Table N1104.1(1): Prescriptive Compliance for Residential Buildings

TABLE N1104.1(1)
PRESCRIPTIVE COMPLIANCE PATHS FOR RESIDENTIAL BUILDINGS[a,b,c]

Building Components	Path 1	Path 2 Sun tempered[d]	Path 3	Path 4 Sun tempered[d]	Path 5	Path 6 Sun tempered[d]	Path 7 Sun tempered[d]	Path 8 House size limited[e]	Path 9 Log homes/ solid timber	Path 10
Maximum allowable window area[f]	No Limit	No Limit	No Limit	No Limit	No Limit	No Limit	No Limit	12%	No Limit	No Limit
Window class[g]	U=0.40	U=0.40	U=0.50	U=0.50	U=0.60	U=0.60	U=0.60	U=0.40	U=0.40	U=0.35
Exterior doors	U=0.20[h]	U=0.20[h]	U=0.20	U=0.20	U=0.20	U=0.20	U=0.20[h]	U=0.20	U=0.54	U=0.20[h]
Wall insulation[i]	R-21[j]	R-15	R-21A[k]	R-15A[k]	R-24A[k]	R-21A[k]	R-21A[k]	R-15	[c]	R-15
Underfloor insulation	R-25	R-21	R-25	R-21	R-30	R-21	R-25	R-21	R-30	R-30
Flat ceilings	R-38	R-49	R-49A[k]	R-38	R-49A[k]	R-49A[k]	R-49A[k]	R-49	R-49	R-49
Vaulted ceilings[l]	R-30[m]	R-30[m]	R-30[m]	R-38	R-38	R-38	R-38	R-38	R-38	R-38
Skylight class[g]	U=0.50	U=0.50	U=0.50	U=0.50	U=0.50	U=0.50	U=0.50	U=0.50	U=0.50	U=0.50
Skylight area[n]	<2%	<2%	<2%	<2%	<2%	<2%	<2%	<2%	<2%	<2%
Below-grade wood, concrete or masonry walls[o]	R-15	R-15	R-15	R-15	R-15	R-15	R-15	R-15	R-15	R-15
Slab floor edge insulation	R-15	R-15	R-15	R-15	R-15	R-15	R-15	R-15	R-15	R-15
Forced air duct insulation	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8

[a] Path 1 is based on cost effectiveness. Paths 2-7 are based on energy equivalence with Path 1. Cost effectiveness of Paths 2-9 not evaluated.

[b] As allowed in current 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*-factor standards. Calculations to document equivalent heat loss shall be performed using the procedure and approved *U*-factors contained in Table N1104.1(2).

[c] *R*-values used in this table are nominal, for the insulation only and not for the entire assembly. The wall component for Path 9 shall be a minimum solid log or timber wall thickness of 3.5 inches (90 mm).

[d] The sun-tempered house shall have one lot line which borders on a street within 30 degrees of true east-west and 50 percent or more of the total glazing for the heated space on the south elevation. An approved alternate to street orientation based on solar design and access shall be accepted by the building official.

[e] Path 8 applies only to residential buildings with less than 1,500 sq. ft. heated floor space AND glazing area less than 12 percent of heated space floor area.

[f] Reduced window area may not be used as a trade-off criterion for thermal performance of any component, except as noted in Table N1104.1(2).

[g] Window and skylight *U*-factors shall not exceed the number listed. *U*-factors may also be listed as "class" on some windows and skylights (i.e., CL40 is same as U=0.40).

[h] 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.

[i] 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.

[j] 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.

[k] A=advanced frame construction as defined in Section N1104.5.1 for walls, and Section N1104.6 for ceilings.

[l] 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), and a 0.5 perm (dry cup) vapor retarder installed.

[m] Vaulted area, unless insulated to R-38, may not exceed 50 percent of the total heated space floor area.

[n] The skylight area is a percentage of the heated space floor area. Any glazing in the roof/ceiling assembly above the conditioned space shall be considered a skylight.

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

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Oregon BUILDING CODES DIVISION

OREGON STATE UNIVERSITY EXTENSION SERVICE

Windows, Doors and Skylights

This pamphlet is one in a series that describes residential energy conservation requirements of the Oregon Residential Specialty Code and the Structural Specialty Code for Group R buildings three stories and less in height. Other pamphlets in this series may be obtained from Oregon Dept of Energy at www.oregon.gov/energy/ 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, the energy *code* sets U-factor standards and establishes minor limitations on window and skylight area.

Table N1104.1(1) lists prescriptive window standards. Prescriptive Path 1 is the "Base Path." The window U-factor requirement for the Base Path is 0.40. The skylight U-factor requirement for the Base Path is 0.50 (the same as for all paths). Other paths trade less efficient windows for insulation upgrades in other parts of the building shell.

If a prescriptive path is used for code compliance, R- and U-factors listed for that prescriptive path must be used. R- and U-factors in one path may not be mixed with R- and U- factors in other paths. R- and U-factor standards may be better than code specifications.

Window and skylight area limits

Most prescriptive paths do not limit window area. Path 8, however, restricts window area to 12 percent of the heated space floor area.

Window area is calculated using the area of the rough opening.

Skylight area is unlimited for skylights with tested U-factors of 0.40 or less. Otherwise, skylight area is limited to 2 percent or less of the heated floor area. If skylight area exceeds the 2 percent limit, performance calculations using Table N1104.1(2) must be submitted to show *code* compliance. The pamphlet *How* to *Do Residential Thermal Performance Calculations Using Table N1104.1(2)* explains the performance calculation procedure.

Skylight area is calculated using the area of the rough opening.

Calculating window and skylight area limits

To calculate the window limit for Path 8, multiply the heated space floor area by 0.12. (Path 8 heated space floor area must be less than 1,500 square feet.) For example, a 1,500 square foot house could have up to 180 square feet of glazing and still be within Path 8 window area limits (1,500 x 0.12 = 180). If window area for the home exceeds 180 square feet, some other prescriptive path or Table N1104.1(2) must be used to meet code standards. Windows in areas that are not part of the heated floor space (garage windows, for example) do not count in the window area total.

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

2,300 x 0.02 = 46 square feet

If the skylight area of this home exceeds 46 square feet and the skylight U-factor is greater than 0.40, a performance calculation would be required.

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: Rvalue 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 architect-ural 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.

The 1 percent limitation on single pane glazing for decorative or unique architectural features is in addition to any other glazing area limitations. Disregard exempted glazing for Path 8 window area limitation and 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 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 Almost all prescriptive paths require doors that have a U-factor of 0.20 (an Rvalue of 5). Foam core, insulated doors with a thermal break meet these prescriptive standards. Prescriptive Path 9, for log homes, allows less efficient doors (all at U-0.54) to maintain the design character of a log home.

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

When is a door, a window?

Glazed areas in an untested wood door may be exempted as decorative or unique architectural features. The remaining area of the wood door is assigned a U-factor of 0.54. If it is a foam core, insulated door with a thermal break, it can be assigned a value of 0.20. A door with any amount of glazing that has a tested value of U-0.54 or less may be used as the exempt door for Paths 1,2,7 and 9. Doors with glazing that is not exempted must have tested U-factors and meet window U-factor requirements.

How to find window and skylight U-factor information

Product literature

The energy code requires tested, rather than calculated U-factors. Product literature available from window suppliers and distributors may contain suitable energy

Figure 1
SAMPLE NFRC WINDOW LABEL

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.

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 can comply with prescriptive values specified in Tables N1111.4(1) and N111.4(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 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.

Sun-tempered paths

If a home fronts a street running within 30 degrees of true east/west, and if 50 percent of the home's windows are on the south side, a sun tempered prescriptive path (Paths 2, 4, 6 and 7) may be used to meet energy code. See the pamphlet *Using Sun-Tempered Prescriptive Options* for details on sun-tempered qualification paths.

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Wall Insulation

This pamphlet is one in a series that describes residential energy conservation requirements of the Oregon Residential Specialty Code and the Structural Specialty Code for Group R buildings three stories and less in height. Other pamphlets in this series may be obtained from Oregon Dept of Energy at www.oregon.gov/energy/ or local building departments or from Oregon Building Codes Division.

Prescriptive wall insulation requirements

Wall insulation for Prescriptive Path 1 in Table N1104.1(1), is R-21. Wall insulation options in other prescriptive paths range from R-15 to R-24.

In some Table N1104.1(1) prescriptive paths, required wall insulation R-values are followed by an "A." The "A" indicates that advanced wall framing is required. Otherwise, standard wall framing is allowed. Consult pamphlet *Advanced Framing for Walls and Ceilings* for advanced framing definitions and requirements.

The energy code specifies required R-values, not products. Any insulation product or combination of products that meets the installed R-value requirement is acceptable. If a prescriptive path is used for code compliance, only R- and U-factors in that prescriptive path may be used. R- and U-factors in one path may not be mixed with R- and U-factors in other paths. R- and U-factor standards may be exceeded.

Minimum wall insulation is R-15. R-11 no longer meets code minimum component requirements. 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 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 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 R-21 wall assembly has a U-factor of 0.060. Any wall assembly with a 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(2)* 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. An R-19 advanced frame wall is also considered equivalent to the R-21 standard.

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.

R-11 batts plus one inch of polyisocyanurate foam (R-7.2 per inch); R-13 batts plus one inch of extruded polystyrene (R-5 per inch); R-15 batts plus one-half inch of polyisocyanurate foam (R-7.2 per inch); or R-19 batts plus one inch of expanded polystyrene foam (3.5 per inch) all meet, exceed, or are considered equivalent to the R-21 standard.

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

Some R-21 walls must have advanced framing. See the pamphlet *Advanced Framing for Walls and Ceilings* for more information.

Drawings that follow illustrate ways of meeting energy code requirements.

R-15 wall options

The R-15 requirement is most easily met by using a high-density R-15 fiberglass batt. The high-density R-15 batt fits in a 2x4 wall cavity without being compressed. All major insulation manufacturers make this product and distribute it in Oregon. The product comes faced or unfaced. The pamphlet *R-Value Codes for Unfaced Batt Insulation* explains how to determine R-values for unfaced products.

Combinations of batts and rigid foam boards could also be used to achieve R-15. A 2x4, R-11 wall with one-half inch of polyisocyanurate (R-7.2 per inch) foam board meets this requirement. A 2x6 frame with R-19 insulation meets (actually exceeds) the R-15 requirement. A 5-1/2 inch blown-in-batt in a 2x6 wall meets or exceeds the R-15 requirement. Foam core panels commonly meet or exceed R-15.

Some R-15 walls must be advanced framed. See the pamphlet *Advanced Framing for Walls and Ceilings* for details.

R-24A wall options

R-24A walls are most commonly constructed using a combination of batts and rigid foam board insulation. An R-21 batt with one inch of R-5 extruded polystyrene foam board insulation meets this requirement. An R-19 batt with one inch of polyisocyanurate foam (R-7.2 per inch) meets or exceeds this requirement.

Log walls

Log homes built to Prescriptive Path 9 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(2) Thermal Performance Calculations must also be compared to an R-21 wall standard. If conventional wood framed walls are incorporated, they must be insulated to R-21.

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 the wall, in so far as practical. Face stapling is not required but is preferred. 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 within insulated cavities.

