skylight area, up to 2 percent of the heated space floor area is entered as "Skylight" (U-0.75). If actual area exceeds 2 percent of heated space floor area, enter excess area under "Window" (U-0.60).

For the Proposed alternative, enter actual skylight area using the tested U-factor or appropriate default U-factor. If skylights have different U-factors, calculate each skylight UA separately.

Exterior doors – without any glazing

Area equals width multiplied by height of the rough opening. Sidelights are included with windows. Deduct entire door area from gross wall area.

Exempt door - unglazed doors, untested or tested:

For Standard base case door area, up to 28 square feet exterior door area per dwelling unit can have a U-factor of 0.54 or less and shall not be included in calculations. Enter all other door area(s) as "Exterior Doors" (U-0.20).

For the Proposed alternative, enter door area as "Exterior Doors" using the tested door U-factor or the default factor (U-0.54). If an untested 1-3/4- inch foam core door with a thermal break is used, use a U-0.20 default factor for the Proposed alternative.

Exterior doors with ≤2.5 ft^2 glazing

Deduct entire door area from gross wall area.

1 percent unique glazing exemption for doors with less than 2.5 ft^2 glazing: If the 1 percent unique glazing exemption is taken, note excluded glazing area on the Table N1104.1(1) worksheet, but do not include it in Standard base case or Proposed alternative calculations. Use net door area: total door area minus exempted glazing area.

In Standard base case, enter square footage of net door area under "Exterior Doors" (U-0.20). If excess glazing area remains, use the base case window default factor (U-0.35).

For Proposed alternative opaque door area, use U-0.54 or the 1-3/4-inch foam core door with thermal break default value (U-0.20) or NFRC-tested U-factor and enter under "Exterior Doors." The glazing exemption "removes" the glass from the door. Thus, tested U-factors are no longer valid. If excess glazing area remains after the exemption, use default glazing U-factors.

When no glazing exemption is available for doors with less than 2.5 ft^2 glazing: Enter excess opaque area under "Exterior Doors" (U-0.20). Enter excess glazing as "Window" (U-0.35) in the Standard base case. In the Proposed alternative, use default U-factor if not a tested door assembly.

Tested doors: Use actual net door area and tested U-factor for the Proposed alternative.

Untested doors: Use actual net door area and U-0.54 or the 1-3/4-inch foam core door with thermal break default factor (U-0.20) for the Proposed alternative.

Exterior doors with >2.5 ft^2 glazing

Deduct entire door area from gross wall area.

When the glazing in these doors are either double pane glazing with low-*e* coating on one surface, or triple pane, it can be assigned a default of U-0.40 if NFRC certification is not available. A U-factor of 0.40 can be used as the U-factor for the Proposed alternative.

If glazing in the door is not either double pane glazing with low-*e* coating on one surface, or triple pane, use of the following described options: "1 percent unique glazing exemption for doors with more than 2.5 ft^2 glazing" or "No glazing exemption for doors with more than 2.5 ft^2 glazing"

1 percent unique glazing exemption for doors with more than 2.5 ft^2 glazing: If the 1 percent unique glazing exemption is taken, note excluded glazing area on the Table N1104.1(1) worksheet, but do not include it in Standard base case or Proposed alternative calculations. Use net door area: total door area minus exempted glazed area.

Tested doors: Exclude 2.5 ft^2 of exempted area from calculations. Enter excess opaque area under "Exterior Doors" (U-0.20) in the Standard base case. Enter glazed area in excess of 2.5 ft^2 as "Window" (U-0.40).

For Proposed alternative, use U-0.54 or the 1-3/4-inch foam core door with thermal break default value (U-0.20) for net opaque door area.

Untested doors: Exclude 2.5 ft^2 of exempted area from calculations. Enter glazed area in excess of 2.5 ft^2 as "Window"U-0.40) in Standard base case. Enter excess opaque door area under "Exterior Doors" (U-0.20). Excess glazed area must be included as windows.

For Proposed alternative, use U-0.54 or the 1-3/4-inch foam core door with thermal break default value (U-0.20) for net opaque door area. Enter net glazed area under "Window" using default window U-values (0.60 or 0.65).

No glazing exemption for doors with more than 2.5 ft^2 glazing:

Tested doors: For Standard base case, enter net door area under "Exterior Door" (U-0.20). Enter glazed area in excess of 2.5 ft^2 as "Window" (U-0.35).

For Proposed alternative, enter actual door area as "Exterior Door" using NFRC tested U-factor.

Untested doors: For Standard base case, enter net door area under "Exterior Door" (U-0.20) in Standard base case. Enter glazed area in excess of 2.5 ft^2 as "Window" (U-0.35).

For Proposed alternative opaque door area, use U-0.54 or the 1-3/4-inch foam core door with thermal break default value (U-0.20) and enter under "Exterior Doors." Use window default factors for glazed door area in excess of 2.5 ft^2.

Underfloor

Underfloor area is floor area that divides heated from unheated spaces. Examples include floors above unheated crawl spaces or unheated basements, cantilevered floors, and floors above unheated garages.

Underfloor area called for in the calculation may be different from total "heated space floor area" of the home. Heated space floor area in a two-story home includes the area of both the first and second floors because both are heated. But in many homes, only the first floor divides heated from unheated space, so only first floor area is used as underfloor area for the calculation.

The minimum component requirement for underfloor area is R-21, or U-0.035.

Slab edge (in linear feet of perimeter)

To calculate slab heat loss, first determine linear footage of the slab perimeter. Slab edge losses pertain to on-grade slabs only, which are part of the heated space floor area.

Minimum component requirement is R-10, or F-0.54.

Slab interior – for heated slabs

In addition to slab edge perimeter insulation,

Basement walls

Basement walls are not included in Table N1104.1(1) calculations because the minimum component requirement is R-15. The basement wall insulation requirement includes insulation at the rim joist.

Air infiltration

Air infiltration is not included in Table N1104.1(1) thermal performance calculations.

Footnote b

Footnote b indicates that performance trade-offs are limited to building components listed in Table N1104.1(1). Furnace efficiency, duct insulation and passive and active solar heating are not considered in thermal performance calculations.

Footnote e

Footnote e to Table N1104.1(1) states U-factors calculated using standard ASHRAE methodology may be used. Consult the Oregon Department of Energy for information about assumptions used to calculate new component U-factors.

What happens if Proposed UA exceeds Code UA?

If Proposed UA exceeds Code UA, the building does not comply with energy code. Make changes in proposed U-factors until you find a combination of measures equivalent to or less than Code UA.

Example calculations

Following are examples of Table N1104.1(1) thermal performance calculations:

In **Example 1**, the builder is using windows that exceed code standards and trade-offs with floor insulation that does not meet Standard base case requirements.

Example 2 shows how to do calculations for a building that has R-30 vaults in excess of 50 percent of heated floor space.

Example 3 shows how to do calculations for a building that has R-30 vaults in excess of 50 percent of heated floor area and skylights in excess of 2 percent of heated floor space.

Example 4 shows how to do calculations when the exempt door is a 40 square feet solid wood, exceeding the 28 square feet limitation.

Example 5 shows how to treat untested glazing in thermal performance calculations.

How-to incorporate Table N1101.1(2) building envelope measures into calculations

Example 6 shows how to do calculations when Additional Measure 3 from Table N1101.1(2) is selected. Option 3 requires U-0.025 and U-0.033 flat and vaulted ceilings, U-0.047 (R-24) walls, and U-0.32 windows.

Since Option 3 only consists of "building envelope" improvements, no other additional measures are necessary.

Example 7 shows how to do calculations when Additional Measure 5 from Table N1101.1(2) is selected. Option 5 requires U-0.025 and U-0.033 flat and vaulted ceilings, and U-0.32 windows. It **also** requires that 75 percent of permanently installed lighting fixtures as CFL or linear fluorescent or a min efficacy of 40 lumens per watt.

Since Option 5 consists of a measure besides "building envelope" improvements, that measure is also required to be installed in addition to the modified Table N1104.1(1) calculation.

TABLE N1104.1(2)— APPROVED DEFAULT U-FACTORS

FLAT CEILINGS[a]		
Insulation	**Type**	**U-Factor**
R-38	Conventional framing	0.031
R-38	=>8/12 roof pitch	0.028
R-38	Advance framing[c]	0.026
R-49	Conventional framing	0.025
R-49	=>8/12 roof pitch	0.024
R-49	Advance framing[c]	0.020
VAULTED CEILINGS[a]		
Insulation	**Type**	**U-Factor**
R-21	Rafter framings	0.047
R-30	Rafter framing	0.033
R-38	Rafter framing	0.027
R-21	Scissors truss	0.055
R-30	Scissors truss	0.046
R-38	Scissors truss	0.042
R-49	Scissors truss	0.039
R-30	Advance scissors truss[c]	0.032
R-38	Advance scissors truss[c]	0.026
R-49	Advance scissors truss[c]	0.020
EPS FOAM CORE PANEL VAULTED CEILINGS		
Insulation	**Type**	**U-Factor**
R-29	8-1/4” EPS foam core panel	0.037
R-37	10-1/4” EPS foam core panel	0.030
R-44	12-1/4” EPS foam core panel	0.025
FLOORS[a]		
Insulation	**Type**	**U-Factor**
R-21	Underfloor	0.035
R-25	Underfloor	0.032
R-30	Underfloor	0.028
SLAB-ON-GRADE		
Insulation	**Type**	**F-Factor[f]**
R-10	Slab edge	0.54
R-15	Slab edge	0.52
EPS FOAM CORE PANEL EXTERIOR WALLS		
Insulation	**Type**	**U-Factor**
R-14.88	4-1/2” EPS foam core panel	0.065
R-22.58	6-1/4” EPS foam core panel	0.045
R-29.31	8-1/4” EPS foam core panel	0.035

EXTERIOR WALLS[a]			
Insulation	**Insulation Sheathing**	**Framing**	**U-Factor**
R-15	0	Conventional framing	0.080
R-15	0	Intermediate framing[b]	0.075
R-19	0	Conventional framing	0.065
R-19	0	Intermediate framing[b]	0.063
R-19	0	Advance framing[d]	0.061
R-21	0	Conventional framing	0.060
R-21	0	Intermediate framing[b]	0.058
R-21	0	Advance framing[d]	0.055
R-11	3.5[e]	Conventional framing	0.069
R-11	5[e]	Conventional framing	0.063
R-11	7[e]	Conventional framing	0.055
R-11	3.5[e]	Advance framing[d]	0.067
R-11	5[e]	Advance framing[d]	0.061
R-11	7[e]	Advance framing[d]	0.054
R-13	3.5[e]	Conventional framing	0.064
R-13	5[e]	Conventional framing	0.058
R-13	7[e]	Conventional framing	0.052
R-13	3.5[e]	Advance framing[d]	0.062
R-13	5[e]	Advance framing[d]	0.056
R-13	7[e]	Advance framing[d]	0.050
R-15	3.5[e]	Conventional framing	0.060
R-15	5[e]	Conventional framing	0.055
R-15	7[e]	Conventional framing	0.049
R-15	3.5[e]	Advance framing[d]	0.057
R-15	5[e]	Advance framing[d]	0.052
R-15	7[e]	Advance framing[d]	0.047
R-19	3.5[e]	Conventional framing	0.052
R-19	5[e]	Conventional framing	0.047
R-19	7[e]	Conventional framing	0.043
R-19	3.5[e]	Advance framing[d]	0.049
R-19	5[e]	Advance framing[d]	0.045
R-19	7[e]	Advance framing[d]	0.041
R-21	3.5[e]	Conventional framing	0.048
R-21	5[e]	Conventional framing	0.044
R-21	7[e]	Conventional framing	0.040
R-21	3.5[e]	Advance framing[d]	0.044
R-21	5[e]	Advance framing[d]	0.042
R-21	7[e]	Advance framing[d]	0.038

TABLE N1104.1(2) — APPROVED DEFAULT U-FACTORS

[a] *U*-factors are for wood frame construction. *U*-factors for other assemblies, which include steel framing, brick or other masonry, stucco, etc., shall be calculated using standard ASHRAE procedures.

[b] Intermediate framing consists of wall studs placed at a minimum 16 inches on-center with insulated headers. Voids in headers shall be insulated with rigid insulation having a minimum R-value of 4 per one-inch (w/m^3-k) thickness.

[c] Advanced framing construction for ceilings as defined in Section 1104.6

[d] Advanced framing construction for walls as defined in Section 1104.5.1

[e] Insulation sheathing shall be rigid insulation material, installed continuously over entire exterior or interior of wall (excluding partition walls).

[f] *F*-Factor is heat loss coefficient in Btu/hr/ºF per lineal foot of concrete slab perimeter.