Figure 1
R-21 Wall insulation examples

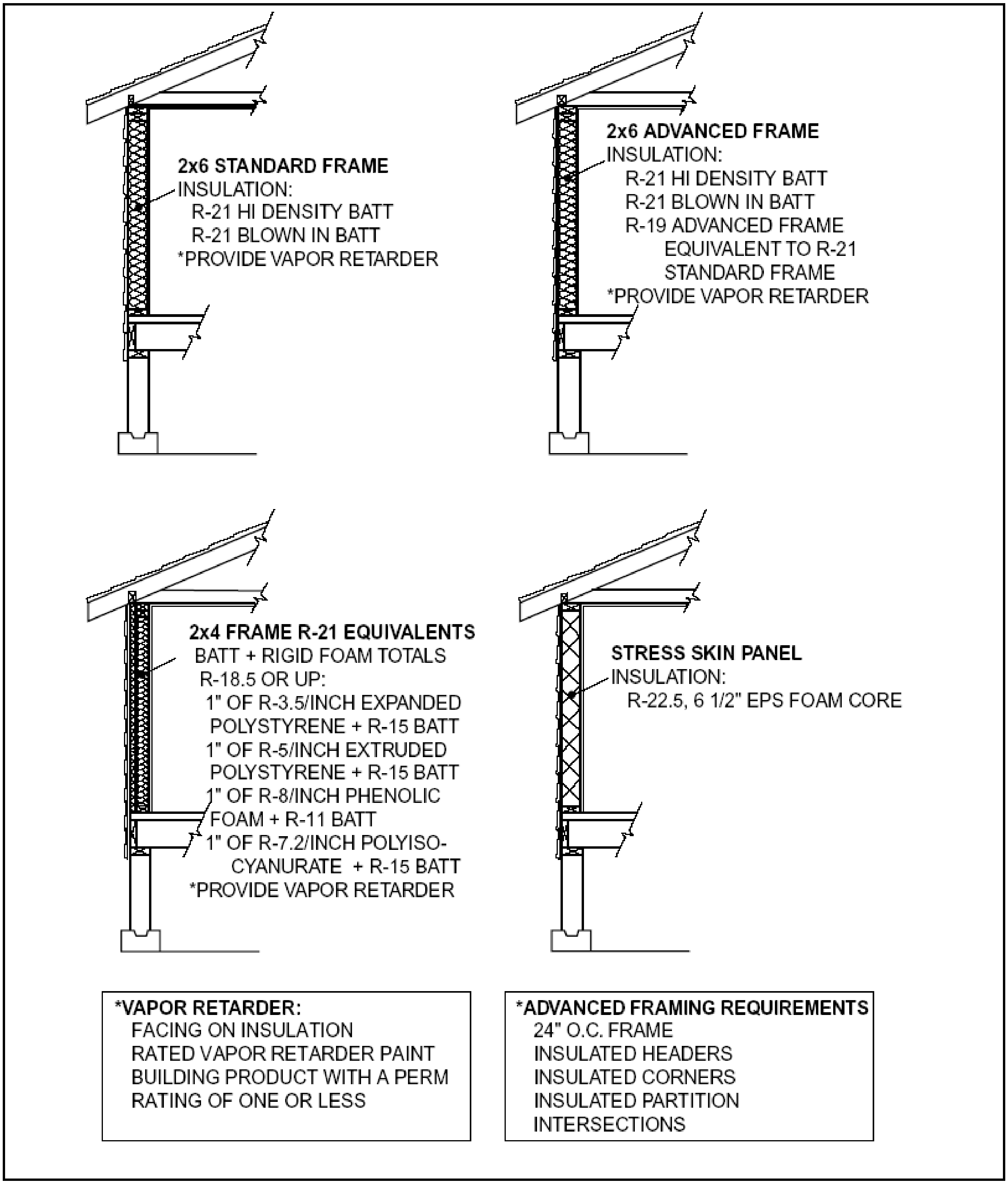


Figure 2

R-15 Wall insulation examples

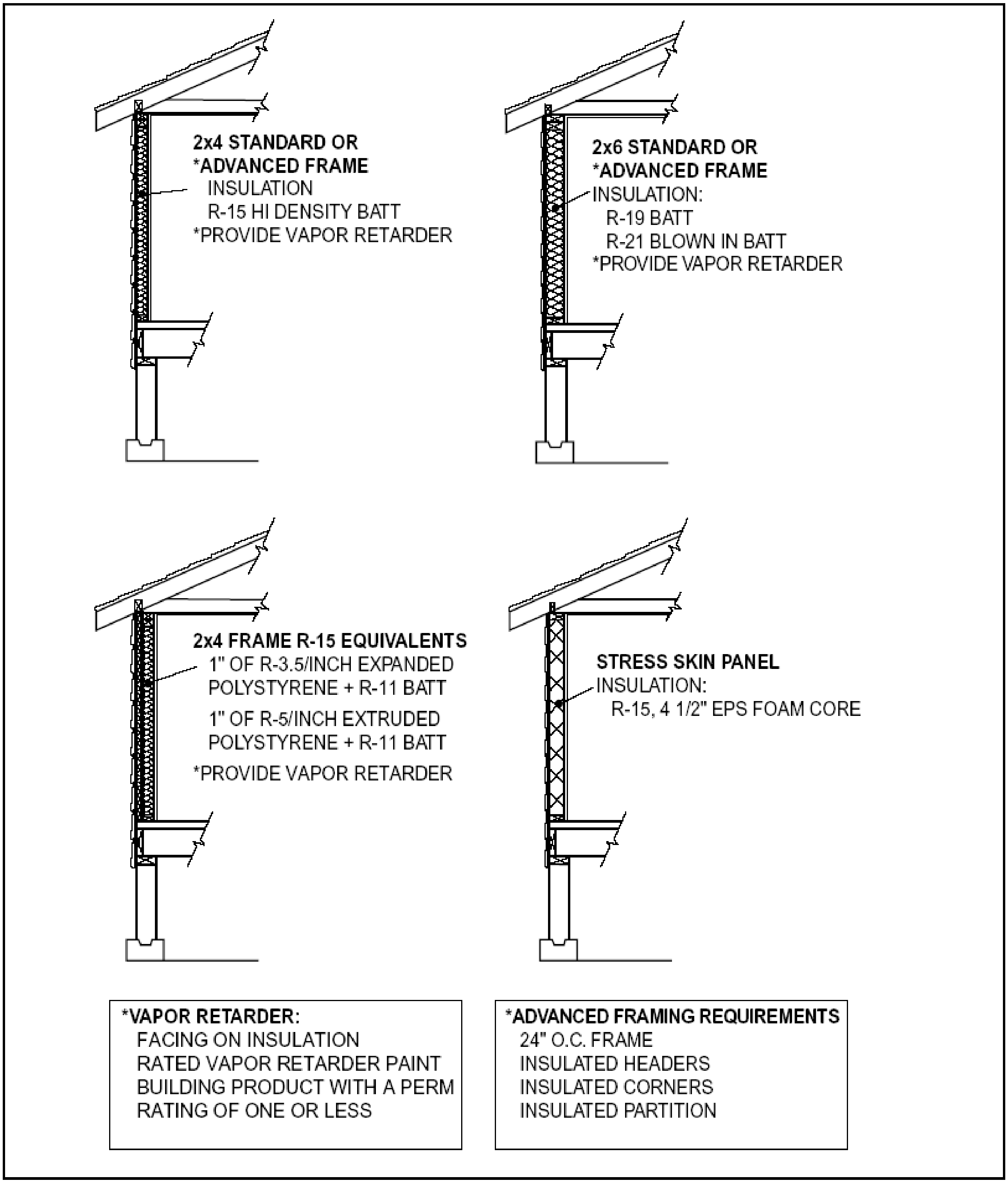
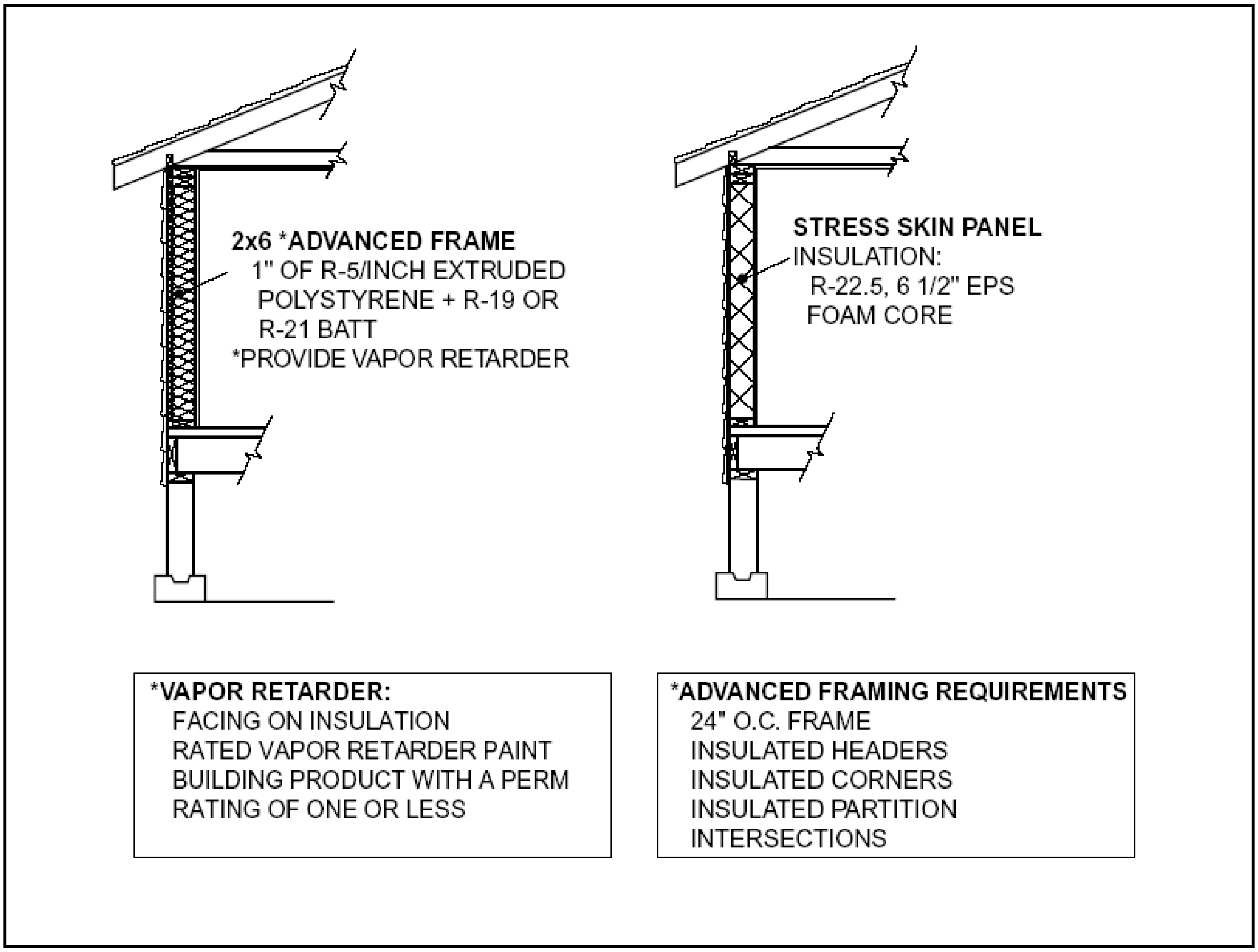


Figure 3
R-24A Wall insulation examples



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.

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Underfloor Insulation

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Prescriptive requirements for underfloor insulation

Table 1104.1(1), Prescriptive Compliance Paths for Residential Buildings, lists required floor insulation levels. Path 1 is the "Base Path 1." The floor insulation requirement in Path 1 is R-25. Floor insulation options for other prescriptive paths range from R-21 to R-30.

The energy code specifies required R-values, not products. Any insulation product or combination of insulation products that meets installed R-value requirements is acceptable. If a prescriptive path is used for code compliance, only R- and U-factors in that prescriptive path may be used. R- and U-factors in one path may not be mixed with R- and U-factors in other paths. R- and U-factor standards may be exceeded. Section drawings or written specifications that accompany the plans must identify floor insulation R-value.

R-25 floor insulation options

Standard density R-25 batts 7-1/2 to 8 inches thick are typically used to meet the underfloor requirement. 8-1/4 inch foam core floor panels meet or exceed R-25.

R-21 floor insulation options

High density 5-1/2-inch R-21 batts, doubled R-11 batts or foam core panels 6-1/2 inches or thicker meet the R-21 floor insulation requirement.

R-30 floor insulation options

Standard density R-30 batts 9-1/2 inches thick, high density batts 8-1/2 inches thick or 8-1/2-inch foam core floor panels may achieve R-30.

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.

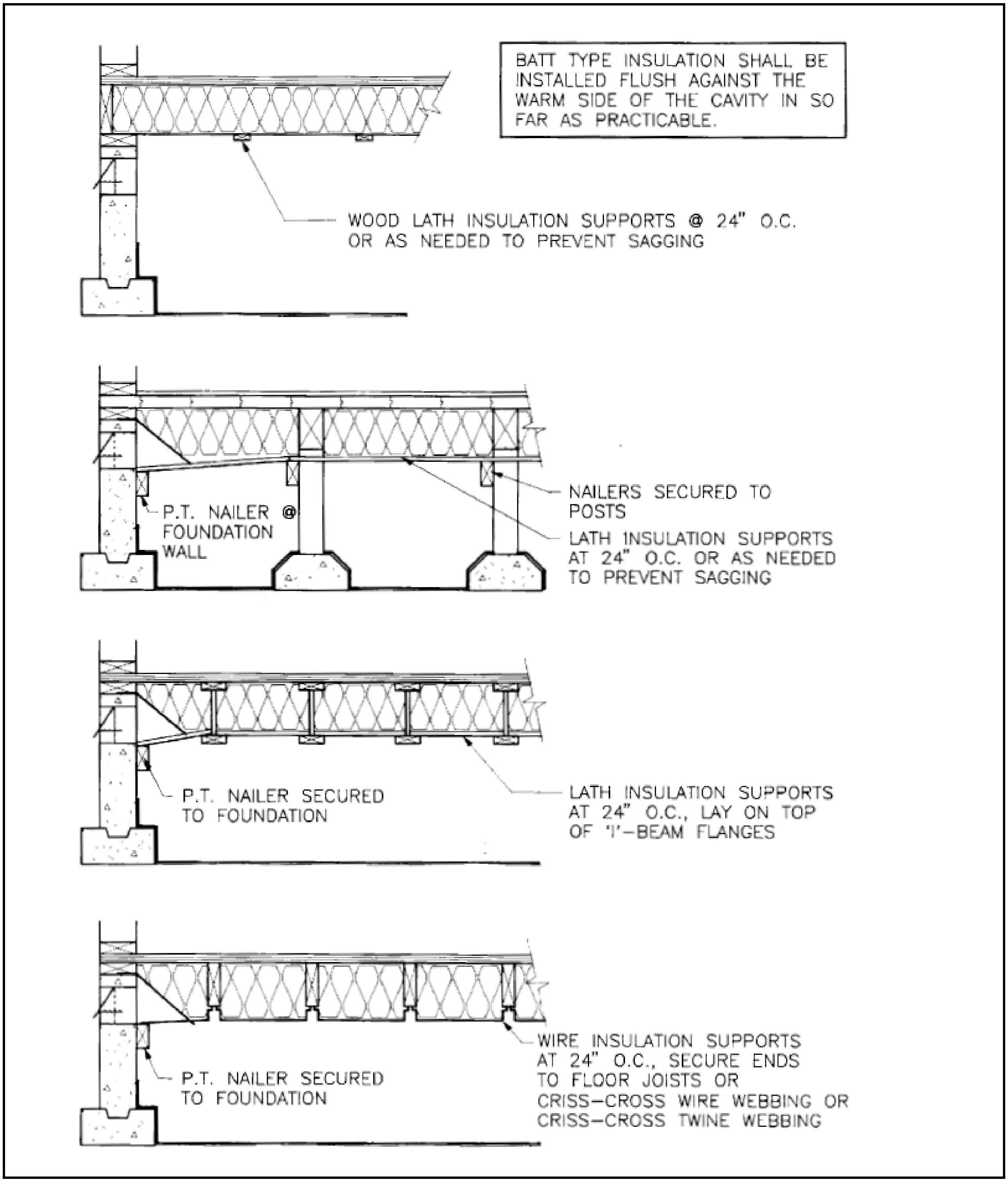
Installing deeper batts in post and beam floors may require special measures to keep crawl space vents clear. Baffles can be used to keep vent openings clear. Or vents can be installed lower in the stem wall, so they floor cavities, splitting the batt above and below so they are not blocked by insulation.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

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 only 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



Decking floor systems need 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.

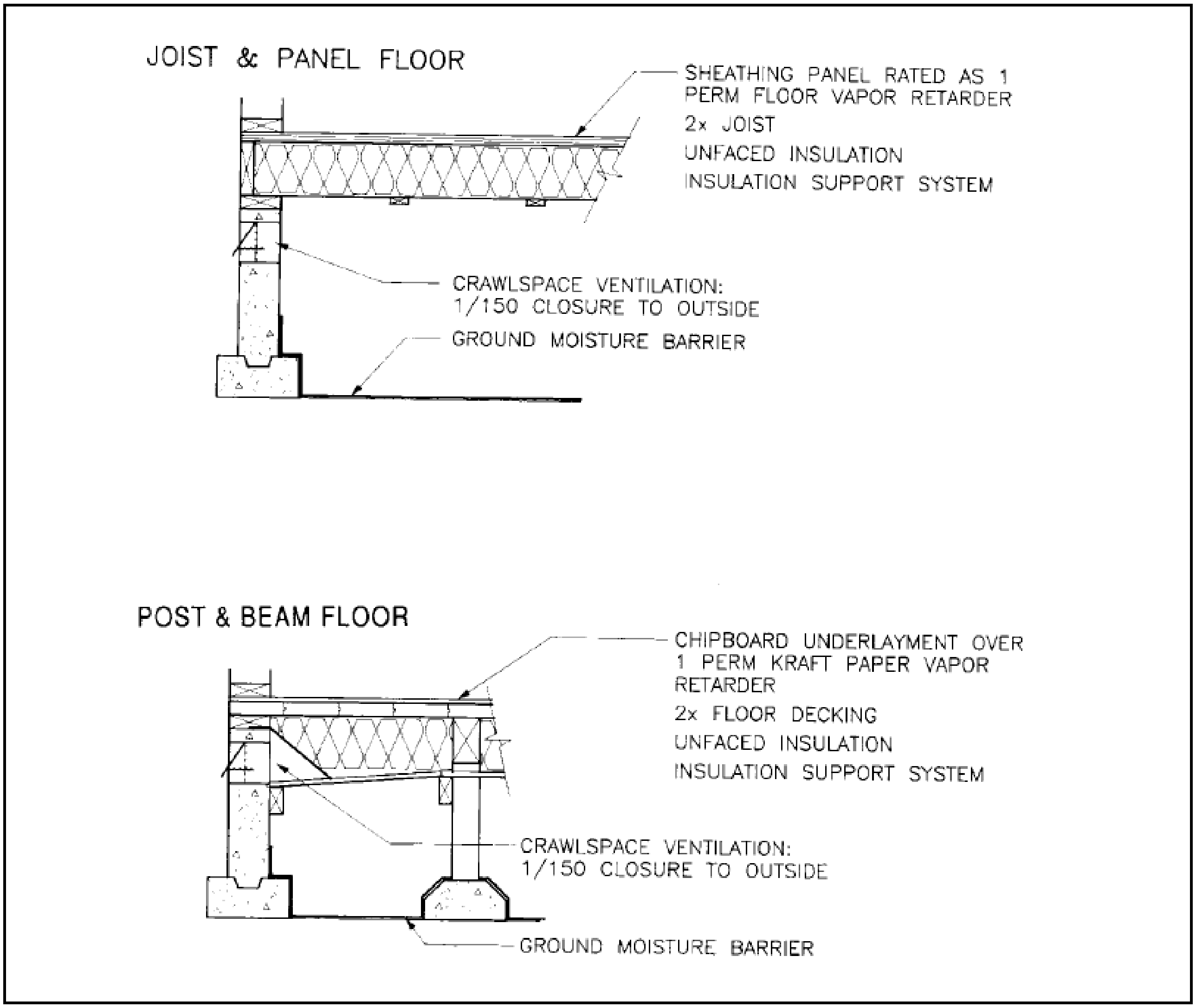
Crawl space ventilation and ground cover

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



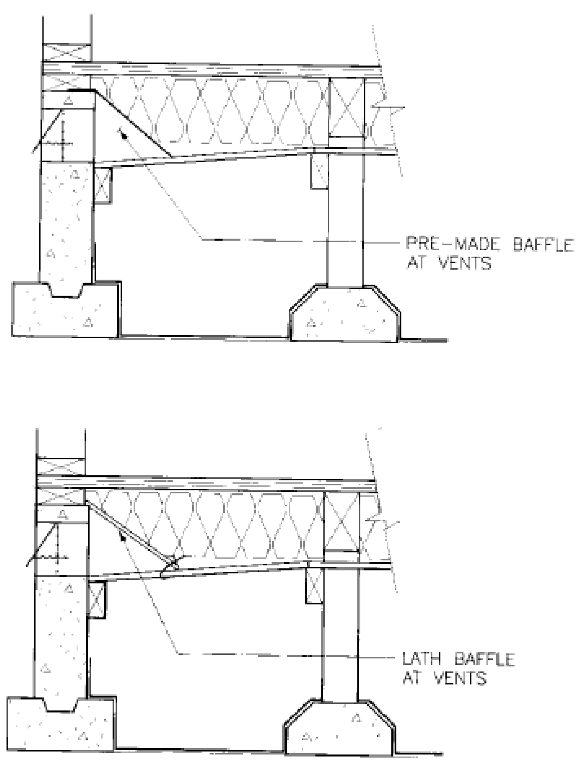
Perimeter crawl space insulation vs. underfloor insulation

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 ongoing interest in developing an alternative system 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



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Flat Ceiling Insulation

This pamphlet is one in a series that describes residential energy conservation requirements of the Oregon Residential Specialty Code and the Structural Specialty Code for Group R buildings three stories and less in height. Other pamphlets in this series may be obtained from Oregon Dept of Energy at www.oregon.gov/energy/ or local building departments or from Oregon Building Codes Division.

Prescriptive requirements for flat ceiling insulation

Table 1104.1(1), Prescriptive Compliance Paths for Residential Buildings, lists required flat ceiling R-values. Path 1 represents the "Base Path." The flat ceiling R-value in Path 1 is R-38. Flat ceiling requirements in other prescriptive paths range up to R-49.

In some prescriptive paths, required flat ceiling insulation R-values are followed by an "A." The "A" indicates that advanced ceiling framing is required. Otherwise, standard framing is allowed. The pamphlet *Advanced Framing for Walls and Ceilings* describes advanced ceiling framing.

The energy code specifies required R-values, not products. Any insulation product or combination of insulation products that meets the installed R-value requirement is acceptable. If a prescriptive path is used for code compliance, only R- and U-factors in that prescriptive path may be used. R- and U-factors in one path may not be mixed with R- and U-factors in other paths. R- and U-factor standards may be exceeded.

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

R-38 ceiling insulation options

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

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

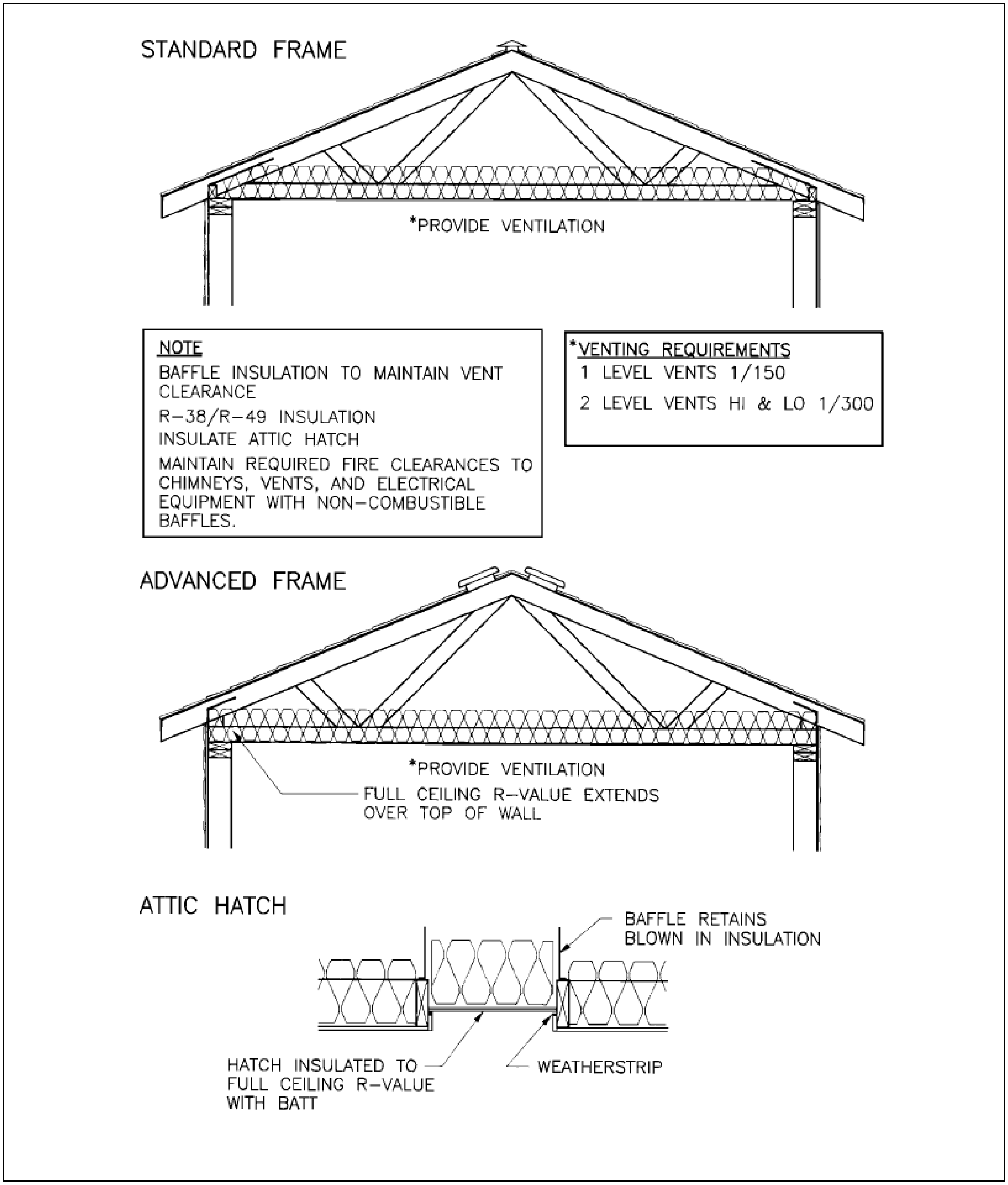
To achieve the required R-value with loose fill no matter what the product a certain number of pounds of insulation must be installed per square foot of ceiling surface. Otherwise, insulation will settle and its R-value will be less than required.

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" insulation as it's 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

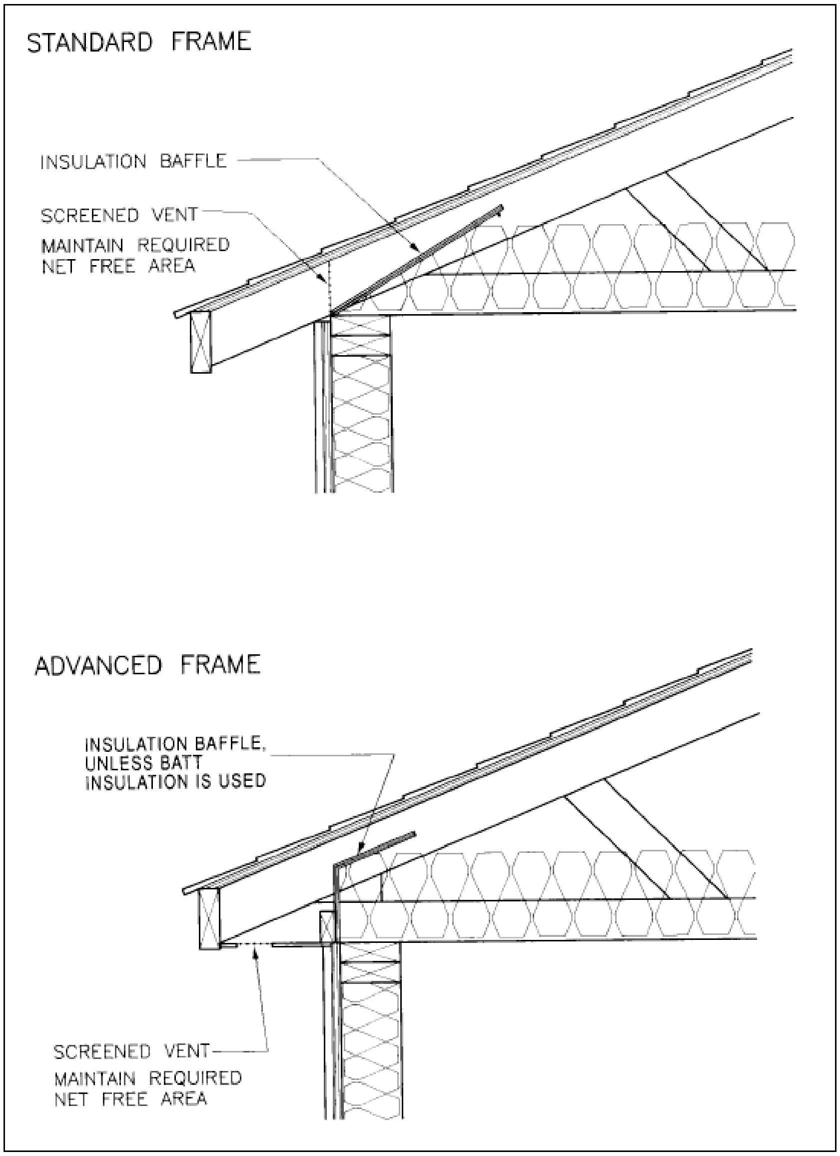
If the attic hatch is in an insulated ceiling, a baffle is required to keep insulation away from the hatch opening. The attic hatch is part of the ceiling. It must be insulated to the same level as the ceiling. Typically, pieces of batt insulation or rigid foam are used. Weatherstripping must be used 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 30x30 inch passageway must be available above the insulation. The furnace must be installed above the insulation, and the 28-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



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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.

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Oregon BUILDING CODES DIVISION

OREGON STATE UNIVERSITY EXTENSION SERVICE

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 the Structural Specialty Code for Group R buildings three stories and less in height. Other pamphlets in this series may be obtained from Oregon Dept of Energy at www.oregon.gov/energy/ 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 N1104.1(1), Prescriptive Compliance Paths for Residential Buildings, list required R-values for vaulted ceilings. Path 1 represents the "Base Path." The vaulted ceiling R-value in Path 1 is R-30. Other prescriptive paths require R-38 insulation.

To provide design flexibility, footnote l to Table 1104.1(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.

Vaulted ceiling area is restricted in prescriptive options with R-30 vault insulation. If an R-30 vault option is used (Paths 1, 2, and 3), vaulted ceiling area may not exceed 50 percent of total heated 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 R-38. Typically the entire vaulted ceiling would be insulated to R-38. Alternatively, a compliance path with an R-38 vault could be used (Paths 4, 5, 6, 7, 8 or 10), or compliance could be demonstrated using Table 1104.1(2) thermal performance calculations. To determine vault area, multiply vault length by its width, measured along the slope to the ridge.

The energy code specifies required R-values, not products. Any insulation product or combination of insulation products that meets the installed R-value requirement is acceptable. If a prescriptive path is used for code compliance, only R- and U-factors in that path may be used. R- and U-factors in one path may not be mixed with R- and U-factors in other paths.

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

R-30 vaulted ceiling insulation options

Foil-faced batts or unfaced batts covered with polyethylene are typically used to insulate single rafter vaults. Kraft-faced batts do not have the 0.5 perm rating required for use in ceilings without attic spaces. Loose fill may be used in vaults with attic space above them 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 to 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.

10-1/4 inch thick foam core panels meet or exceed the R-30 vault requirement.