Example 1
Builder trades window performance against underfloor insulation

Heated Floor Area
Slab 674
Crawl 1627
Total 2301 Ft^2

$\frac{\text{Skylight Area}}{\text{Floor Area}} = \frac{16}{2301} = 0.006\%$

More efficient windows make it possible to decrease floor insulation.

TABLE N1104.1(1)
RESIDENTIAL THERMAL PERFORMANCE CALCULATIONS

Example 1 BUILDING COMPONENTS [b]	Standard base case [a]			Proposed alternative			
	Areas [c]	U-factor	Areas x U	R-value[d]	Areas[c]	U-factor [e]	Areas x U
Flat ceilings	1965	0.031	60.91	R-38	1965	0.031	60.91
Vaulted ceilings [f]	407	0.042	17.09	R-38	407	0.042	17.09
Conventional wood-framed walls	1754	0.060	105.24	R-21	1754	0.060	105.24
Underfloor	1627	0.028	45.56	R-25	1627	0.032	52.06
Slab edge	117'	(perimeter ft. =) F=0.52 [g]	60.84	R-15	117'	0.52	60.84
Windows	287	0.35	100.45	-	287	0.32	91.84
Skylights <2%[h]	16	0.75	12.0	-	16	0.75	12.0
Skylights >2%[h]		0.60					
Exterior doors [i]	17	0.20	3.4	Insul	17	0.20	3.4
Doors with >2.5 ft^2 glazing	40	0.40	16.0	-	40	0.40	16.0
		CODE UA =	421.49			Proposed UA [j] =	419.38

Example 2
Home exceeds prescriptive R-30 vault area limit

When R-38 vault area exceeds 50 percent of the floor area, enter vault in excess of 50 percent as flat ceiling for Standard base case.

Floor Area = 2301   Flat Ceiling = 857
Vault (Gross) = 1463 Skylights = 16
Allowable Vault 2301 X .5=1151 Ft^2 (Note max=50% of floor area)
Net Vault = Gross Vault 1463 - Skylights 16 = 1447
Excess Vault as Flat Ceiling: Net Vault 1477 - Allowable Vault 1151 = 296 Vault as Flat Ceiling

TABLE N1104.1(1)
RESIDENTIAL THERMAL PERFORMANCE CALCULATIONS

BUILDING COMPONENTS [b]	Standard base case [a]			Proposed alternative			
	Areas [c]	U-factor	Areas x U	R-value[d]	Areas[c]	U-factor [e]	Areas x U
Flat ceilings	857 + 296	0.031	35.76	R-49 Std	857	0.025	21.43
Vaulted ceilings [f]	1151	0.042	48.32	R-38	1447	0.042	60.77
Conventional wood-framed walls	2447	0.060	146.82	R-21	2497	0.060	146.82
Underfloor	1627	0.028	45.56	R-30	1627	0.028	45.56
Slab edge	117	(perimeter ft. =) F=0.52 [g]	60.84	R-15	117	0.52	60.84
Windows	287	0.35	100.45	-	287	0.35	100.45
Skylights <2%[h]	16	0.75	12.00	-	16	0.75	12.00
Skylights >2%[h]		0.60					
Exterior doors [i]	17	0.20	3.40	Insul	17	0.20	3.40
Doors with >2.5 ft^2 glazing	40	0.40	16.00	-	40	0.40	16.00
		CODE UA =	**469.15**			**Proposed UA [j] =**	**465.16**

Example 3
Home exceeds R-30 vault and 2 percent skylight limit

Enter excess R-30 vault as flat ceiling and excess skylight area as window for Standard base case.

Actual Skylight Area: 48 Ft 2 Allowable Skylight Area 2301 X .02 = 46 Ft^2
1463 Gross Vault - 48 Skylight 1415 Net Value
1415 - 1151 264 Excess Vault Area to Flat Ceiling
48 Actual Skylight - 46 Allowed 2 Ft to Window

TABLE N1104.1(1)
RESIDENTIAL THERMAL PERFORMANCE CALCULATIONS

BUILDING COMPONENTS [b]	Standard base case [a]			Proposed alternative			
	Areas [c]	U-factor	Areas x U	R-value[d]	Areas[c]	U-factor [e]	Areas x U
Flat ceilings	857 + 264	0.031	34.77	R-49 std.	857	0.025	21.43
Vaulted ceilings [f]	1151	0.042	48.32	R-38	1415	0.042	59.43
Conventional wood-framed walls	2447	0.060	146.82	R-21	2447	0.060	146.82
Underfloor	1627	0.028	45.56	R-30	1627	0.028	45.56
Slab edge	117	(perimeter ft. =) F=0.52 [g]	60.84	R-15	117	0.52	60.84
Windows	287	0.35	100.45	-	287	0.35	100.45
Skylights <2%[h]	46	0.75	34.5	-	48	0.75	36.0
Skylights >2%[h]	2	0.60	1.2	-			
Exterior doors [i]	17	0.20	3.4	-	17	0.20	3.4
Doors with >2.5 ft^2 glazing	40	0.40	16.0	-	40	0.40	16.0
		CODE UA =	**491.85**			**Proposed UA [j] =**	**489.93**

Example 4
Exterior wood door is 40 ft^2 and exceeds 28 ft^2 feet allowance

Actual Wood Door is 40 Ft^2
Door Area Qualifying as Exempt 28 Ft^2
Excess Area to Exterior Door: 40 – 28 = 12 Ft^2

When an exterior door area exceeds 28 square feet and the door is wood, enter excess area as exterior door for Standard base case.

TABLE N1104.1(1)
RESIDENTIAL THERMAL PERFORMANCE CALCULATIONS

BUILDING COMPONENTS [b]	Standard base case [a]			Proposed alternative			
	Areas [c]	U-factor	Areas x U	R-value[d]	Areas[c]	U-factor [e]	Areas x U
Flat ceilings	1965	0.031	60.92	R-38	1965	0.031	60.92
Vaulted ceilings [f]	407	0.042	17.09	R-38	407	0.042	17.09
Conventional wood-framed walls	1734	0.060	104.04	R-21	1734	0.060	104.04
Underfloor	1627	0.028	45.56	R-30	1627	0.028	45.56
Slab edge	117	(perimeter ft. =) F=0.52 [g]	60.84	R-15	117	0.52	60.84
Windows	287	0.35	130.8	-	287	0.32	91.8
Skylights <2%[h]	16	0.75	8.0	-	16	0.75	8.0
Skylights >2%[h]		0.60					
Exterior doors [i]	17+12	0.20	5.80	Insul	17	0.20	3.4
				Wood	12	0.54	6.48
Doors with >2.5 ft^2 glazing	40	0.40	16.0	-	40	0.40	16.0
		CODE UA =	422.70			Proposed UA [j] =	418.17

Example 5
House with untested door sidelight

Untested Sidelight 12 Ft^2
Default U-Value = 0.54 (Wood Frame, 1/2" Air Space, Clear Glass)

Use the default U-value for an untested door sidelight for the Proposed Alternate.

TABLE N1104.1(1)
RESIDENTIAL THERMAL PERFORMANCE CALCULATIONS

BUILDING COMPONENTS [b]	Standard base case [a]			Proposed alternative			
	Areas [c]	U-factor	Areas x U	R-value[d]	Areas[c]	U-factor [e]	Areas x U
Flat ceilings	1965	0.031	60.92	R-38	1965	0.031	60.92
Vaulted ceilings [f]	407	0.042	17.09	R-38	407	0.042	17.09
Conventional wood-framed walls	1754	0.060	105.24	R-21	1754	0.060	105.24
Underfloor	1627	0.028	45.56	R-30	1627	0.028	45.56
Slab edge	117	(perimeter ft. =) F=0.52 [g]	60.84	R-15	117	0.52	60.84
Windows	275+12	0.35	100.45	-	275	0.34	93.50
				-	12	0.54	6.48
Skylights <2%[h]	16	0.75	12.0	-	16	0.75	12.0
Skylights >2%[h]		0.60					
Exterior doors [i]	17	0.20	3.4	-	17	0.20	3.4
Doors with >2.5 ft^2 glazing	40	0.40	16.0	-	40	0.40	16.0
		CODE UA =	421.50			Proposed UA [j] =	421.03

Example 6
How to incorporate Additional Measure 3 in Standard base case

Modified Standard base case when Additional Measure 3 is selected

PROPOSED CONSTRUCTION

Flat Ceiling Construction/R-value	Raised-Heel Truss, R-38
Vaulted Ceiling Construction/R-value	Raised-Heel Scissors Truss, R-38
Exterior Walls Construction/R-value	2x6 Advance Framed, R-19 w/R-5 rigid exterior
Window U-Factor	U-0.32

TABLE N1104.1(1)
RESIDENTIAL THERMAL PERFORMANCE CALCULATIONS

BUILDING COMPONENTS [b]	Standard base case [a]			Proposed alternative			
	Areas [c]	U-factor	Areas x U	R-value[d]	Areas[c]	U-factor [e]	Areas x U
Flat ceilings	1965	0.025	49.13	R-38A	1965	0.026	51.09
Vaulted ceilings [f]	407	0.033	13.13	R-38A	407	0.026	10.58
Conventional wood-framed walls	1754	0.047	82.44	R-24A	1754	0.045	78.93
Underfloor	1627	0.028	45.56	R-30	1627	0.028	45.56
Slab edge	117′	(perimeter ft. =) F=0.52 [g]	60.84	R-15	117′	0.52	60.84
Windows	287	0.32	91.84	-	287	0.32	91.84
Skylights <2%[h]	16	0.75	12.0	-	16	0.75	12.0
Skylights >2%[h]		0.60					
Exterior doors [i]	17	0.20	3.4	Insul	17	0.20	3.4
Doors with >2.5 ft² glazing	40	0.40	16.0	-	40	0.40	16.0
		CODE UA =	374.63			Proposed UA [j] =	370.24

Example 7
How to incorporate Additional Measure 5 in Standard base case

Modified Standard base case when Additional Measure 5 is selected

PROPOSED CONSTRUCTION

Flat Ceiling Construction/R-value	Raised-Heel Truss, R-38
Vaulted Ceiling Construction/R-value	Raised-Heel Scissors Truss, R-38
Window U-Factor	U-0.32

TABLE N1104.1(1)
RESIDENTIAL THERMAL PERFORMANCE CALCULATIONS

BUILDING COMPONENTS [b]	Standard base case [a]			Proposed alternative			
	Areas [c]	U-factor	Areas x U	R-value[d]	Areas[c]	U-factor [e]	Areas x U
Flat ceilings	1965	0.025	49.13	R-38A	1965	0.026	51.09
Vaulted ceilings [f]	407	0.033	13.43	R-38A	407	0.026	10.58
Conventional wood-framed walls	1754	0.060	105.24	R-21	1754	0.060	105.24
Underfloor	1627	0.028	45.56	R-30	1627	0.028	45.56
Slab edge	117′	(perimeter ft. =) F=0.52 [g]	60.84	R-15	117′	0.52	60.84
Windows	287	0.32	91.84	-	287	0.32	91.84
Skylights <2%[h]	16	0.75	12.0	-	16	0.75	12.0
Skylights >2%[h]		0.60					
Exterior doors [i]	17	0.20	3.4	Insul	17	0.20	3.4
Doors with >2.5 ft² glazing	40	0.40	16.0	-	40	0.40	16.0
		CODE UA =	397.43			Proposed UA [j] =	396.55

Information presented in this publication supports the Oregon Residential Specialty Code. This publication does not include all code requirements. Refer to the code and check with your code official for additional requirements. If information in this publication conflicts with code or your local officials, follow requirements of code and your local officials.

For more information about the residential energy code, call the Building Codes Division at (503) 378-4133 or the Oregon Dept of Energy (503) 378-4040 in Salem or toll-free, 1-800-221-8035.

This publication was prepared by Alan Seymour, Energy Code Analyst, Oregon Department of Energy for the Oregon Building Codes Division. Funding was provided by Northwest Energy Efficiency Alliance.

Building Codes Division

Working with Oregonians to ensure safe building construction while supporting a positive business climate.

OREGON DEPARTMENT OF ENERGY

Contains recycled materials

Recessed Lights

This pamphlet is one in a series that describes residential energy conservation requirements of the Oregon Residential Specialty Code and Structural Specialty Code. Other pamphlets in this series may be downloaded from Oregon Department of Energy web site at http://egov.oregon.gov/ENERGY/CONS/Codes/cdpub.shtml or local building departments or from Oregon Building Codes Division.

The Oregon residential code does not allow installation of recessed lights in cavities intended to be insulated – insulated ceilings, for example. The restriction avoids a potential fire hazard: covering a recessed light fixture with insulation.