Figure 1:
Vault insulation examples

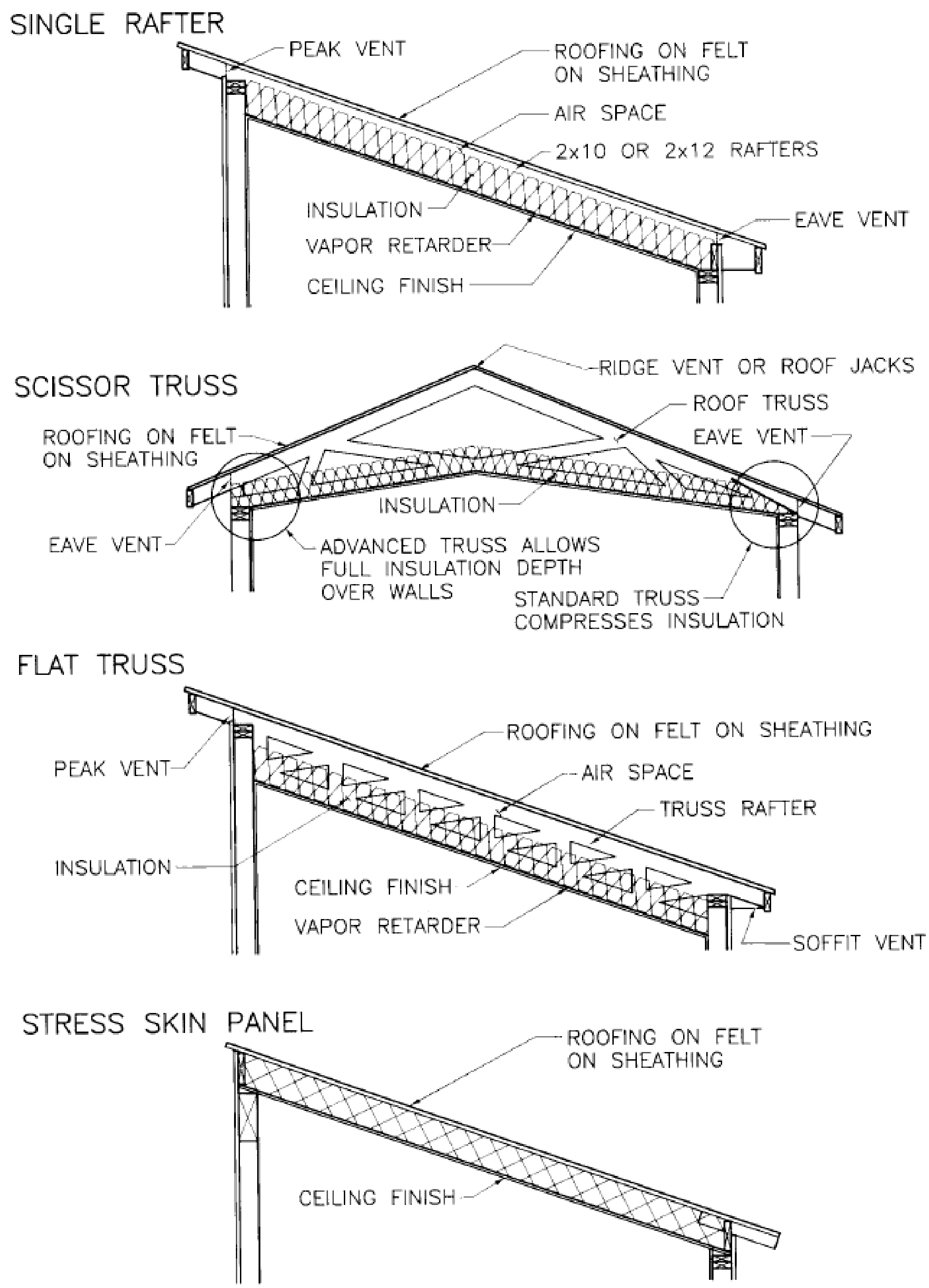


Figure 2:
Vault ventilation details

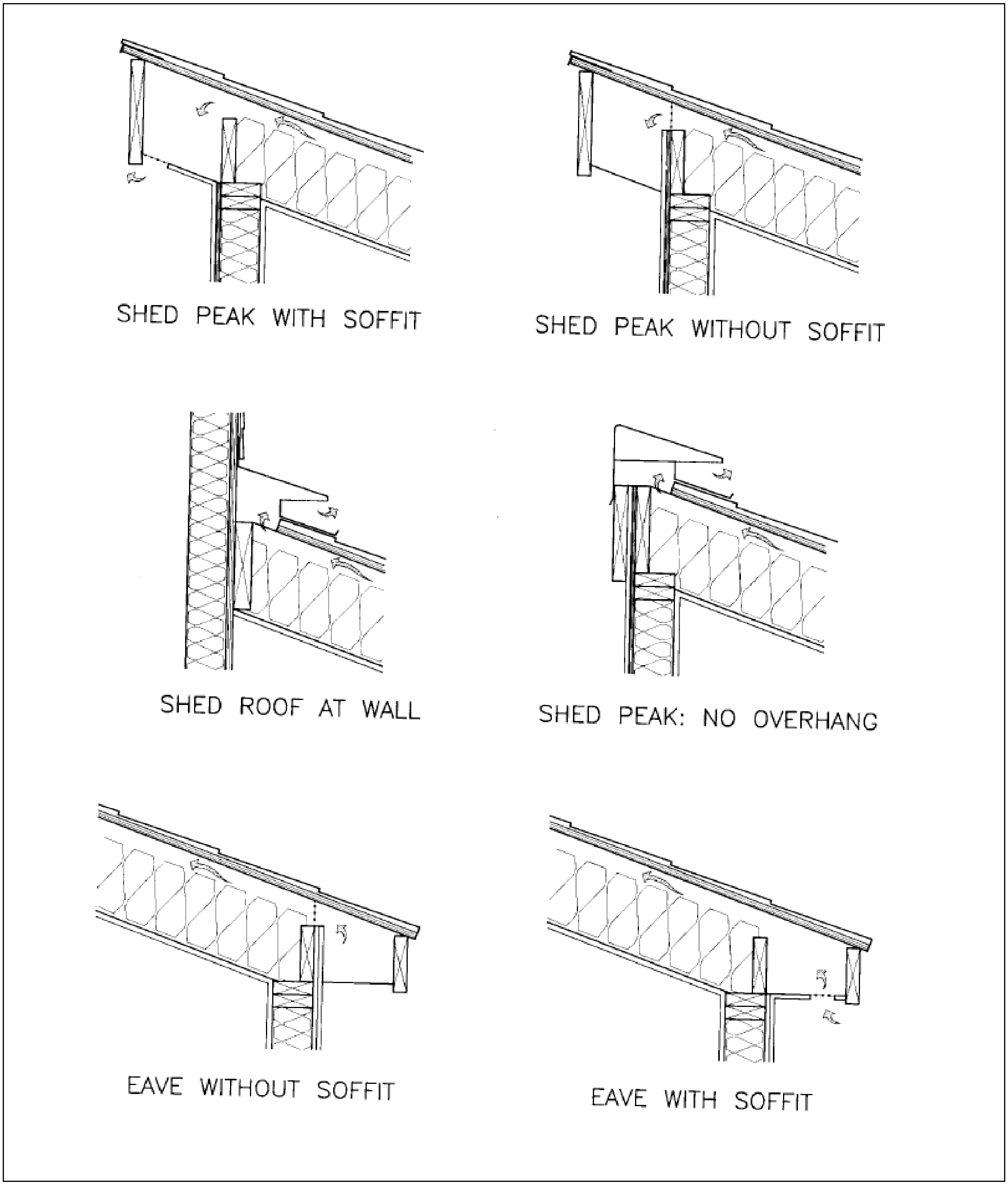
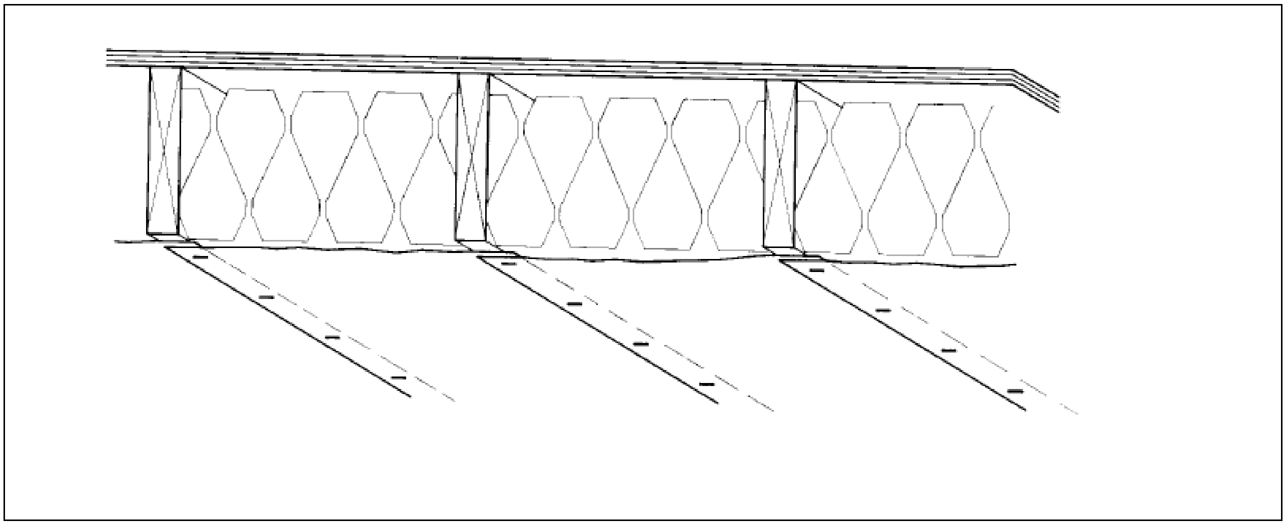


Figure 3:
Face stapling at vaults



R-38 vaulted ceiling insulation options

One way to get R-38 vaults is to provide truss joist or scissors truss framing. These framing systems 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.

10-1/4-inch thick foam core panels meet the R-38 requirement.

Ventilation of vaulted ceilings

Requirements for vault ventilation are from the Oregon Structural or Residential Specialty Codes. Where determined necessary by the building official, 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 them, a 0.5 perm vapor retarder is required. It helps protect the vault from moisture sources inside the home. Foil faced insulation (0.5 perm) is typically used. To maintain the integrity of the vapor retarder, code requires the flanges of foil-faced insulation to be lapped and face stapled at the ceiling framing members. Section drawings or written specifications that accompany the plans must identify the 0.5 perm vault 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.*

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Oregon BUILDING CODES DIVISION

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Basement Wall Insulation Requirements

This pamphlet is one in a series that describes residential energy conservation requirements of the Oregon Residential Specialty Code and the Structural Specialty Code for Group R buildings three stories and less in height. Other pamphlets in this series may be obtained from Oregon Dept of Energy at www.oregon.gov/energy/ or local building departments or from Oregon Building Codes Division.

Prescriptive insulation requirements for basement walls

All prescriptive paths require basement walls 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. This is a significant change from previous energy code, which required insulation only to 12 inches below grade.

The energy code specifies required R-values, not products. Any insulation product or combination of insulation products that meets the installed R-value requirement is acceptable. If a prescriptive path is used for code compliance, only R- and U-factors in that prescriptive path may be used. R- and U-factors in one path may not be mixed with R- and U-factors in other paths. R- and U-factor standards may be exceeded.

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 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 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.

Figure 1:
Interior basement wall insulation detail

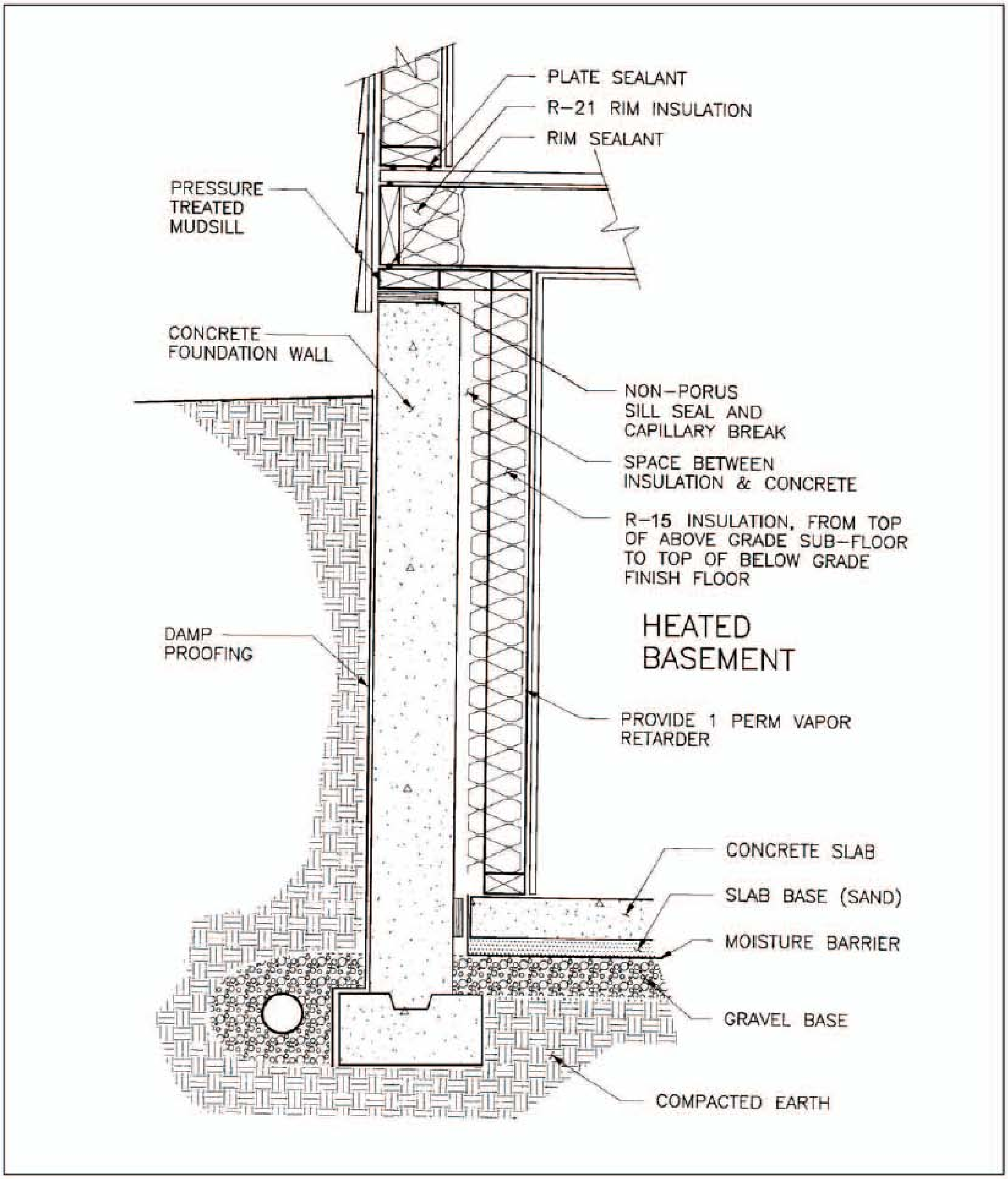
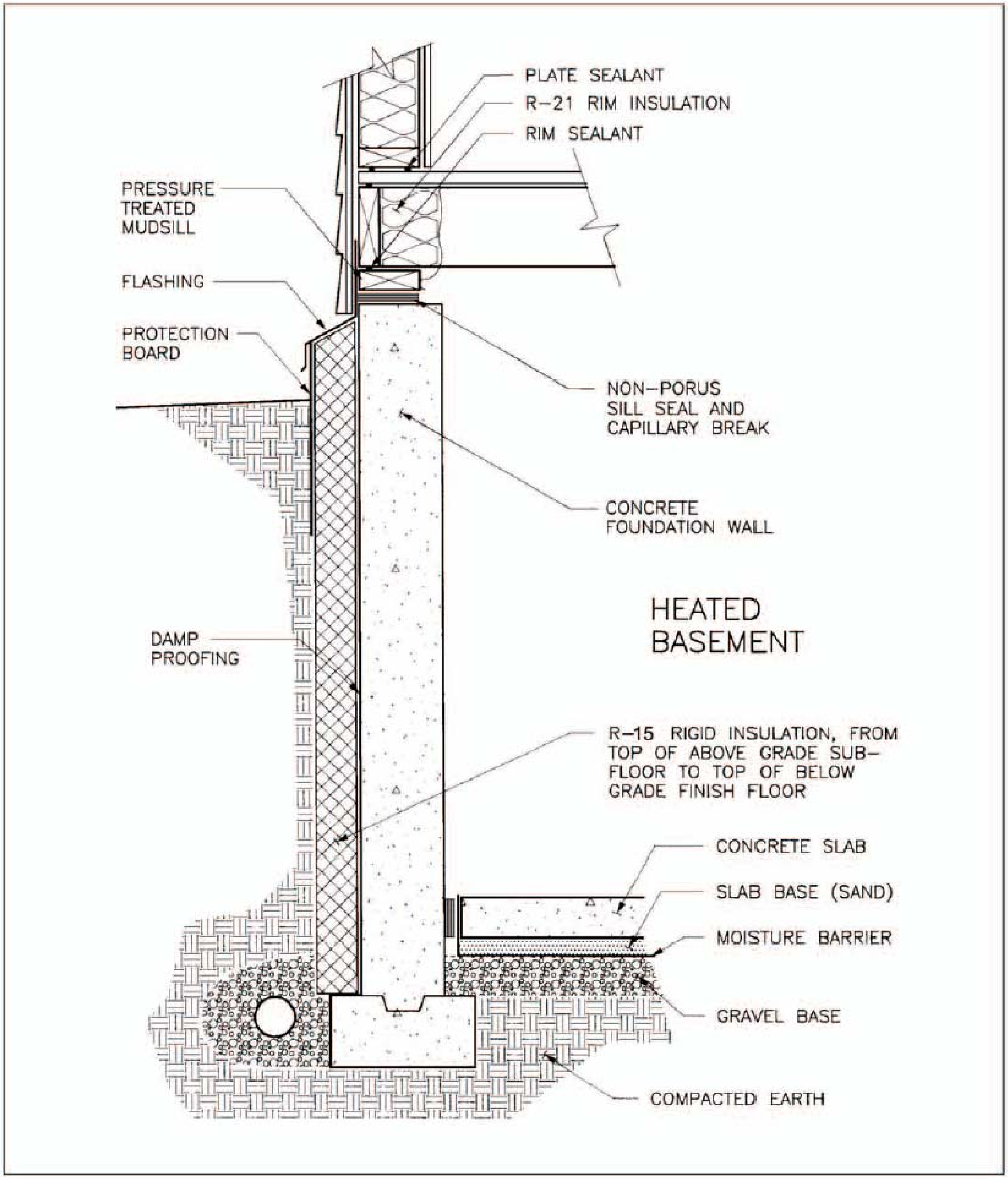


Figure 2:
Exterior basement wall insulation detail



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Oregon BUILDING CODES DIVISION

OREGON STATE UNIVERSITY EXTENSION SERVICE

Slab Floor Edge Insulation

This pamphlet is one in a series that describes residential energy conservation requirements of the Oregon Residential Specialty Code and the Structural Specialty Code for Group R buildings three stories and less in height. Other pamphlets in this series may be obtained from Oregon Dept of Energy at www.oregon.gov/energy/ or local building departments or from Oregon Building Codes Division.

Prescriptive requirements for slab floor edge insulation

All prescriptive paths 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 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 U-factors in that prescriptive path may be used. R- and U-factors in one path may not be mixed with R- and U-factors in other paths. R- and U-factor standards may be exceeded.

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 to the bottom of the thickened edge.

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.

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 heated and unheated spaces.

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

Slab moisture protection

The energy code does not require vapor retarders for slab floors.

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 a recommended practice that allows concrete to cure more evenly.

Figure 1:
Monolithic slab on grade insulation details

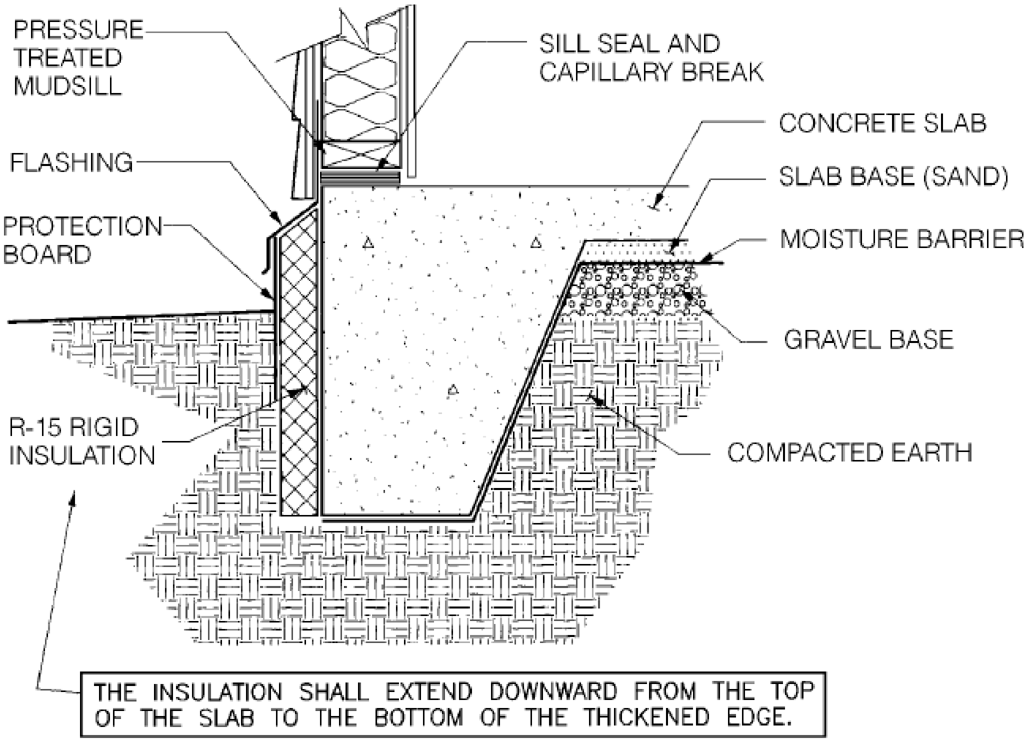


Figure 2:
Floating slab on grade insulation details

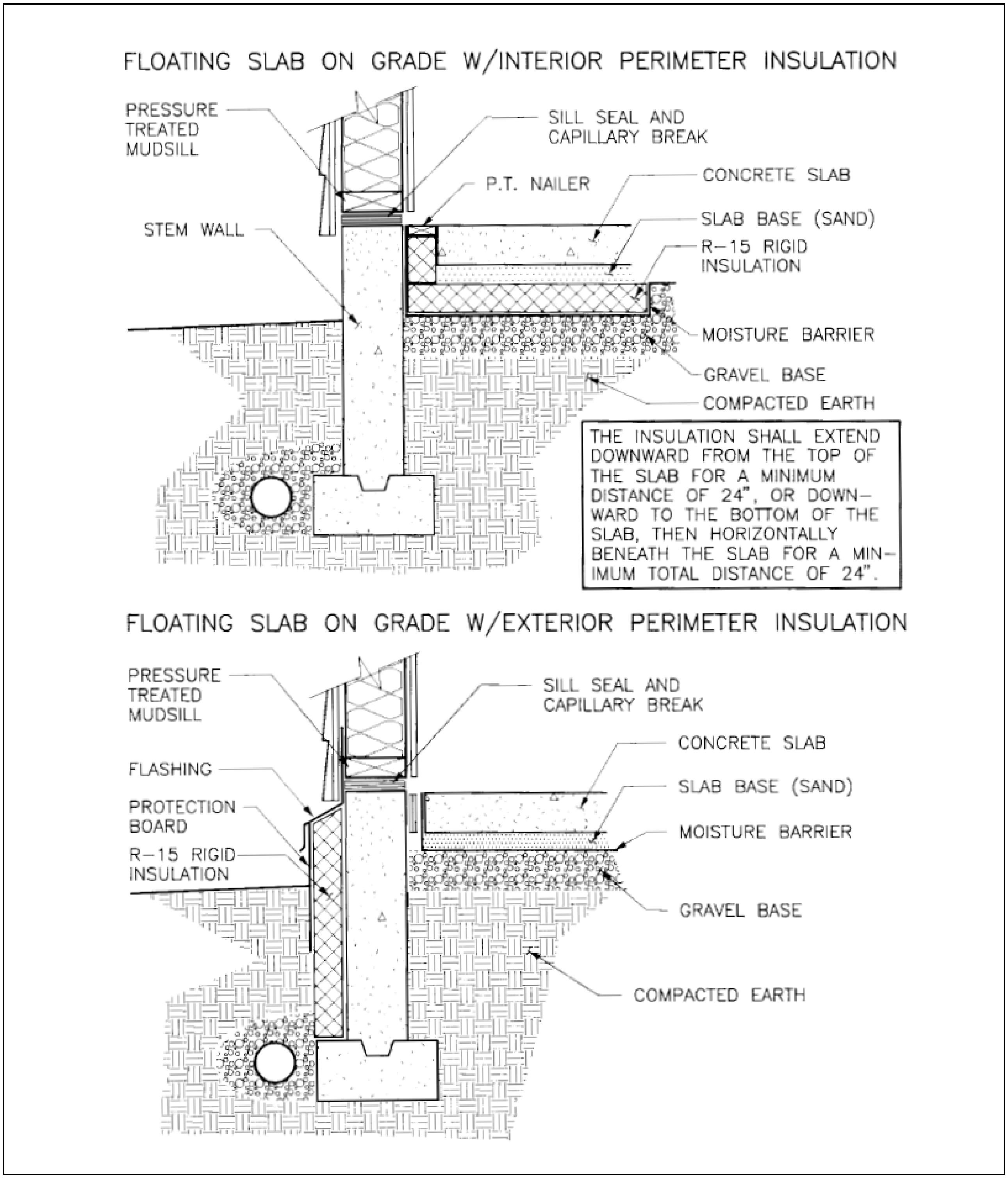


Figure 3:
Thermal break between slabs of heated and unheated floor spaces

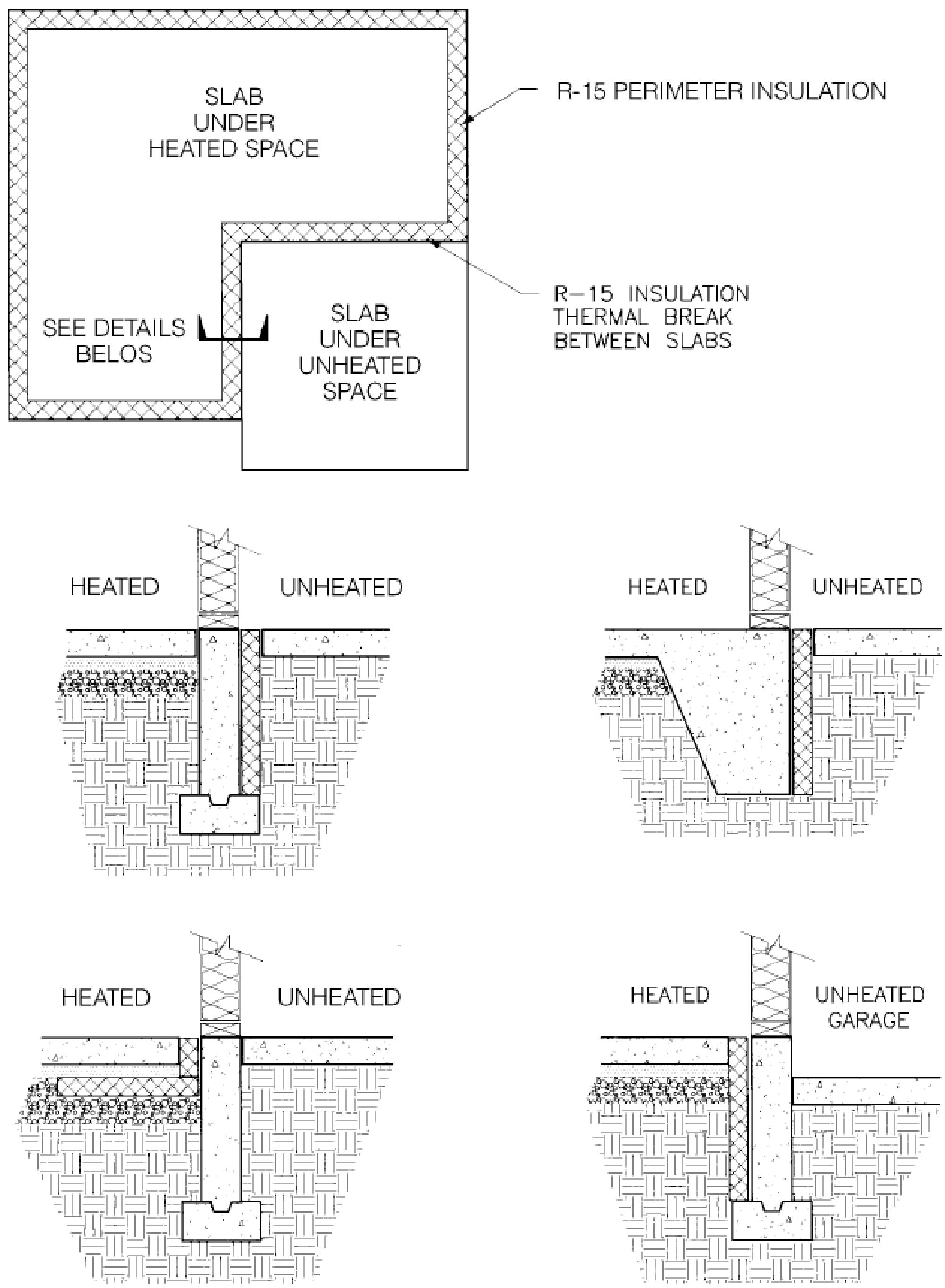
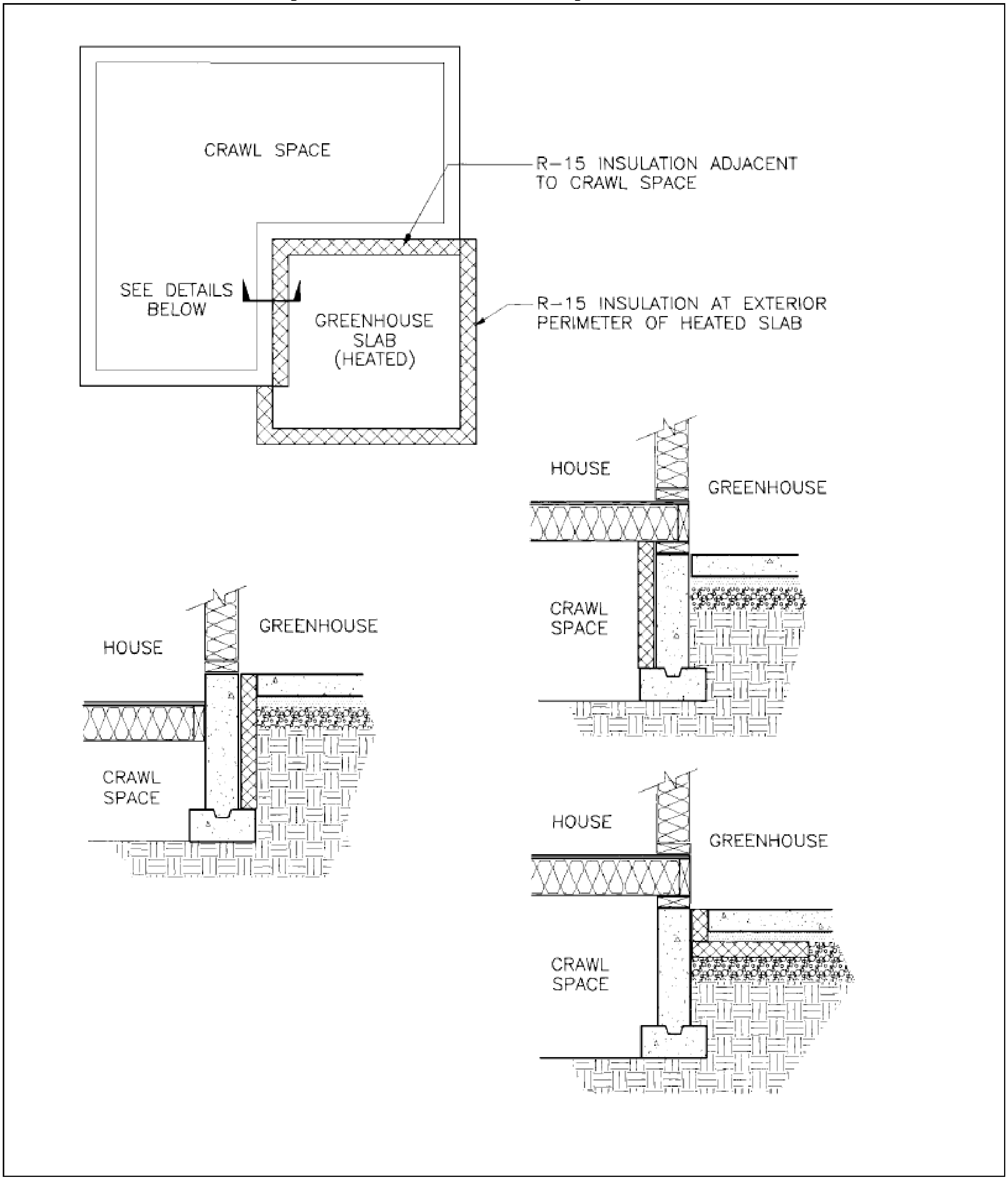


Figure 4:
Thermal break between heated space slabs and unheated crawl spaces



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Oregon BUILDING CODES DIVISION

OREGON STATE UNIVERSITY EXTENSION SERVICE

Using Sun-Tempered Prescriptive Options

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Sunlight is an energy conservation measure

The Oregon energy code recognizes that homes may reduce their need for conventional forms of space heat by effectively using sunlight.