Recessed lighting fixtures must also be airtight. This can be accomplished by one of the following:

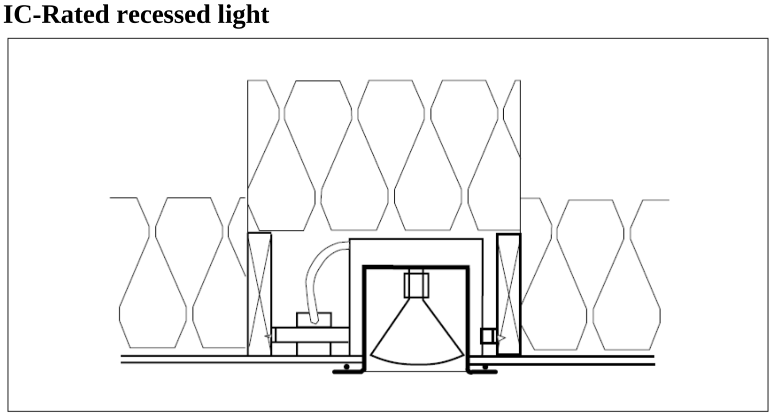
- Type IC rated, manufactured with no penetrations between the inside of the recessed fixture and ceiling cavity, and the annular space between the ceiling cutout and lighting fixture shall be sealed.
- Type IC rated in accordance with ASTM E283 with no more than 2.0 cfm air movement from the conditioned space to the ceiling cavity, at 1.57 psi pressure (75 Pa) difference, shall be labeled, and the annular space between the ceiling cutout and lighting fixture shall be sealed.
- Type IC rated installed inside a sealed box constructed from a minimum 0.5-inch-thick gypsum wallboard or constructed from a preformed polymeric vapor barrier, or other airtight assembly manufactured for this purpose.

Recessed lights act as chimneys for heat loss and moisture transfer into attic and rafter spaces. Thus the requirement also has energy and moisture control benefits.

Look closely at product literature for the IC rating. The IC rating is also stamped on the fixture. If you do not see "IC" and the fixture has not been tested as "air-tight," the fixture cannot be installed in spaces that are intended to be insulated.

Existing recessed lights that are not IC-rated may be found when ceiling insulation levels are increased as part of a remodel. In these situations, a non-combustible baffle must be used to keep insulation back and maintain a three-inch fire clearance around the fixture. The top of the fixture should either not be covered or maintain a 24-inch clearance above the top fixture. Code does not require replacement of existing non-IC rated lights in existing buildings.

Figure 1:
IC-Rated recessed light



Information presented in this publication supports the Oregon Residential Specialty Code. This publication does not include all code requirements. Refer to the code and check with your code official for additional requirements. If information in this publication conflicts with code or your local officials, follow requirements of code and your local officials.

For more information about the residential energy code, call the Building Codes Division at (503) 378-4133 or the Oregon Dept of Energy (503) 378-4040 in Salem or toll-free, 1-800-221-8035.

This publication was prepared by Alan Seymour, Energy Code Analyst, Oregon Department of Energy for the Oregon Building Codes Division. Illustrations are by Gene Stevenson. Funding was provided by Northwest Energy Efficiency Alliance.

Building Codes Division

Working with Oregonians to ensure safe building construction while supporting a positive business climate.

OREGON DEPARTMENT OF ENERGY

Contains recycled materials

Reducing Heat Loss Due to Air Leakage

This pamphlet is one in a series that describes residential energy conservation requirements of the Oregon Residential Specialty Code and Structural Specialty Code. Other pamphlets in this series may be downloaded from Oregon Department of Energy web site at http://egov.oregon.gov/ENERGY/CONS/Codes/cdpub.shtml or local building departments or from Oregon Building Codes Division.

Code requirements for air leakage control

Air leakage is random movement of air into and out of a building through cracks and holes in the building shell. In technical bulletins, air leakage is called "infiltration" (air moving into a building) or "exfiltration" (air moving out of a building). In everyday language, air leaks are called "drafts."

To reduce heat loss due to air leaks, energy code establishes testing criteria for air tightness of windows and doors. Energy code also specifies construction joints that must be sealed during construction. Requirements for air leakage control remain unchanged from earlier versions of the energy code.

Window and door air leakage

Laboratory testing establishes air leakage rates for windows and doors. Window leakage rates are given in cubic feet per minute (cfm) per linear foot of sash crack. Door air leakage is most commonly expressed as cfm per square foot of door area.

Window air leakage must not exceed 0.37 cfm per linear foot of sash crack. Swinging door air leakage must not exceed 0.37 cfm per square foot of door area. Sliding door air leakage must not exceed 0.37 cfm per square foot of door area.

These air leakage rates are not particularly stringent. Many manufacturers meet or exceed these standards.

To determine whether windows and doors meet these requirements, ask the retailer or manufacturer for product literature. Product literature should list performance data, including air leakage. The standard test to look for is ASTM (American Society of Testing Materials) E-283, "Standard Test Methods for Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors." The air leakage test must be conducted under a 25 mph wind speed.

Sealing the building envelope

Energy code specifies that the following construction joints must be sealed:

- Exterior joints around window and door frames
- Joints between wall cavities and window and door frames
- Joints between the wall and foundation
- Joints between the wall and roof
- Joints between wall panels
- Penetrations or utility services through exterior walls, floors and roofs

Code also requires sealing of "all other openings" in the building envelope "in a manner approved by the building official."

Exterior joints around window and door frames and between wall cavities and window and door frames

Air leaks can by-pass tightly closed windows and doors and create uncomfortable drafts. Sealing at windows and doors reduces air leakage through rough openings. Exterior caulking around the exterior trim or behind window fins helps reduce air leakage. On the inside, rough openings are stuffed with filler material such as insulation scrap then sealed over with caulk. Expandable foam caulk, polyethylene backer rod, or rope caulk are also used.

Figure 1:
General wall air sealing

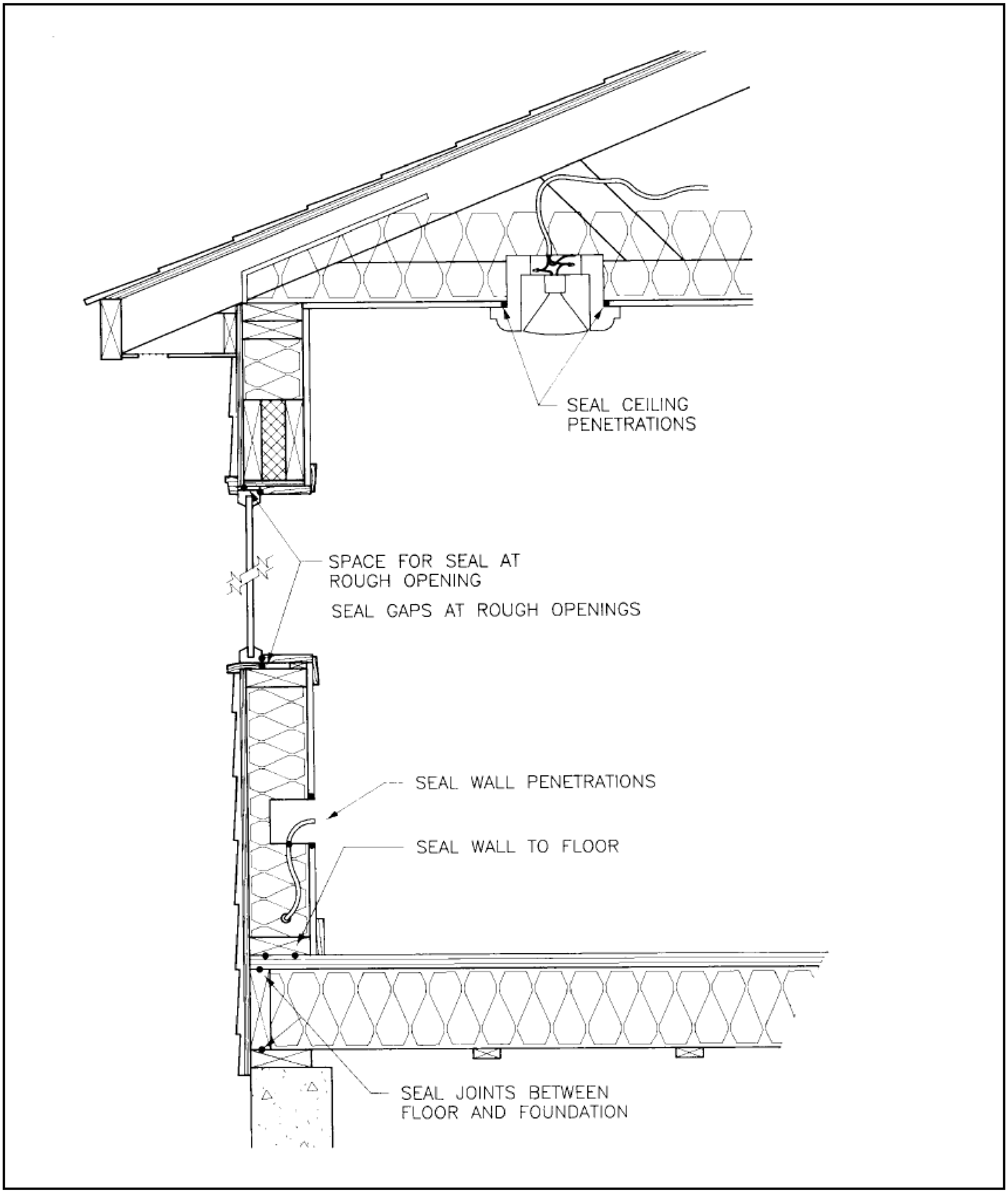


Figure 2:
Sealing the tub penetration

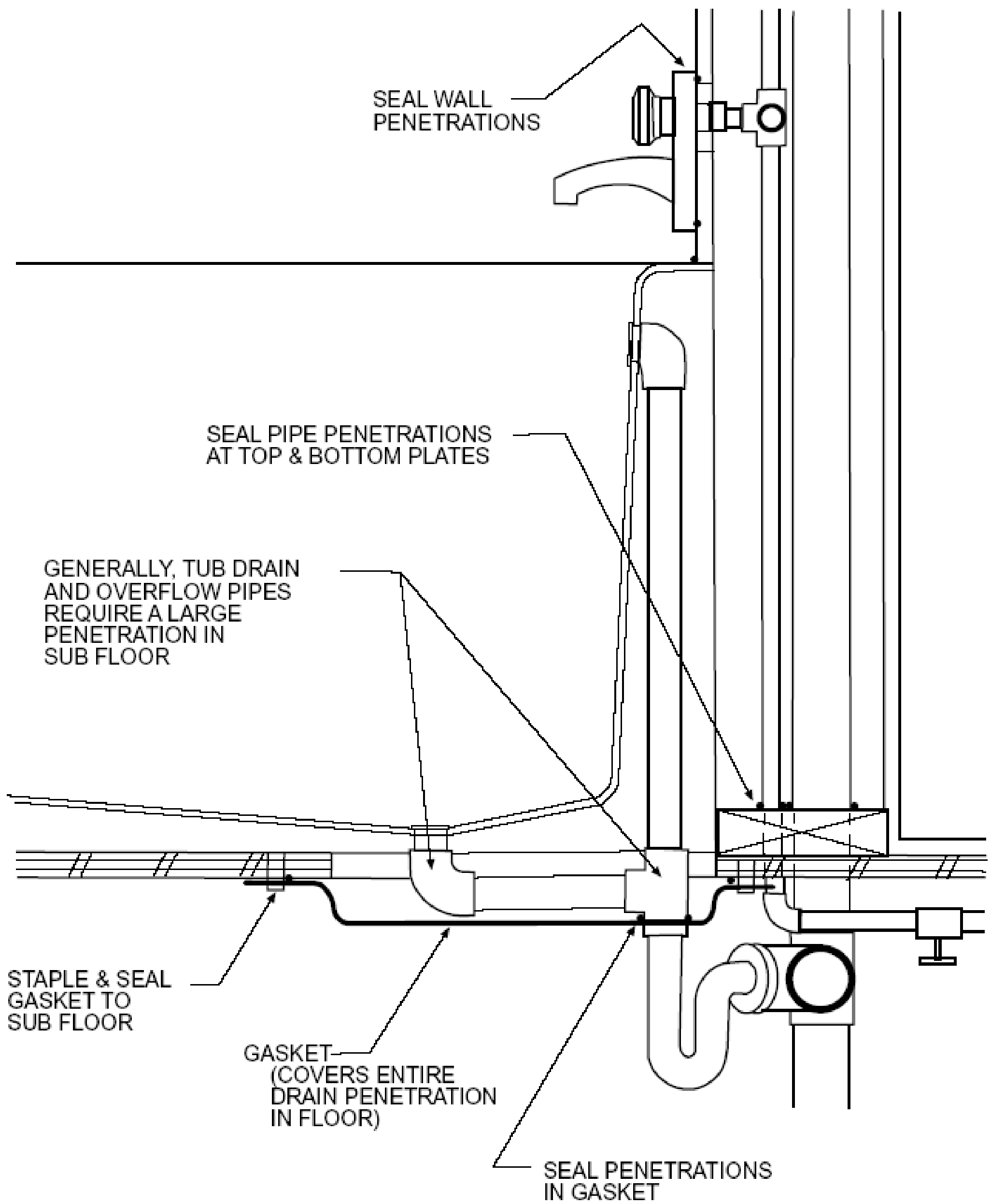
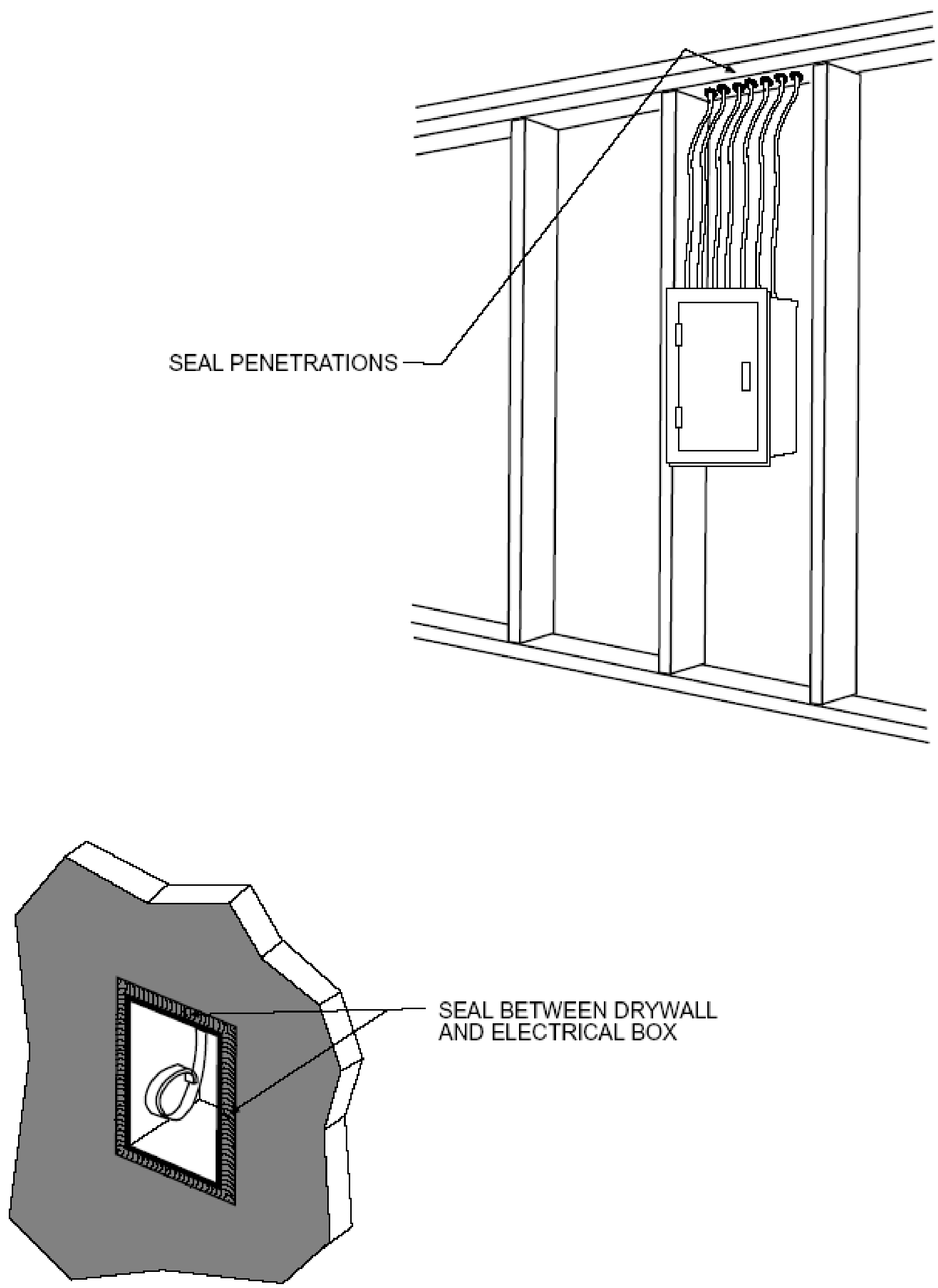


Figure 3:
Sealing electrical penetrations



Joints between the wall and foundation

Joints between the wall and foundation may include the wall-to-floor joint, the floor-to-mudsill joint, and the mudsill-to-foundation joint. All may be sealed with caulk either during assembly or before cover. The wall-to- floor joint may be best addressed after the building is closed in and dried out. Fiberglass strips below the mudsill are not effective at sealing the joint but may provide backing for caulking or foam sealant.

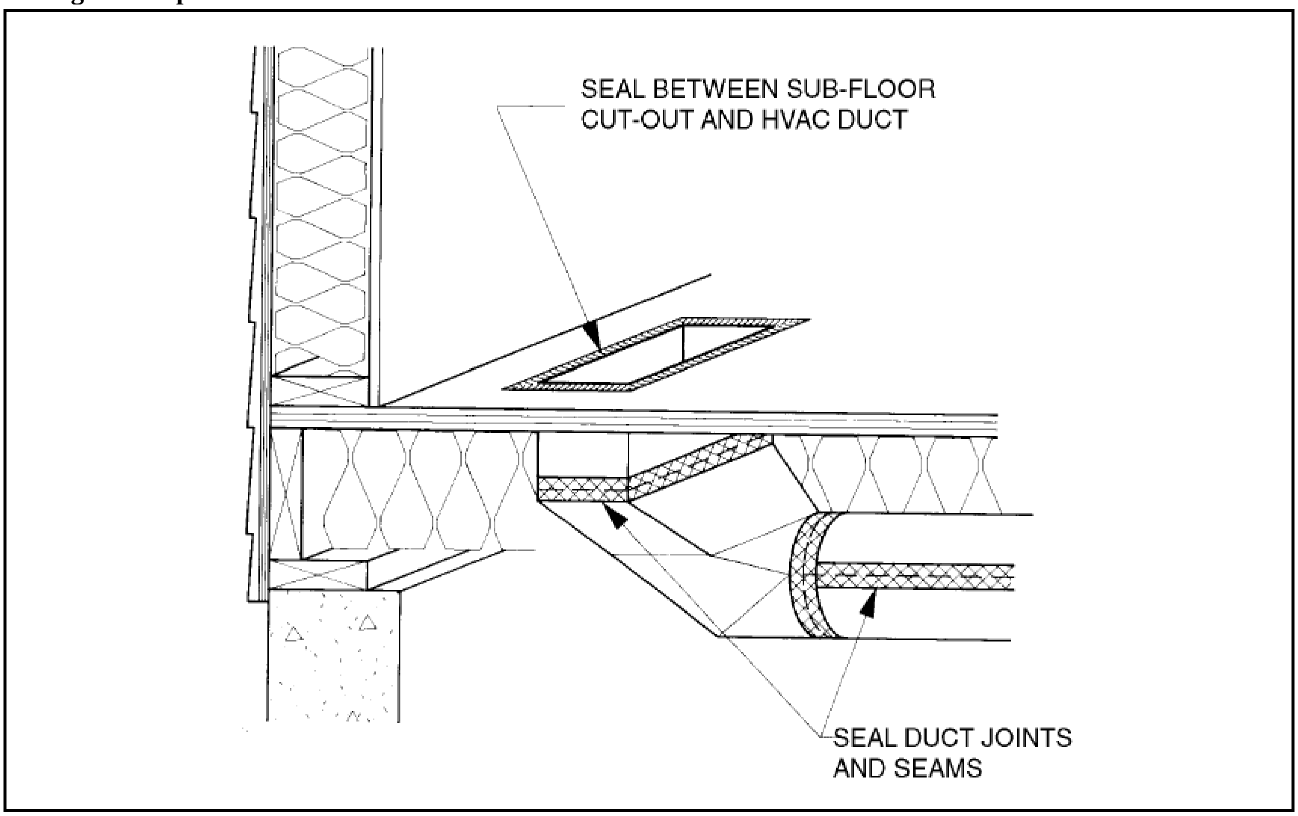
Joints between the wall and ceiling

In most cases, drywall mud and tape seal the joint between the wall and roof. In some homes, however, drywall is not used for wall and ceiling finish, so other sealing is needed to join finish ceiling and wall materials. For instance, caulking may be needed in open beam ceilings to prevent air leaks at beam pockets and to join the wall and ceiling together.

Joints between wall panels

Joints between wall panels are usually sealed by drywall mud and tape. Mud and tape might not be applied if the wall will be covered with paneling or cabinets. If mud and tape are not used, some other sealant should be used to seal joints. Make sure that dissimilar wall finish materials are sealed at corners. Joints between wall panels must be sealed to prevent heat loss and minimize moisture penetration into wall cavities.

Figure 4:
Sealing HVAC penetrations



Penetrations or utility services through exterior walls, floors and ceilings

Plumbing, wiring, and phone penetrations may create air leakage pathways from the crawl space, up through interior walls and into the attic. These pathways short-circuit insulation and air sealing in exterior walls. Stack effect in buildings increases air leakage rates through these “thermal by-pass” routes.

Penetrations in floors, walls, and ceilings must be sealed. The subcontractor who makes the hole can seal the penetration. Or holes can be sealed just prior to the rough mechanical/electrical/plumbing inspection.

Finish sealing

Final caulking and sealing takes place after finish mechanical, electrical, and plumbing are complete. Outlet and switch boxes on exterior walls are sealed to the wall finish material. Vent fans and other recessed fixtures are sealed to the wall or ceiling finish. Gaps between registers and grills and finish materials also must be sealed.

Duct system sealing

Duct air leakage is not specifically mentioned in the energy code. However, sealing is required by Residential Code M1601.2, “Joints and Seams of Ducts.”

Because air in the duct system is under pressure, duct leakage can be far more significant than leakage through the building envelope. Studies of Northwest homes have found that 20 to 40 percent of the heat produced by the furnace can be lost through the duct system.

Information presented in this publication supports the Oregon Residential Specialty Code. This publication does not include all code requirements. Refer to the code and check with your code official for additional requirements. If information in this publication conflicts with code or your local officials, follow requirements of code and your local officials.

For more information about the residential energy code, call the Building Codes Division at (503) 378-4133 or the Oregon Dept of Energy (503) 378-4040 in Salem or toll-free, 1-800-221-8035.

This publication was prepared by Alan Seymour, Energy Code Analyst, Oregon Department of Energy for the Oregon Building Codes Division. Illustrations are by Gene Stevenson. Funding was provided by Northwest Energy Efficiency Alliance.

Building Codes Division

Working with Oregonians to ensure safe building construction while supporting a positive business climate.

OREGON DEPARTMENT OF ENERGY

Contains recycled materials

Oregon Residential Energy Code

April 2008 • No. 14

Moisture Control Measures

This pamphlet is one in a series that describes residential energy conservation requirements of the Oregon Residential Specialty Code and Structural Specialty Code. Other pamphlets in this series may be downloaded from Oregon Department of Energy web site at http://egov.oregon.gov/ENERGY/CONS/Codes/cdpub.shtml or local building departments or from Oregon Building Codes Division.

Moisture control measures required by the Oregon Residential Code include vapor retarders in walls, floors, and ceilings without attics and a ground cover in crawl spaces and below slabs in heated spaces. Section drawings or written specifications that accompany the plans must show moisture control measures.

Along with damp-proofing and ventilation requirements, moisture control reduces moisture problems in homes and multifamily buildings.

Vapor retarder requirements

Vapor retarders reduce moisture condensation within floor, wall and ceiling cavities. Most interior finish materials are permeable. Water vapor can move through them, by a process called "diffusion," into structural cavities. If vapor diffuses into structural cavities, and if the cavities are cold enough, water vapor can condense on insulation, sheathing, or framing members. Wet insulation loses its R-value. Wet structural cavities can promote growth of damaging mold and dry rot.

"Perm ratings" indicate how well materials resist moisture penetration. The lower the perm rating, the better a material prevents moisture diffusion.