Table 13-A, Prescriptive Compliance Paths for Residential Buildings, lists four prescriptive paths (2, 4, 6, and 7) that include "sun-tempering" as a conservation measure. Sun-tempered paths trade solar gains for insulation in other building components.

If a prescriptive path is used for code compliance, only R- and U-factors in that prescriptive path may be used. R- and U-factors in one path may not be mixed with R- and U-factors in other paths. R- and U-factor standards may be exceeded.

Prescriptive requirements for sun-tempered homes

If a lot fronts a street that runs within 30 degrees of true east/west *and* if 50 percent of the home's total window area faces south, sun-tempered prescriptive paths may be used to comply with the energy code.

The street orientation requirement is a simple way of determining if a home has access to the sun. Solar access studies in Oregon indicate that lots on east/west streets have good solar access and that lots on north/ south streets have poor solar access. An approved alternate to street orientation may be used if at least 50 percent of the home's total window area faces south **and** there's adequate solar access as defined in the pamphlet *Determining Solar Access for the Oregon Residential Energy Code* (available from the Oregon Dept of Energy) **and** the adjacent properties to the south are already developed or long-term solar access is protected in some other way.

To determine how much window area must face south, calculate total window area (total rough opening area) and divide by two. For example, a home with 350 square feet of windows needs 175 square feet of windows on the south side to qualify under a sun tempered prescriptive option. Glazing in unheated spaces - - garage windows, for instance - - don't count as part of the total.

Showing sun-tempered details on the plan

Street orientation is commonly shown on the plat for each subdivision in degrees, minutes, and seconds. This information must be noted on the site plan submitted with blueprints. A north arrow on the site plan indicates orientation.

Window locations must be shown on the plan view or elevation drawings. Breaking out south window area from total window area expedites review.

Figure 1 shows examples of lots that qualify under sun-tempered prescriptive options. Figure 2 shows examples of lots that don't qualify.

Figure 1:
Lots that qualify under sun-tempered prescriptive options

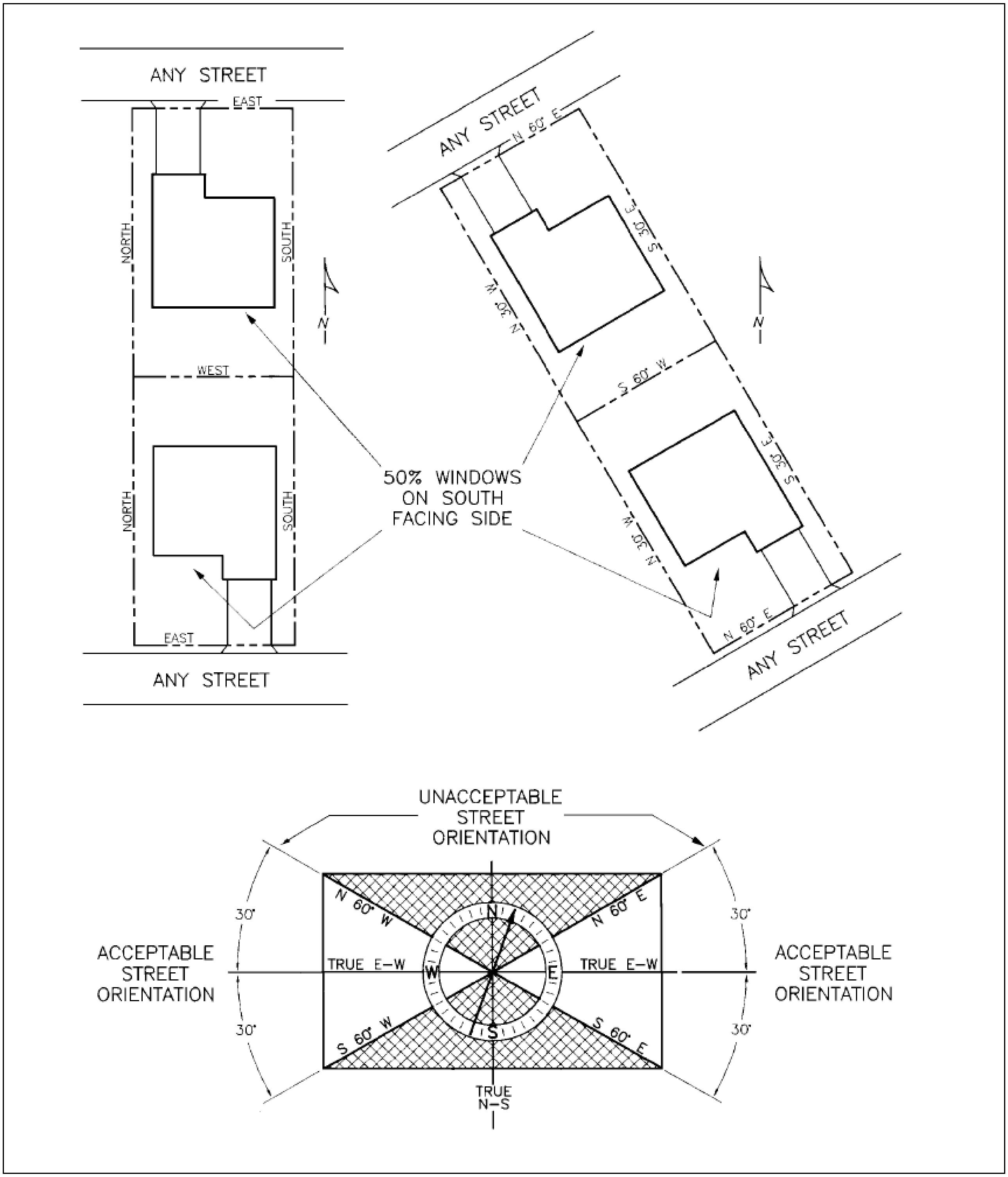
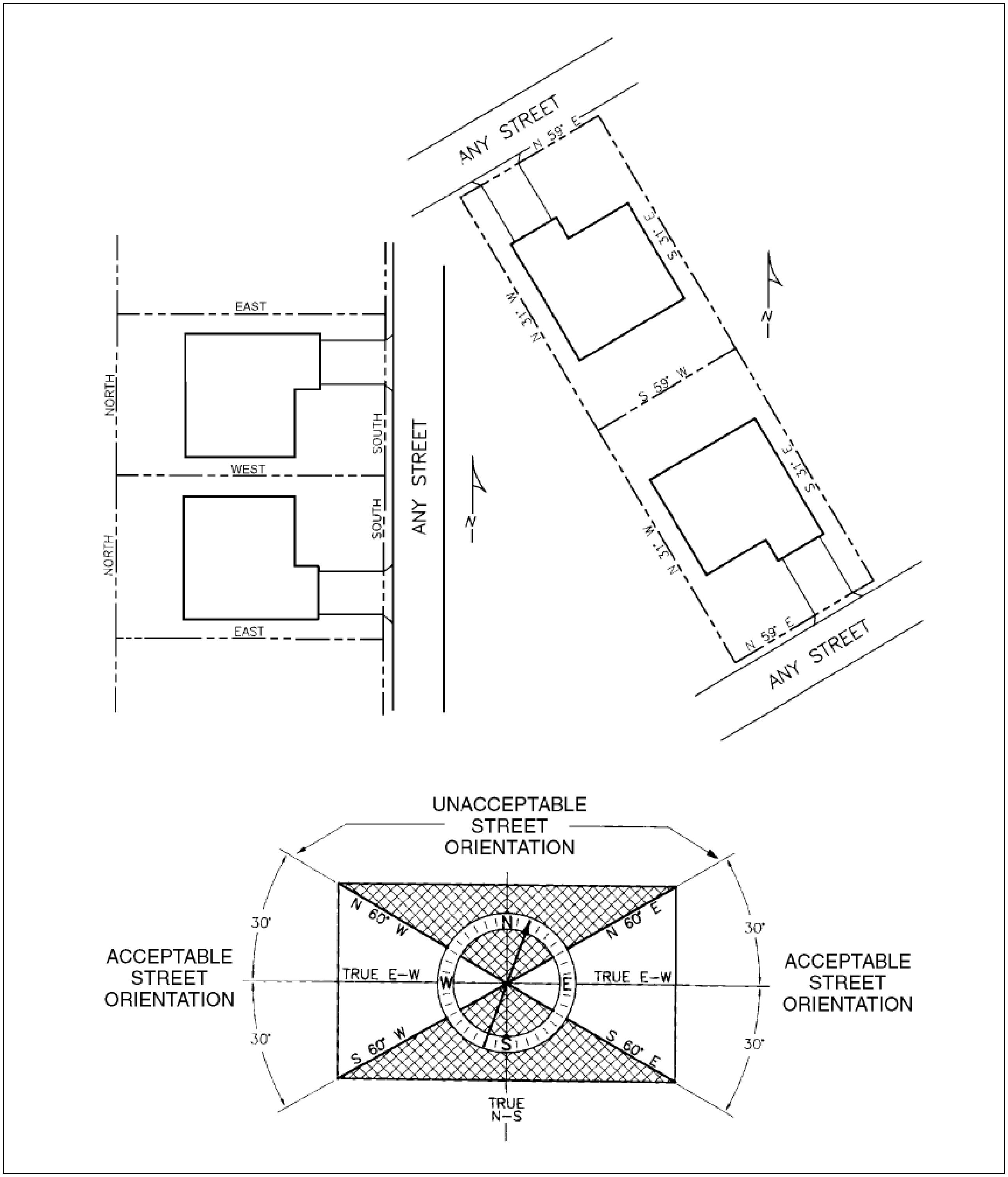


Figure 2:
Lots that do not qualify under sun-tempered prescriptive options



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Advanced Framing for Walls and Ceilings

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Prescriptive paths that require advanced framing

Several prescriptive paths (3, 4, 5, 6, and 7) in Table N1104.1(1), Prescriptive Compliance Paths for Residential Buildings require advanced framing in walls or ceilings or both. Advanced framing is required if an R-value in Table N1104.1(1) is followed by an "A." Section drawings or written specifications that accompany the plan must indicate advanced framing where required.

Structural requirements in the code limit 2x4 advanced framing to one story homes. Thus, structural requirements preclude use of advanced framed walls in some cases. Walls with 2x6 studs, 24-inch on-center framing may be used for two story buildings.

Firewall construction also requires specific framing details that are not compatible with advanced framing methods.

Check structural and fire wall requirements first. If they are compatible with advanced framing, advanced frame prescriptive paths are options for energy code compliance.

If a prescriptive path is used for code compliance, only the R- and U-factors in that prescriptive path may be used. R- and U-factors in one path may not be mixed with R- and U-factors in other paths. R- and U-factor standards may be exceeded.

Energy code definition of advanced frame walls

Advanced frame walls must have all of the following features:

- 24-inch on center framing
- insulated corners
- insulation in exterior walls behind partition intersections
- insulated headers

Code requires that insulation in corners and partition intersections be equivalent to insulation in the surrounding wall. Headers with voids one inch thick or greater must be filled with rigid insulation that has a minimum R-value of 4.0 per inch.

Depending on the type of truss used in gable end walls, gable end wall headers may be eliminated. If the gable truss is structural, headers in the gable end wall are not needed because loads are transferred to side walls. If the gable truss does not transfer loads to side walls, insulated structural headers are needed in the wall below the truss.

Figures 1, 2, and 3 show ways to insulate corners, partitions and headers.

Siding and sheathing considerations for advanced frame walls

Structural sheathing is rated for 24-inch or 16-inch on-center framing. Ratings are stamped on the sheeting material. For advanced framing, be sure structural sheathing is rated for 24 inches on center.

Advanced frame walls may not be appropriate for every job. Structural considerations must be taken into account. Also, some siding systems work better with conventional framing. Make sure siding and framing