Installing a vapor retarder on the warm side of insulation prevents water vapor diffusion into the cavity. Facing on insulation is a vapor retarder. Certain paints are formulated to act as vapor retarders. Check with your building official to be sure paints are locally accepted.

Figure 1 shows the diffusion process and how vapor retarders work.

Wall vapor retarders

Code requires a one-perm vapor retarder in walls. Faced insulation may meet both R-value and vapor retarder requirements. When unfaced batts or blown-in batts are used, a vapor retarder must be provided. Vapor retarder paints are common wall vapor retarders.

Floor vapor retarders

A one-perm formulated vapor retarder is also required on floors. The vapor retarder requirement is often met by using exterior grade plywood or strand board sheathing for the floor. The exterior glue in structural floor panels typically has a perm rating of one or less. In post-and-beam floor systems, a separate vapor retarder must be installed if the vapor retarder is not an integral part of the insulation. Typically, kraft paper (rated at one perm or less) installed above decking and below finish floor underlayment serves as the vapor retarder.

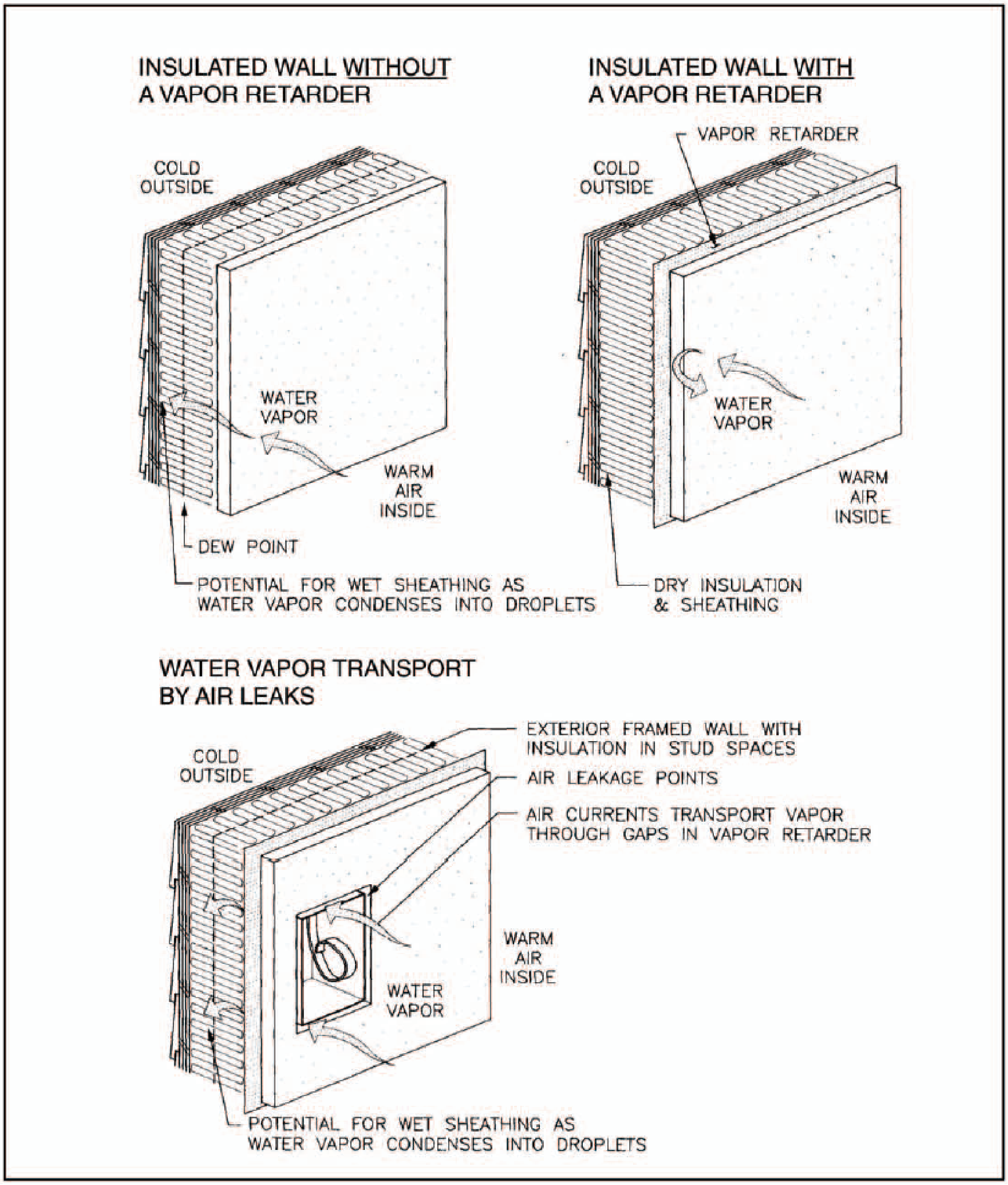
Don't confuse the floor vapor barrier with the ground moisture barrier. They are two separate code requirements.

Slab floors do not require vapor retarders yet a ground moisture barrier is required.

Ceiling vapor retarders

No vapor retarder is required for ceilings with attics above them. Attic ventilation presumably counteracts moisture diffusion into the attic space.

Figure 1
Controlling Moisture Diffusion with Vapor Retarders



A 1.0 perm vapor retarder is required in ceilings without attic spaces above them, such as single rafter vaults. Most vapor retarder paints have a tested perm rating of at least 1.0. These paints cannot have any tint added. Tint increases porosity, reducing the paint's effectiveness as a vapor retarder.

Ground cover

Vapor retarders protect structural cavities from moisture sources inside the home. Ground covers protect the home from moisture sources in the ground. Ground covers are required in crawl spaces and below slabs. Six-mil black plastic is commonly used. Clear plastic is not permitted because it is subject to ultraviolet degradation and allows light penetration, which may allow plant growth.

The ground cover must be lapped 12 inches at all joints, cover the entire underfloor area, and extend 12 inches up the foundation wall. A ground cover of 55-pound rolled roofing or an approved equivalent must be installed below slab floors in heated spaces.

Ventilation requirements work with energy code moisture control measures

Energy code measures that control moisture work together with measures in the Residential Specialty Code (ORSC), Mechanical Code (OMSC) and Structural Code (OSSC) that address:

- Ventilation of attics (ORSC R806 and OSSC 1203.2).
- Ventilation of crawl spaces (ORSC R408 and OSSC 2516 (c)).
- Ventilation of living spaces (ORSC R303, OSSC 1203.4 [natural ventilation], or OSMC Chapter 4 [mechanical ventilation]).
- Range hoods (ORSC M1502 and OMSC 505).
- Clothes dryers (ORSC M1501 and OMSC 504.6).

Residential Code and Structural Code require waterproofing and dampproofing for below-grade walls (ORSC R406 and OSSC 1807).

Special systems

Occasionally homes will include features with exceptional potential for moisture damage. Indoor swimming pools and hot tubs are examples. In these instances, additional moisture protection measures are advisable and may be required by the code official.

Perm ratings of common building materials

Perm rating (dry cup) is a measure of the ability of a material of specific thickness to transmit moisture. It's expressed in terms of the amount of moisture transmitted per unit time for a specified area and differential pressure. Dry cup perm rating is expressed in grains/hr/ft /inches of Hg. Permeance may be measured by using ASTM E96-72 or other approved dry cup method. The closer the dry cup perm rating is to zero, the better the vapor barrier. Permeability is permeance of a material of a specified unit length (perm/inch).

Perm ratings of common building materials

Material	Thickness	Permeance[1]
Structural Materials		
Concrete (1:2:4 mix)	1	3.2[2]
Brick masonry	4	0.8[2]
Concrete block	8	2.4[2]
Plaster on wood lath	3/4	11.0[3]
Gypsum wall board	3/8	50.0[2]
Exterior plywood	1/4	0.7[2]
Interior plywood	1/4	1.9[2]
Thermal Insulations		
Air (still)	1	120.0[2]
Extruded polystyrene	1	0.4-1.2[4]
Expanded polystyrene	1	2.0-5.8[4]
Polyisocyanurate	1 (foil face)	0.05[4]
Polyisocyanurate	1 (no foil)	26.0
Plastic Films and Metal Foils		
Aluminum foil	1 mil	0
Polyethylene	4 mil	0.08
Polyethylene	6 mil	0.06
Polyethylene cross laminated high density (Tu-Tuff™)	4 mil	0.02
Building Paper, Felts and Roofing Papers		
Saturated and coated rolled roofing		0.05
Kraft paper and asphalt laminated reinforced 30-120-30		0.3
Kraft thermal insulation facing		1.0[4]
Foil thermal insulation facing		0.5[4]
15 lb. asphalt felt		1.0
Olefin, spunbond high density fiber (Tyvek™, Parsec™)		94.0[4]

Material	Permeance[1]
Paints (1 coat)	
Vapor retarder paint	0.6-0.9[5]
Selected primer-sealer paint	0.9[5]
Primer-sealer	6.28
Vinyl-acrylic primer	8.62
Semi-gloss vinyl-acrylic enamel	6.61
Paints (2 coats)	
Aluminum varnish on wood	0.3-0.5
Enamels on smooth plaster	0.5-1.5
Various primers plus	1 coat
flat oil paint on plaster	1.6-3.0

1 Values from 1981 ASHRAE Fundamentals Handbook unless otherwise noted.
2 Other than wet or dry cup method.
3 Wet cup method.
4 Value supplied by manufacturer.
5 Value from Rodale Products Testing Laboratory.

Perm ratings for specific paints should be verified by independent testing using ASTM E-96A or equivalent TAPPI test standards.

Information presented in this publication supports the Oregon Residential Specialty Code. This publication does not include all code requirements. Refer to the code and check with your code official for additional requirements. If information in this publication conflicts with code or your local officials, follow requirements of code and your local officials.

For more information about the residential energy code, call the Building Codes Division at (503) 378-4133 or the Oregon Dept of Energy (503) 378-4040 in Salem or toll-free, 1-800-221-8035.

This publication was prepared by Alan Seymour, Energy Code Analyst, Oregon Department of Energy for the Oregon Building Codes Division. Illustrations are by Gene Stevenson. Funding was provided by Northwest Energy Efficiency Alliance.

Building Codes Division
Working with Oregonians to ensure safe building construction while supporting a positive business climate.

OREGON DEPARTMENT OF ENERGY

Contains recycled materials

Requirements for Warm-Air Heating, Ventilating and Air Conditioning Systems

This pamphlet is one in a series that describes residential energy conservation requirements of the Oregon Residential Specialty Code and Structural Specialty Code. Other pamphlets in this series may be downloaded from Oregon Department of Energy web site at http://egov.oregon.gov/ENERGY/CONS/Codes/cdpub.shtml or local building departments or from Oregon Building Codes Division.

Duct insulation requirements

All heating and central ventilation system ducts outside conditioned spaces must be insulated to R-8. Duct boots and the furnace plenum also must be insulated. R-8 duct insulation may be achieved by using an R-8 duct insulation product, doubling R-4 insulation, or using an R-8 manufactured flex duct. Insulated ducts should be installed in a way that minimizes insulation compression.

The new energy code raised duct insulation requirements because studies show significant heat loss through duct systems. Without insulation and air sealing, ducts may lose as much as 20 to 40 percent of heat produced by the furnace.

Residential Code (ORSC) and Mechanical Specialty Code (OMSC) requirements that affect duct systems

Residential Code Chapter 16 and Mechanical Code Chapter 6 include requirements that affect duct systems. Requirements address fire ratings, labeling, sealing of joints and seams, materials standards, vibration mitigation, support, and fastening.

If duct insulation is faced, facing material must have a flame spread rating of not more than 25 and a smoke developed rating of not more than 50. Insulation fire rating and R-value must be stamped on the insulation face.

Air sealing of ducts also is required. All joints and seams of the duct system must use the appropriate UL-181 rated tape or sealed with UL-181 rated mastics. Cloth-backed duct tape is not allowed.

Combustion air requirements

Code cross-references incorporate adequate exterior combustion air requirements from Residential Code R-1005 and Structural Code 2111.14 for masonry and factory-built fireplaces, and factory-built stoves.

System controls

Each HVAC system must have a thermostat to control temperature. In zoned buildings, each zone must have its own thermostat.

At a minimum, thermostats must be numerically marked and capable of being set between 55 and 75 °F for heating-only thermostats; between 70 and 85 °F for cooling-only thermostats; and between 55 and 85 °F for thermostats that control both heating and cooling.

The system control must have a switch or other means of setting back or shutting off heating and cooling during periods of reduced need.

All control features called for in code are widely available.