Figure 1:
Insulated corner details

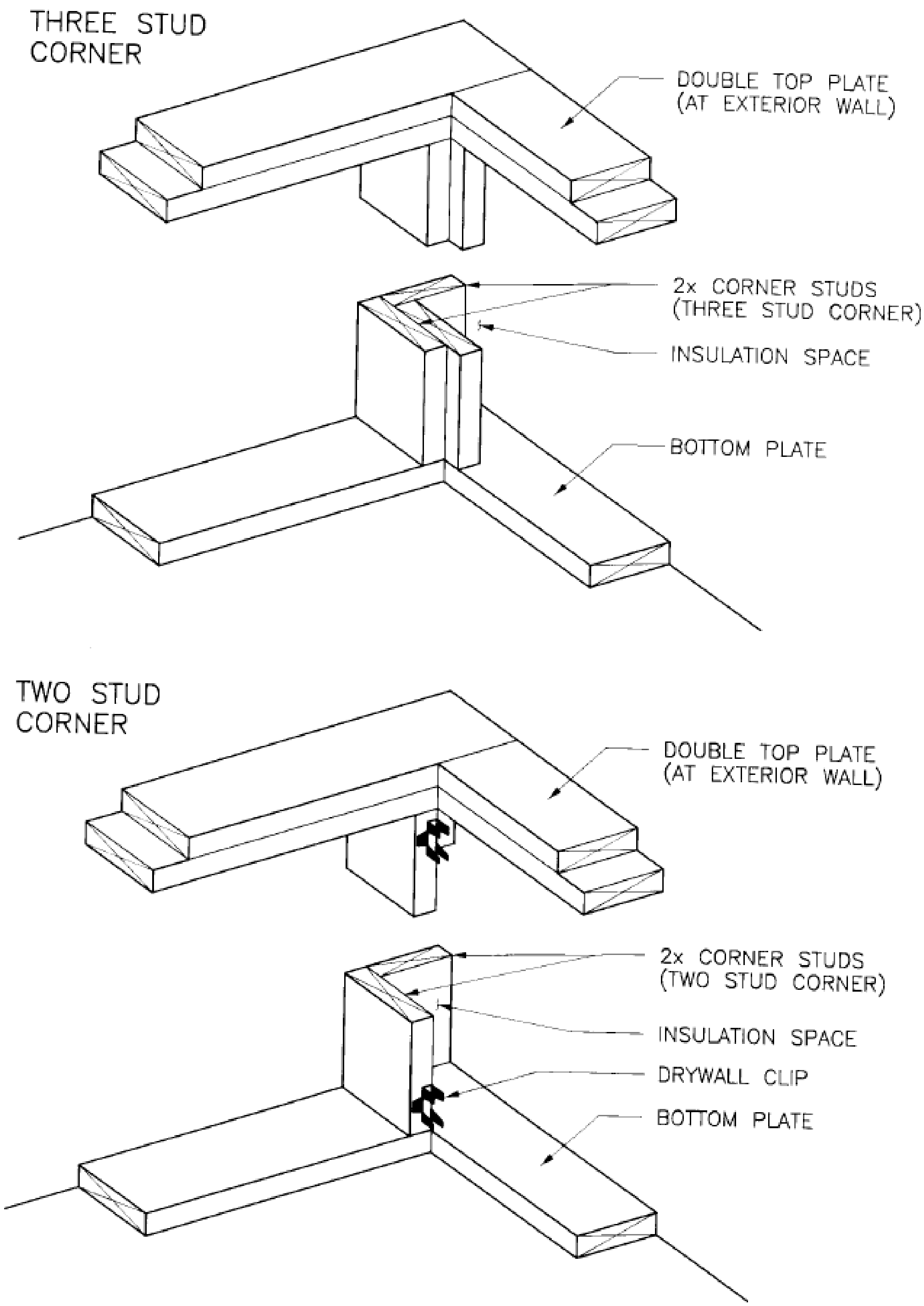


Figure 2:
Insulated partition intersections

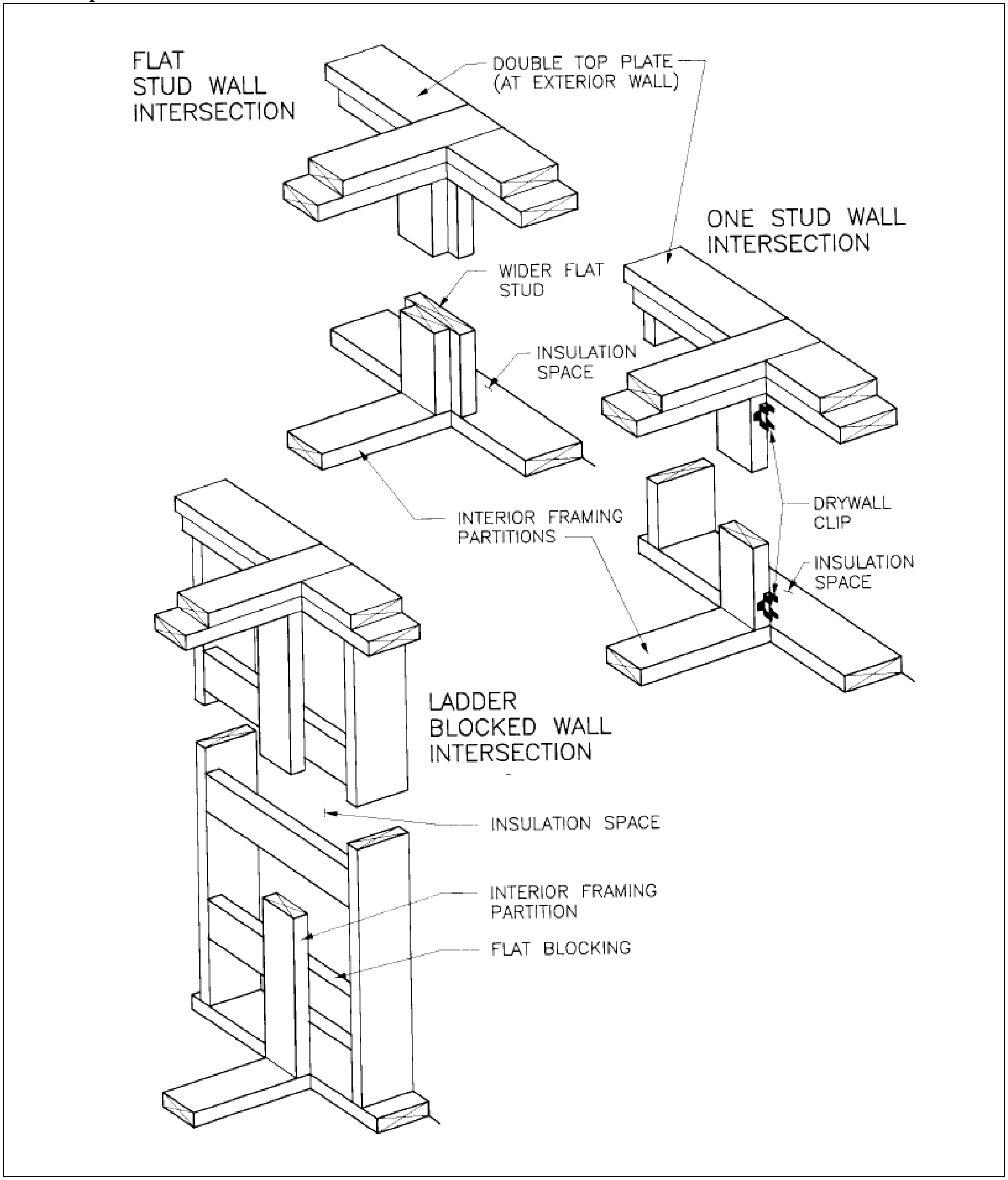
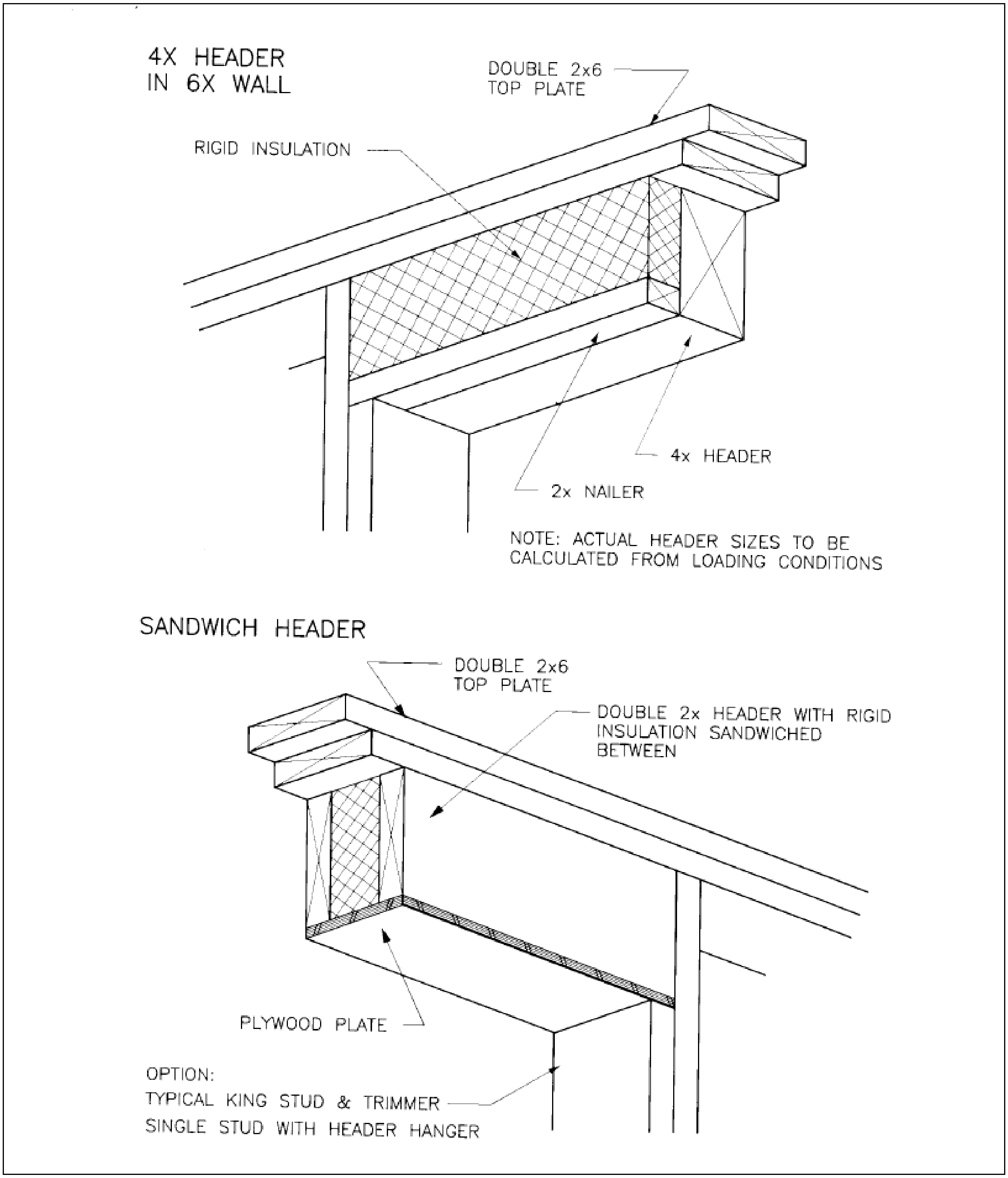


Figure 3:
Insulated header details



systems are compatible before choosing an advanced frame prescriptive path.

Advanced frame R-19 walls as approved alternates to standard R-21 walls

A footnote to Table N1104.1(1) indicates that use of advanced framing with R-19 insulation is considered to be the thermal equivalent and approved alternate to a standard frame with R-21 insulation.

Point loading and advanced frame walls

When 24-inch on-center framing is used in walls, it is good practice, but not a requirement, to lay out the roof so trusses bear directly over wall studs. This is called "point loading" and is illustrated in Figure 4.

Energy code definition of advanced frame ceilings

Advanced frame ceilings are constructed to allow full-depth attic insulation to be installed all the way to the outside wall. Advanced ceiling framing eliminates the three- to four-foot strip at the building perimeter where conventional roof trusses compress attic insulation to zero. This under-insulated strip commonly accounts for 25 percent of ceiling area.

Figure 5 shows ways to get full insulation all the way to the outside wall. Oversized or raised-heel trusses are most commonly used. However, framing techniques such as box ceilings or dropped ceilings also may be used to create space for full-depth ceiling insulation.