Heat pump controls

Each heat pump system must have an outdoor thermostat or a control that regulates the cut-on temperature for the compression heating to be higher than the cut-on temperature for the supplementary heat, and the cut-off temperature for the compression heating to be higher than the cut-off temperature for the supplementary heat.

STATE OF OREGON 1859

Information presented in this publication supports the Oregon Residential Specialty Code. This publication does not include all code requirements. Refer to the code and check with your code official for additional requirements. If information in this publication conflicts with code or your local officials, follow requirements of code and your local officials.

For more information about the residential energy code, call the Building Codes Division at (503) 378-4133 or the Oregon Dept of Energy (503) 378-4040 in Salem or toll-free, 1-800-221-8035.

This publication was prepared by Alan Seymour, Energy Code Analyst, Oregon Department of Energy for the Oregon Building Codes Division. Funding was provided by Northwest Energy Efficiency Alliance.

Building Codes Division

Working with Oregonians to ensure safe building construction while supporting a positive business climate.

OREGON DEPARTMENT OF ENERGY

Contains recycled materials

How to Show Energy Code Information on the Plan

This pamphlet is one in a series that describes residential energy conservation requirements of the Oregon Residential Specialty Code and Structural Specialty Code. Other pamphlets in this series may be downloaded from Oregon Department of Energy web site at http://egov.oregon.gov/ENERGY/CONS/Codes/cdpub.shtml or local building departments or from Oregon Building Codes Division.

Using prescriptive options

The following drawings show typical components of residential buildings and energy details for each path in Table N1101.1(1), "Prescriptive Envelope Compliance" and each Additional Measure from Table N1101.1(2). The drawings are examples and show only energy code details.

Use the drawings and Tables N1101.1(1) to make sure all required conservation measures are shown on plans submitted to the building department. Identify the prescriptive path number on the plan.

Using residential thermal performance calculations

If Table 1104.1(1), "Residential Thermal Performance Calculations," is used to demonstrate compliance with energy code, plan drawings should show "Proposed Alternative" conservation measures that are calculated to be thermally equivalent to "Standard Base Case" code measures.

Information presented in this publication supports the Oregon Residential Specialty Code. This publication does not include all code requirements. Refer to the code and check with your code official for additional requirements. If information in this publication conflicts with code or your local officials, follow requirements of code and your local officials.

For more information about the residential energy code, call the Building Codes Division at (503) 378-4133 or the Oregon Dept of Energy (503) 378-4040 in Salem or toll-free, 1-800-221-8035.

This publication was prepared by Alan Seymour, Energy Code Analyst, Oregon Department of Energy for the Oregon Building Codes Division. Illustrations are by Gene Stevenson. Funding was provided by Northwest Energy Efficiency Alliance.

Building Codes Division

Working with Oregonians to ensure safe building construction while supporting a positive business climate.

OREGON DEPARTMENT OF ENERGY

STATE OF OREGON 1859

Contains recyced materials

Figure 1:
Code envelope details for Standard Base Case using Additional Measures 1, 2, 7, 8 and 9

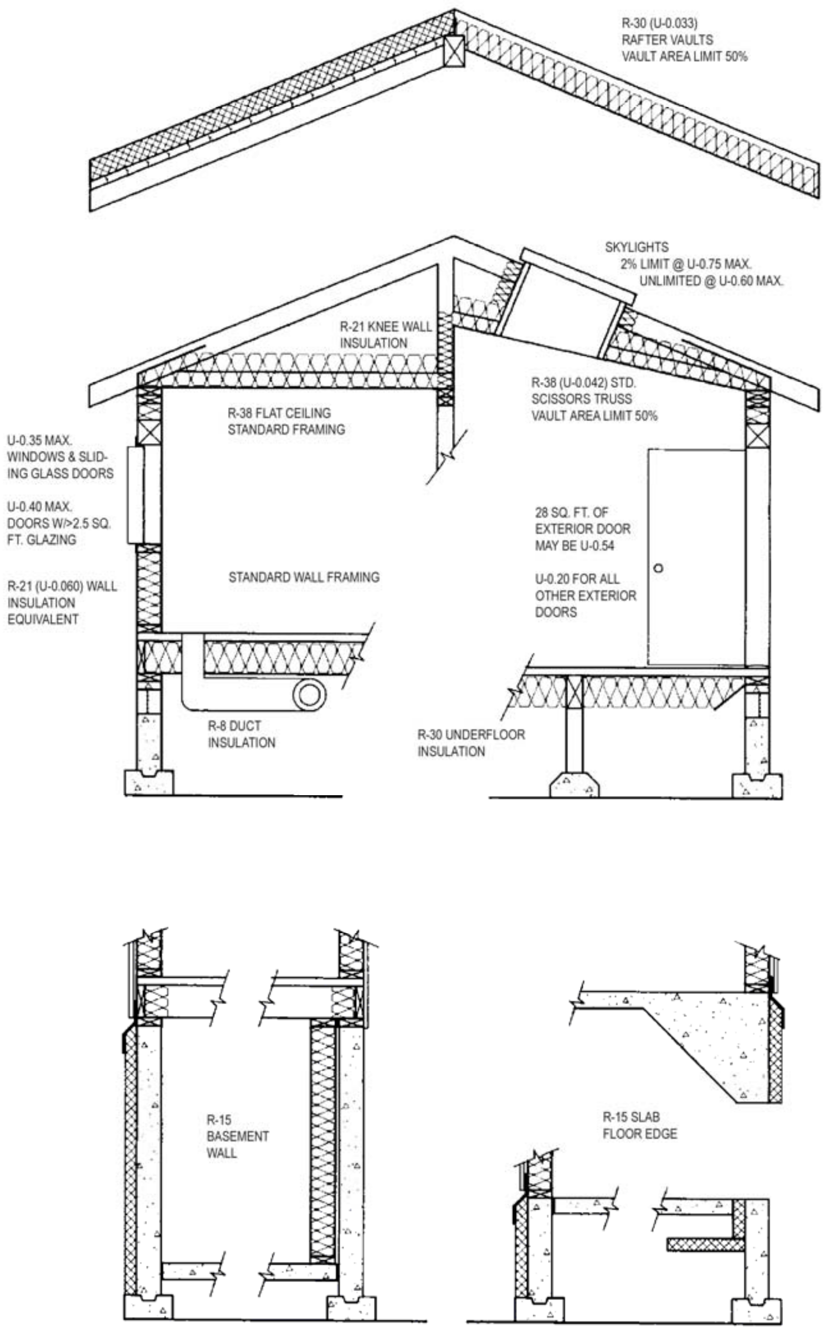


Figure 2:
Code envelope details for Standard Base Case using Additional Measure 3

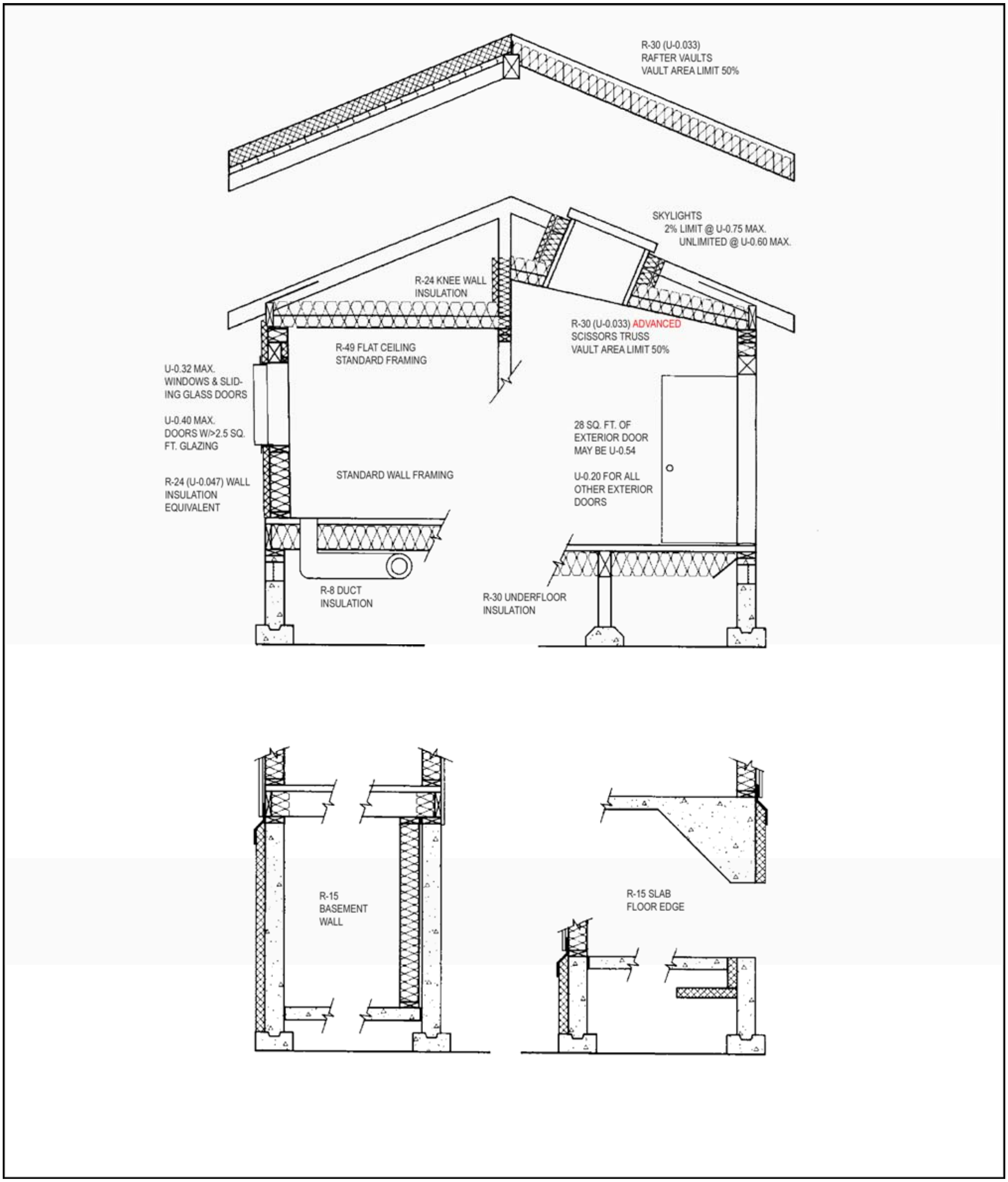


Figure 3:
Code envelope details for Standard Base Case using Additional Measure 4 incorporating windows

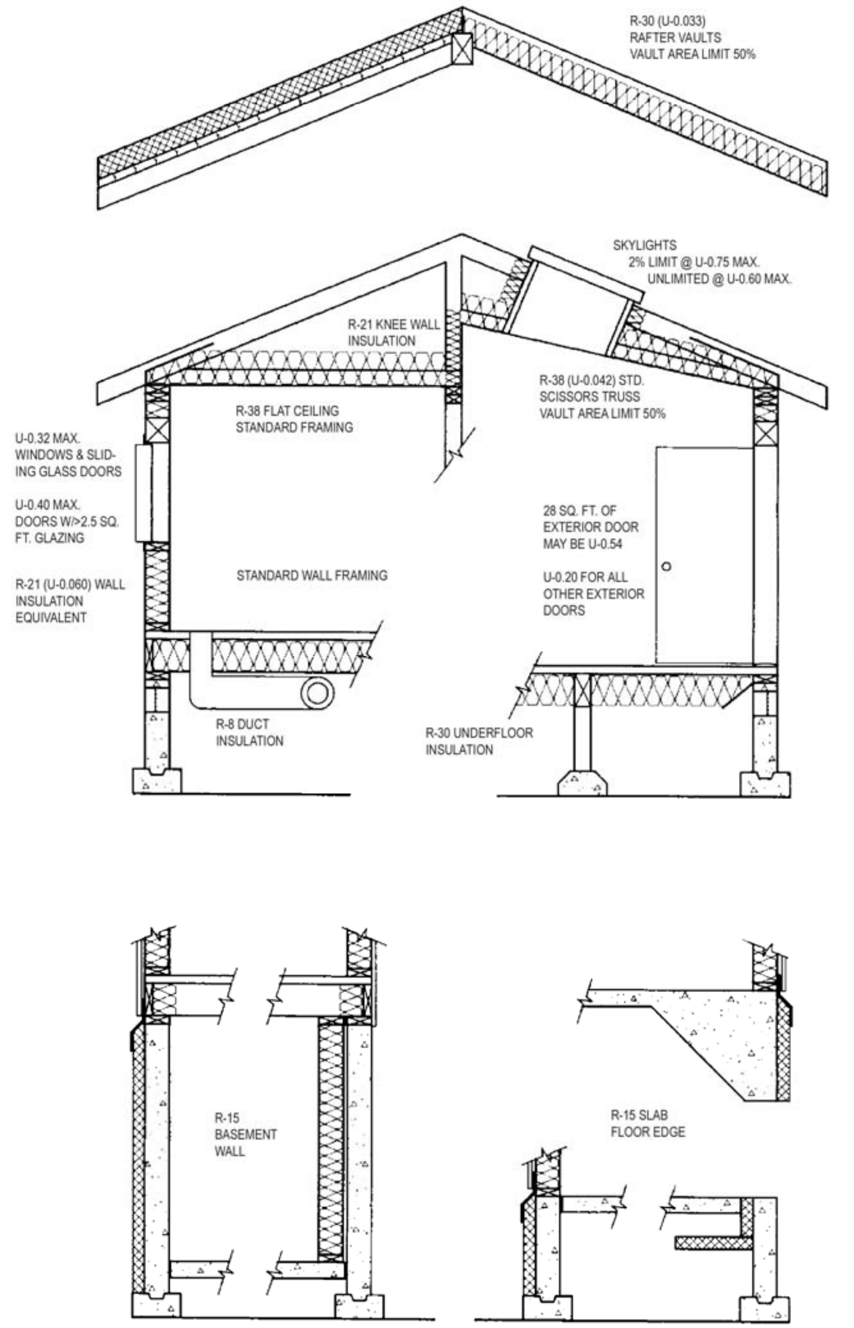


Figure 4:
Code envelope details for Standard Base Case using Additional Measure 4 incorporating ceilings

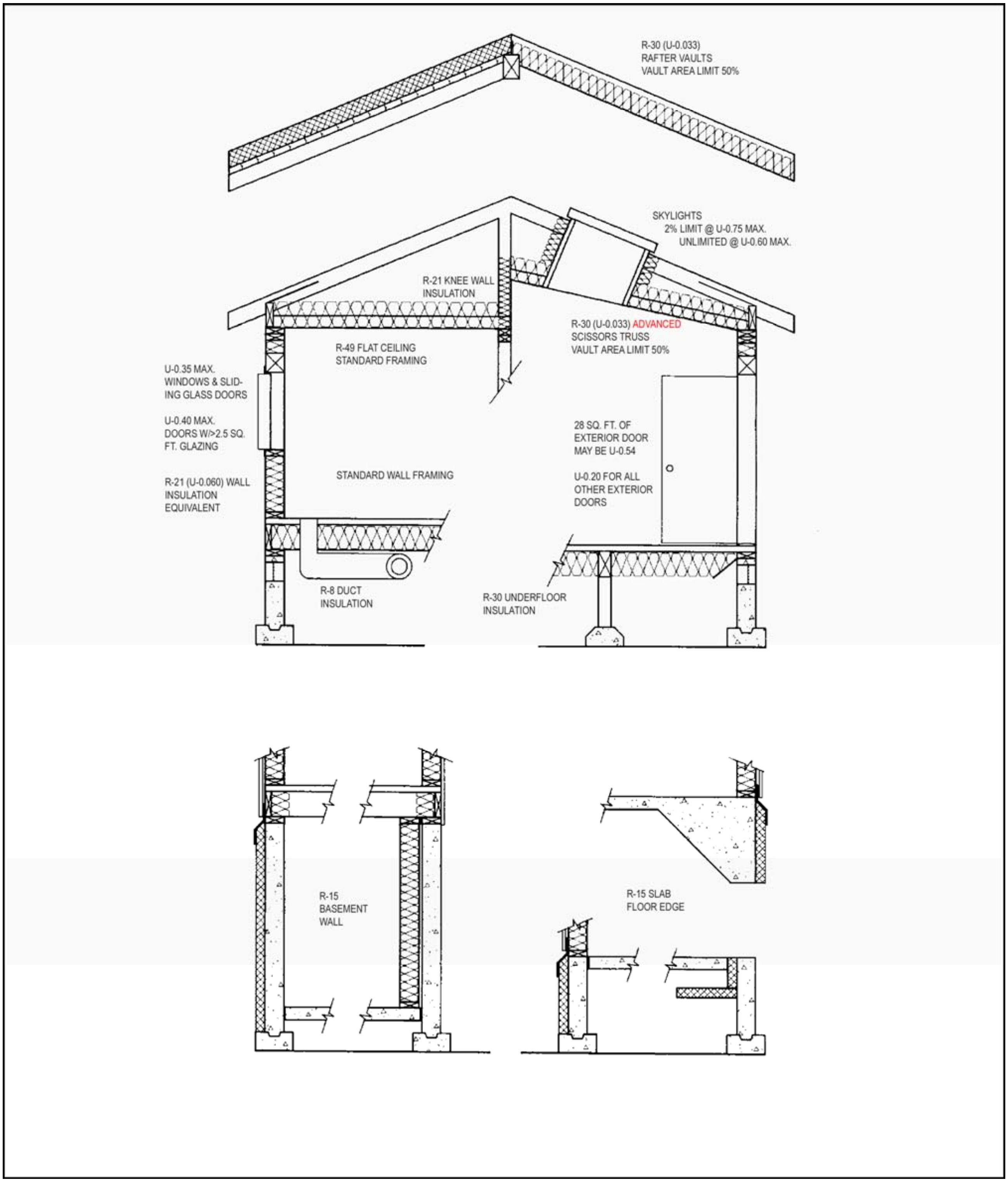


Figure 5:
Code envelope details for Standard Base Case using Additional Measure 4 incorporating walls

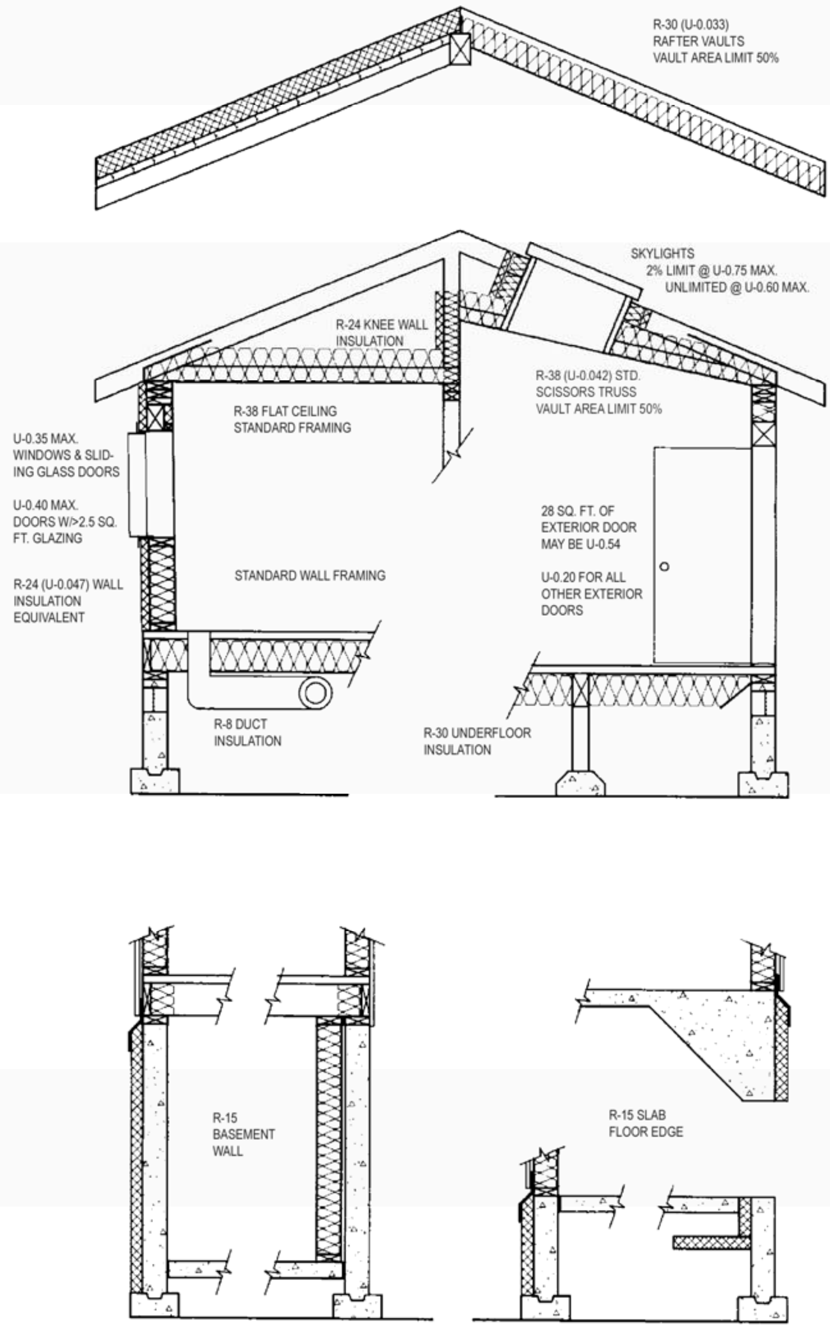
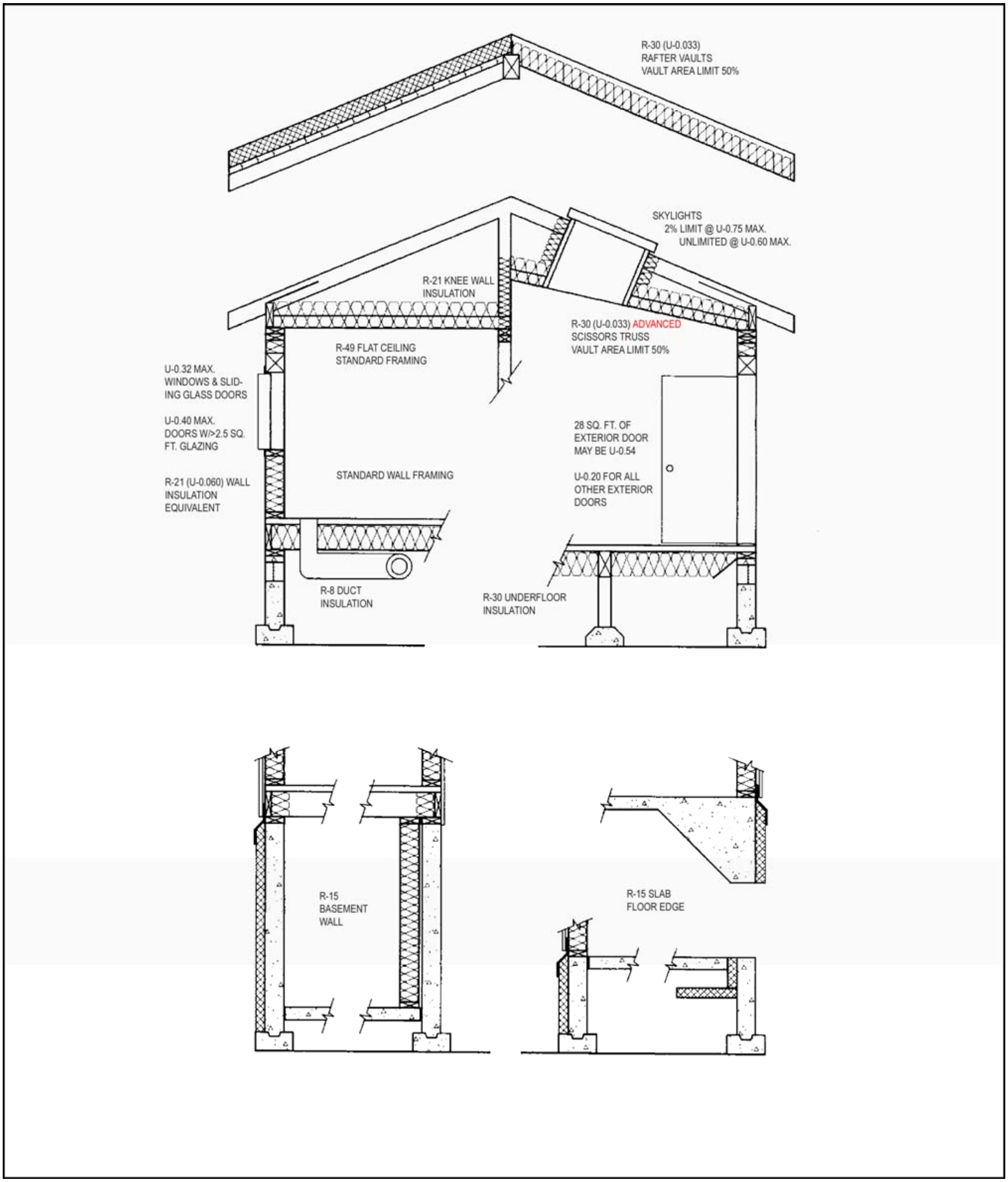


Figure 6:
Code envelope details for Standard Base Case using Additional Measures 5 and 6



Oregon Residential Energy Code

April 2008 • No. 17

R-Value Codes for Unfaced Insulation Batts

This pamphlet is one in a series that describes residential energy conservation requirements of the Oregon Residential Specialty Code and Structural Specialty Code. Other pamphlets in this series may be downloaded from Oregon Department of Energy web site at http://egov.oregon.gov/ENERGY/CONS/Codes/cdpub.shtml or local building departments or from Oregon Building Codes Division.

Identifying R-value of unfaced batt insulation

When insulation is faced, R-value is prominently displayed on the facing. Some unfaced batts have R-values inked into the batt. Many unfaced batts, however, are not labeled with an R-value. Instead, bags are color-coded and batts are marked with a number of stripes, called a stripe code. Together, they indicate R-value.

Owens Corning Fiberglas

Owens Corning uses the following bag colors and stripe codes to indicate R-values of unfaced products:

Owens Corning Fiberglas R-value codes for unfaced insulation

R-value	Thickness	Number of stripes	Bag color
38	12”	4	Brown
38HD*	10-1/4"	1	Black
30	9-1/2”	2	Orange
30 HD	8-1/4’	3	Orange
25	8’	1	White/dark blue
22	6-3/4”	6	Blue-green
21 HD	5-1/2”	4	Violet
19	6-1/4”	5	Blue
15 HD	3-1/2”	2	Olive
13	3-1/2”	4	Purple
11	3-1/2”	3	Green

*HD = High density

Certainteed

Some of Certainteed's unfaced products have an ink stamp indicating R-value. Other unfaced products can be identified by the following bag colors and stripe codes:

Certainteed R-value codes for unfaced insulation

R-value	Thickness	Number of stripes	Bag color
38	12”	3 widely spaced	Brown
38 HD*	10”	3 widely spaced	Black and white
30	10”	2 widely spaced	Red
30 HD	8-1/2”	2 widely spaced	Red
25	8”	1 centered	Red
22	6-1/2”	6	Yellow
21 HD	5-1/2"	1 off center	Mahogany
19	6-1/4”	5	Blue
15 HD	3-1/2”	2 close together	Olive
13	3-1/2”	4	Purple
11	3-1/2”	3	Green

*HD = High density

Johns Manville

Manville's unfaced products are all ink stamped with an R-value.

Johns Manville R-values and thicknesses of unfaced insulation

R-value	Thickness
38	13”
30	11”
25	8.25”
22	7.5”
19	6.75”
13	3.5”
11	3.62-3.5”
30 HD*	8.25”
21 HD	5.5”
15 HD	3.5”

*HD = High density

Information presented in this publication supports the Oregon Residential Specialty Code. This publication does not include all code requirements. Refer to the code and check with your code official for additional requirements. If information in this publication conflicts with code or your local officials, follow requirements of code and your local officials.

For more information about the residential energy code, call the Building Codes Division at (503) 378-4133 or the Oregon Dept of Energy (503) 378-4040 in Salem or toll-free, 1-800-221-8035.

This publication was prepared by Alan Seymour, Energy Code Analyst, Oregon Department of Energy for the Oregon Building Codes Division. Funding was provided by Northwest Energy Efficiency Alliance.

Building Codes Division

Working with Oregonians to ensure safe building construction while supporting a positive business climate.

OREGON DEPARTMENT OF ENERGY

Contains recycled materials

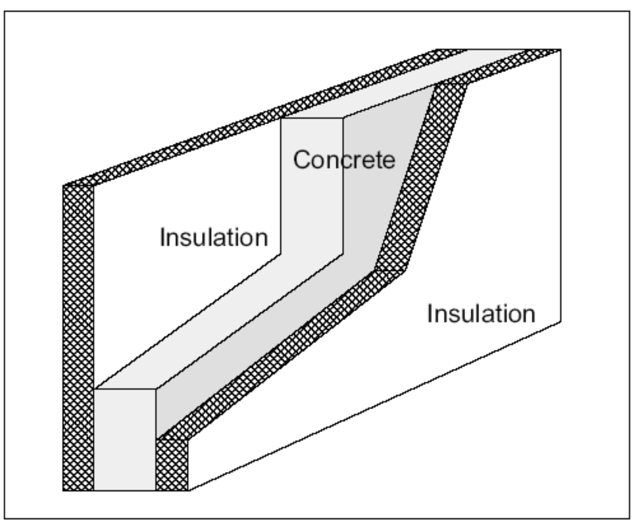
Insulated Concrete Form Systems

This pamphlet is one in a series that describes residential energy conservation requirements of the Oregon Residential Specialty Code and Structural Specialty Code. Other pamphlets in this series may be downloaded from Oregon Department of Energy web site at http://egov.oregon.gov/ENERGY/CONS/Codes/cdpub.shtml or local building departments or from Oregon Building Codes Division.

Insulated Concrete Form (ICF) systems use a prefabricated form made of foam insulation that is assembled into walls at the building site and filled with concrete. Proprietary systems vary, but generally they are composed of a layer of foam insulation on the outside, a concrete layer in the middle and a layer of foam on the inside. Conventional finishes are applied to suit the building.

ICF systems are differentiated by the type of insulation unit, shape of cavity and method of connecting insulation layers. The basic cavity shapes are flat, grid, and post-and-beam.

Figure 1.
Example cross section of flat-type ICF.



Wall Insulation

Many, but not all, ICF systems meet the requirement of the code's Standard Base Case, U-0.060 (R-21) requirement. Any wall with a U-value of 0.060 Btu/hr/ft^2/°F or less meets Standard Base Case requirements. Code requires a minimum of R-15 insulation for basement walls in one- and two-family detached dwellings.

Thermal Storage

Thermal storage improves overall building performance. Adding mass in ICF systems has been shown to improve annual performance of a building. A study by the Portland Cement Association and the Berkeley Solar Group indicated that effective thermal performance of an ICF wall is 14 percent to 18 percent better than a wood frame wall.

Maximum code U-factors are based on steady-state conditions and do not include the effect of thermal storage (mass). Building components must meet code requirements based on their steady-state U-factors. "Effective" R-values commonly provided by vendors may not be used to demonstrate compliance. These values attempt to quantify the improved thermal performance of a tighter air seal and thermal storage and are dependent on the building's operating conditions and local climate.

Infiltration

ICF construction can produce very tight building envelopes, with infiltration commonly less than 0.35 air changes per hour. Thus, they may reduce energy use. But extra care is needed to ensure that sufficient air is available for all combustion appliances (gas and oil furnaces and water heaters, wood stoves and fireplaces). A tight building envelope without proper ventilation can result in indoor air quality problems, including back-drafting and build-up of hazardous combustion gases such as carbon monoxide.

Moisture Control

Energy code requires a one-perm vapor retarder in walls. ICF construction does not guarantee compliance with this requirement. Check vendor information or apply a one-perm moisture barrier on the warm side (in winter) of all interior walls and floors and a half-perm barrier on the warm side of all ceilings.

Heat Transfer

Using metal ties to connect the two layers of foam insulation greatly diminishes the thermal performance of the wall system, especially if the tie protrudes completely through the insulation. Heat transfer through the ICF system varies depending on conductivity. Most ICF systems that use metal ties do not meet Standard Base Case requirements without added insulation sheathing.

Default U-Values

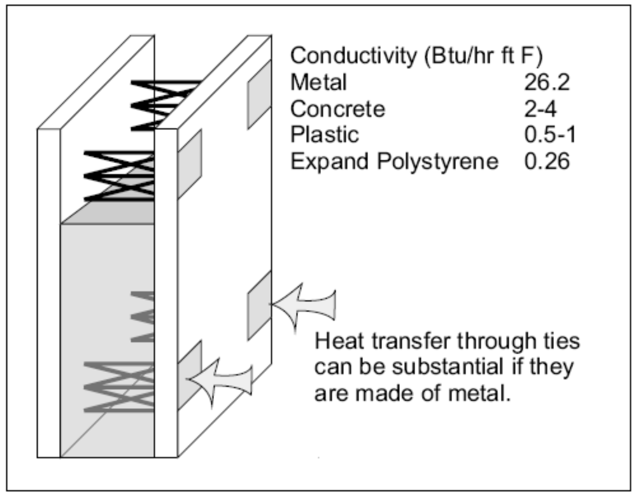
The table on page 3 lists tested U-factors for common ICF products. Use “Total U-factor” values when using the thermal performance calculations table. (See pamphlet no. 12.) Total U-factor values include the effect of air films, T1-11 exterior sheathing and half-inch drywall sheathing. “ICF U-Factor” values are based on the ICF system only.

How to Handle Non-Compliant Walls

A home that has ICF walls with U-factors greater than allowed by the Standard Base Case may comply with code using thermal performance calculation. (See pamphlet no. 12.) The calculation allows the use of components that exceed code requirements to compensate for those that do not meet them.

Another approach is increasing overall thermal performance of the wall so that it meets prescriptive path requirements. The simplest way to do this is to increase insulation on the interior or exterior of the wall assembly. All non-compliant wall types meet minimum code requirements with the addition of 3/4 inches or more of rigid insulation sheathing.

Figure 2.
Heat transfer and conductivity.



Example:

Polysteel - *prior to product update*

R-value of ICF only =	
1/U = 1/0.082 =	12.195 hr/ft²/°F/Btu
Exterior air film	0.17
T1-11 siding	0.77
5/8" gypsum brd	0.50
Interior air film	0.68
3/4" polystyrene board	3.00
Total	17.315
Total wall assembly U-factor	
= 1/17.315 =	0.058

U-factors less than or equal to 0.060 comply with Standard Base Case requirements.

Table 1:
Default U-Factors

Brand Name	Manufacturer	Insulation Thickness	Total Wall Thickness	Insulation Type	ICF U-Factor	Total U-Factor
BLUE MAXX	AAB Building Systems	4.75	11.25		0.048	0.043
		4.75	12.75	EPS	0.047	0.043
Diamond Snap Form	AMF Corp.	4	8	EPS	0.054	0.048
		4	10	EPS	0.052	0.048
		4	12	EPS	0.052	0.048
		4	14	EPS	0.052	0.048
Feather Lite	Feather Lite, Inc.	Varies	8	Foam	0.046	0.042
Fold-Form	Lite Form, Inc.	4	8	EPS	0.054	0.048
		4	10	EPS	0.054	0.048
		4	12	EPS	0.053	0.048
GreenBlock	GREENBLOCK Worlwide	4.5	9.875	EPS	0.055	0.049
Ice Block	Foam Block	Varies	9.25	EPS	0.082	0.070
		Varies	11	EPS	0.080	0.068
Lite Form	Lite Form, Inc.	4	8	XPS	0.047	0.043
		4	10	XPS	0.047	0.043
		4	12	XPS	0.047	0.043
		4	14	XPS	0.047	0.042
		4	16	XPS	0.046	0.042
Polysteel Form	American Polysteel Forms	4.8” avg	9.25	EPS	0.082	0.070
		5.0” avg	11	EPS	0.080	0.068
Quad-Lock	Quad-Lock Building Systems	4.5	8.125	EPS	0.048	0.044
		4.5	10.125	EPS	0.048	0.044
		4.5	12.125	EPS	0.048	0.043
		4.5	14.125	EPS	0.048	0.043
R-FORMS	R-Forms	4	8	XPS	0.047	0.043
		4	10	XPS	0.047	0.043
		4	12	XPS	0.047	0.043
		4	14	XPS	0.047	0.042
Reddi-Form	Reddi-Form	Varies	9.625	EPS	0.052	0.047
Reward Wall	Reward Wall	Varies	9.25	EPS	0.054*	0.048*
ThermoFormed	Termoformed Block Corp.	Varies	8	EPS	0.063	0.055
Therm-O-Wall	Therm-O-Wall	Varies	9.125	EPS	0.066	0.058
		Varies	11	EPS	N.A.	–

Source: Portland Cement Association, 1998 (*1998 Ecotope study)
Note: Shaded values do not meet Standard Base Case requirements

Information presented in this publication supports the Oregon Residential Specialty Code. This publication does not include all code requirements. Refer to the code and check with your code official for additional requirements. If information in this publication conflicts with code or your local officials, follow requirements of code and your local officials.

This publication was prepared by Alan Seymour, Energy Code Analyst, Oregon Department of Energy for the Oregon Building Codes Division. Funding was provided by Northwest Energy Efficiency Alliance.

Contains recycled materials