Figure 4:
Point loaded trusses

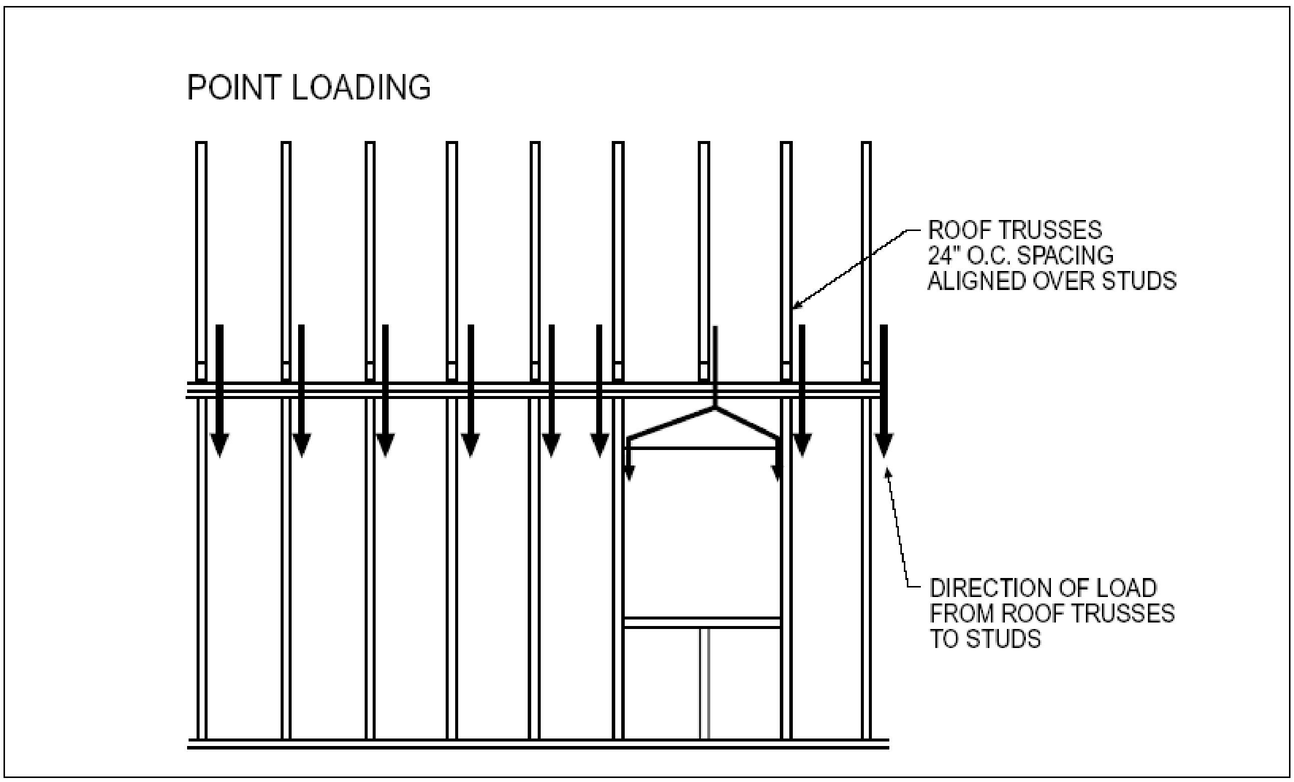


Figure 5:
Standard vs. advanced frame ceilings

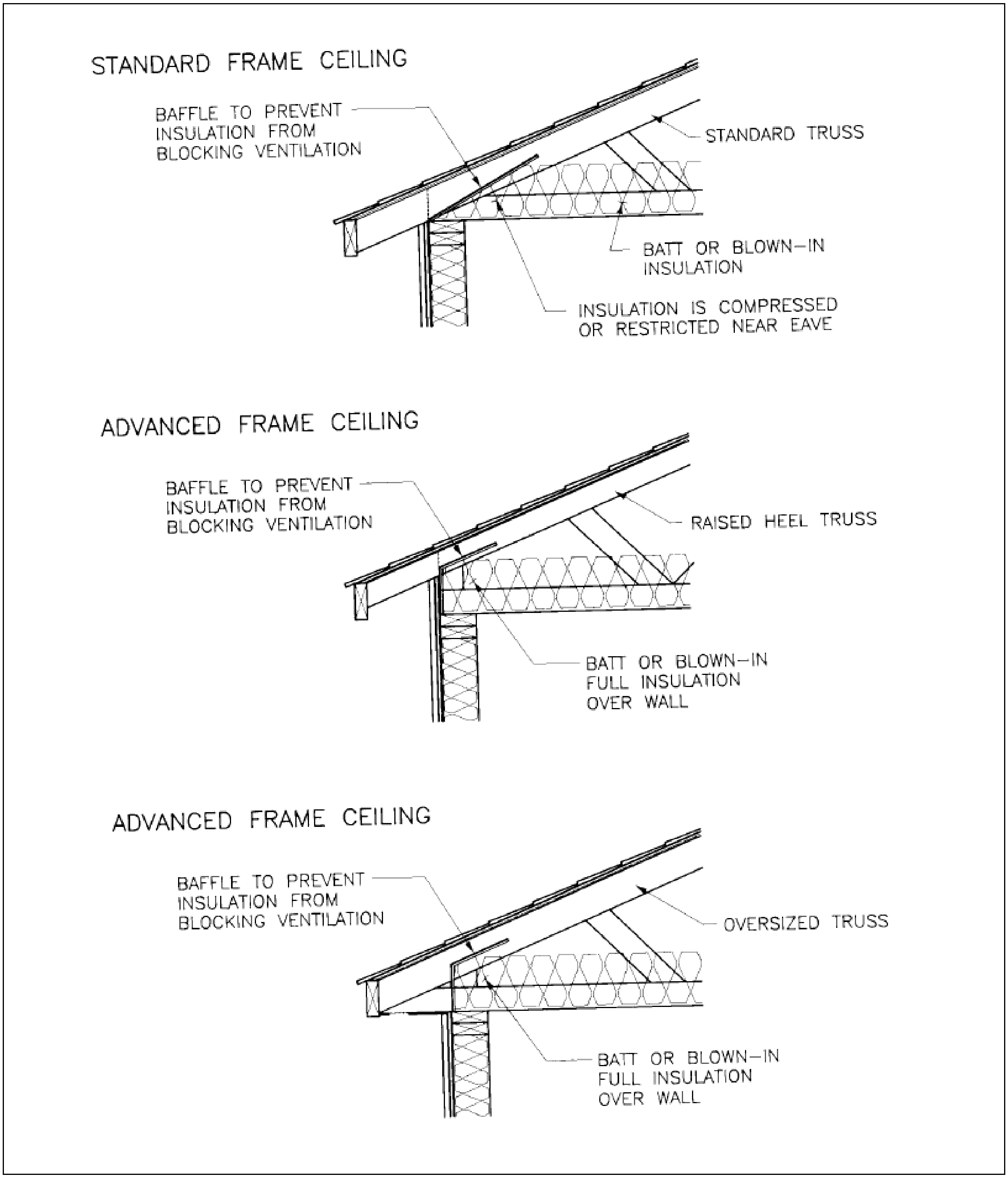
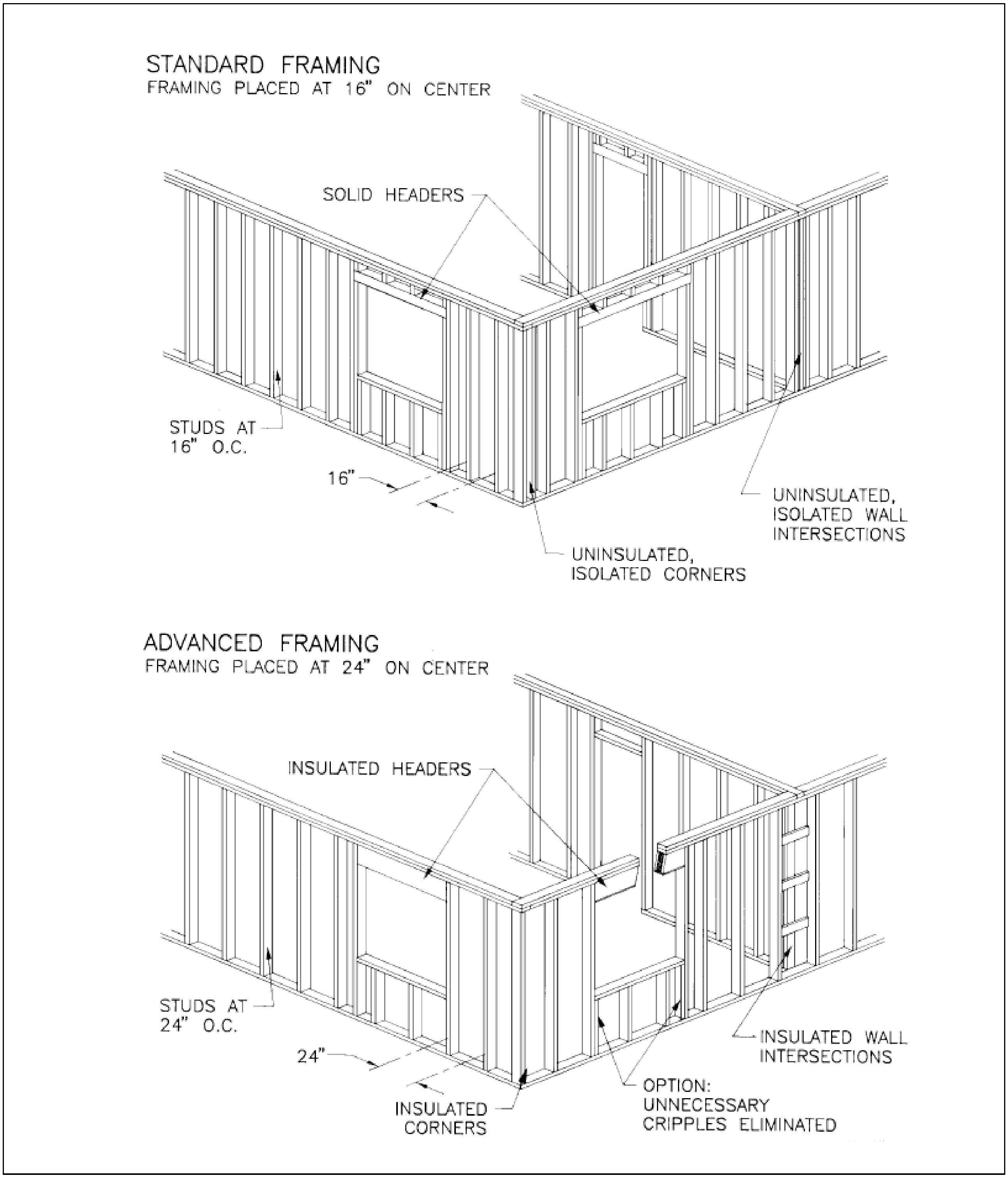


Figure 6:
Standard vs. advanced framed walls



Use of oversized trusses requires installation of a structural block at the bearing point and may require closed-in soffits. Be sure to specify location of the bearing point when ordering oversized trusses. Raised heel trusses increase wall height, thereby affecting siding installation. Advanced frame scissors trusses may be used in vaults, but are not required by code.

How does advanced framing work?

Advanced framing eliminates non-structural wood from the building envelope and replaces it with insulation. Figure 6 shows the difference between standard and advanced wall framing.

Wood has an R-value of about R-1 per inch. Insulation R-values range from R-3.5 to R-8.3 per inch.

Wood creates a path for conductive heat loss, called a "thermal bridge," through the building frame. Reducing thermal bridging by replacing wood with insulation in advanced frame homes improves energy performance.

Computer simulations indicate that homes with advanced framed walls and ceilings use about eight percent less energy for space heat than conventionally framed homes.

Advanced ceiling framing eliminates insulation compression at the ceiling perimeter caused by conventional trusses. Under-insulated perimeters make up a large portion of conventional ceiling area. By allowing space for full-depth ceiling insulation at the ceiling perimeter, advance frame trusses significantly reduce heat loss through the ceiling.

The National Association of Home Builders (NAHB) Research Foundation developed advanced wall framing as a cost-saving measure. NAHB called it “optimal value engineering,” or OVE framing. OVE cost-cutting measures also reduce heat transfer across the building shell.

Information presented in this publication supports the Oregon Residential Specialty Code, or Chapter 13 of the Oregon Structural 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 Bryan Boe, Oregon State University Extension Energy Program and updated and revised by Alan Seymour, Oregon Dept of Energy for the Oregon Building Codes Division. Illustrations are by Gene Stevenson. Funding was provided by Northwest Energy Efficiency Alliance, Portland General Electric, Northwest Natural Gas, Pacific Power and Light, Bonneville Power Administration, Cascade Natural Gas, WP Natural Gas, and Idaho Power.

Oregon
BUILDING
CODES DIVISION

OREGON STATE UNIVERSITY
EXTENSION SERVICE

Table 1104.1(2): Residential Thermal Performance Calculations

TABLE N1104.1(2)
RESIDENTIAL THERMAL PERFORMANCE CALCULATIONS

BUILDING COMPONENTS[b]	Base Path 1[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 Windows[g]		0.031 0.033 0.060					
A. If glazing area is greater than 13 percent of heated space floor area	Take-off area	0.40					
B. If glazing is less than 13 percent of heated space floor area and trade-off is desired	13% of floor area	0.40					
Skylights Exterior doors Underfloor Slab edge		0.50 0.20 0.032 (perimeter ft. =) F=0.52[h]					
		CODE UA =				**Proposed UA[i] =**	

a Base path 1 represents Prescriptive Compliance Path 1 from Table N1104.1(1).

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

c Areas from plan take-offs. All areas must be the same for both Path 1 and Proposed Alternate, except for window areas allowed in footnote g below. The vaulted ceiling area for Base Path 1 must be the actual area from the plan take-off not to exceed 50 percent of the heated space floor area. Any areas in excess of 50 percent for Base Path 1 must be entered at U-0.031 (R-38) with "Flat Ceilings" area. The skylight area for Base Path 1 must be the actual area from the plan take-off, not to exceed 2 percent of the heated space floor area. Any areas in excess of 2 percent for Base Path 1 must be entered at 0.40, with "Windows" area. 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. Default U-factor for an unglazed wood door is 0.54.

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*-factors shall not exceed 0.54 (Nominal R-2). The wall component for Path 9 shall be a minimum solid log or timber wall thickness of 3.5 inches (88.9 mm).

e *U*-factors for wood frame ceilings, walls and floor assemblies shall be as specified in Table N1104.1(3). *U*-factors for other assemblies, which include brick or other masonry, stucco, etc., shall be calculated using standard ASHRAE procedures.

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

g Component *U*-factors trade-offs may be made against window area in detached single family dwellings or rowhouses when window area is less than 13 percent of heated space floor area. The base window area in this case shall be set at 13 percent of the heated space floor area.

h F=The heat loss coefficient, BTU/hr./ft.^{2}/°F. per foot (w/m^3-k) of perimeter.

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

Information presented in this publication supports the Oregon Residential Specialty Code, or Chapter 13 of the Oregon Structural 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.

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Oregon BUILDING CODES DIVISION

OREGON STATE UNIVERSITY EXTENSION SERVICE

How to Do Residential Thermal Performance Calculations Using Table N1104.1(2)

This pamphlet is one in a series that describes residential energy conservation requirements of the Oregon Residential Specialty Code and the Structural Specialty Code for Group R buildings three stories and less in height. Other pamphlets in this series may be obtained from Oregon Dept of Energy at www.oregon.gov/energy/ or local building departments or from Oregon Building Codes Division.

Homes may comply with residential energy code through a prescriptive path (Table N1104.1(1)) or thermal performance calculations using Table N1104.1(2). The seven prescriptive paths represent different packages of measures that achieve similar performance. Prescriptive Path 1 is the “Base Path.” Paths 2 through 7 and 10 are thermal equivalents of Path 1.

Other combinations of measures may be used if thermal performance calculations show that the combination achieves the performance standard of the Base Path. Thermal performance calculations take more time, but have several advantages over prescriptive paths:

Trade-offs can save money. Thermal performance calculations allow “credit” for exceeding requirements. For example, builders often use more efficient widows than prescriptive paths require. Thermal performance calculations allow trading of improved window performance for lower conservation levels elsewhere in the building. Overall building performance still meets the Base Path. Prescriptive paths don’t allow credit for exceeding requirements.

Flexibility. When no prescriptive path seems to work for a particular project, thermal performance calculations may be used to customize the conservation package for the job.

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 calcula-tions to demonstrate code comp-liance. 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 submit-ted on a copy of Table N1104.1(2), shown in this pamphlet. Use of a standard format expedites review of the calculations by the code official.

How Table 13-B 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 code compliance.

In Table N1104.1(2), building heat loss is first calc-ulated as if the building was built using measures in the Base Path (Prescriptive Path 1). On the Table N1104.1(2) worksheet this is called “Base Path 1.” 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 Alternate.” 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

TABLE N1104.1(2) RESIDENTIAL THERMAL PERFORMANCE CALCULATIONS

BUILDING COMPONENTS[b]	Base Path 1[a]			Proposed alternative			
	Areas[c]	U-factor	Areas x U	R-value[d]	Areas[c]	U-factor[e]	Areas x U
Flat ceilings		0.031					
Vaulted ceilings[f]		0.033					
Conventional wood-framed walls		0.060					
Windows[g]							
A. If glazing area is greater than 13 percent of heated space floor area	Take-off area	0.40					
B. If glazing is less than 13 percent of heated space floor area and trade-off is desired	13% of floor area	0.40					
Skylights		0.50					
Exterior doors		0.20					
Underfloor		0.032					
Slab edge		(perimeter ft. =) F=0.52[h]					
		CODE UA =				**Proposed UA[i] =**	

a Base path 1 represents Prescriptive Compliance Path 1 from Table N1104.1(1).

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

c Areas from plan take-offs. All areas must be the same for both Path 1 and Proposed Alternate, except for window areas allowed in footnote g below. The vaulted ceiling area for Base Path 1 must be the actual area from the plan take-off not to exceed 50 percent of the heated space floor area. Any areas in excess of 50 percent for Base Path 1 must be entered at U-0.031 (R-38) with "Flat Ceilings" area. The skylight area for Base Path 1 must be the actual area from the plan take-off, not to exceed 2 percent of the heated space floor area. Any areas in excess of 2 percent for Base Path 1 must be entered at 0.40, with "Windows" area. 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. Default U-factor for an unglazed wood door is 0.54.

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*-factors shall not exceed 0.65 (CL65). Door *U*-factors shall not exceed 0.54 (Nominal R-2). The wall component for Path 9 shall be a minimum solid log or timber wall thickness of 3.5 inches (88.9 mm).

e *U*-factors for wood frame ceilings, walls and floor assemblies shall be as specified in Table N1104.1(3). *U*-factors for other assemblies, which include brick or other masonry, stucco, etc., shall be calculated using standard ASHRAE procedures.

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

g Component *U*-factors trade-offs may be made against window area in detached single family dwellings or rowhouses when window area is less than 13 percent of heated space floor area. The base window area in this case shall be set at 13 percent of the heated space floor area.

h F=The heat loss coefficient, BTU/hr./ft.^{2}/°F. per foot (w/m^3-k) of perimeter.

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

standards. If the Proposed Alternate doesn't initially qualify, the builder or designer improves conservation levels in one or more building components until it does

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(2). The U-factor column for Base Path 1 on Table N1104.1(2) work-sheet lists U-factors for calculating Code UA. Proposed Alternative U-values are listed in Table N1104.1(3) Approved Default U-Factors that follows Table N1104.1(2) that 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 d 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).

Prescriptive Path 1 area limits apply to Table N1104.1(2) calculations

Prescriptive Path 1 contains component limitations: R-30 vaulted ceilings are limited to 50 percent of heated space floor area and skylights (U-0.41 to U-0.50) are limited to 2 percent of heated floor space. These component limits must be observed when calculating Base Path 1 in Table N1104.1(2). 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(2) and this pamphlet explain how component area limits are modeled in Base Path 1 calculation. Example calculation worksheets are on pages 9-11 of this pamphlet.

Calculating component areas

The first step in using Table N1104.1(2) is to find actual areas of each component:

Flat ceilings

Area equals length times 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

Area equals length times 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.

R-30 vault area limit in Base Path calculation: For Base Path 1, enter area of the R-30 vault, not to exceed 50 percent of heated floor space. Include excess vault area with "Flat Ceilings." For Proposed Alternate, 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 Alternate calculation.

Opaque (solid) walls

Area equals length times height, using outside dimensions and rounding to the nearest whole square foot. For triangular walls at vaults and gable ends, area equals base times height divided by two.

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. 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.

Windows

For rectangular windows, area equals width times 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) times radius squared ($A = \pi r2$). For half-round windows, figure whole circle area and divide by two. For triangular windows, area equals base times height divided by two.

Deduct window area from gross wall area. **Window line A:** If window areas for the building exceeds 13 percent of the “heated space floor area,” use actual window area in the window heat loss calculation for both Base Path 1 and Proposed Alternative.

Window line B (for detached single-family dwellings only): If window area is less than 13 percent of heated space floor area, use 13 percent of heated space floor area as window area for Base Path 1. Use actual window area (less than 13 percent) for the Proposed Alternative. This gives a qualification advantage to detached single-family dwellings with reduced glazing area.

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

For site-assembled windows, use default U-factors from Table NF1111.4(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 calculations should indicate which windows were exempted and exempted window area.

Skylights

Area equals rough opening dimension: length times width. Deduct skylight area from gross flat or vaulted ceiling area.

Minimum component requirement is U-0.65. If skylights are untested, use window default U-factors.

2 percent skylight area limit in the Base Path calculation: For Base Path 1 actual skylight area, up to 2 percent of the heated space floor area is entered as “Skylight” (U-0.50). If actual area exceeds 2 percent of heated space floor area, enter excess area under “Window” (U-0.40). Excessive skylight area entered as window may bump the window area total above 13 percent and preclude use of the line B window trade-off.

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

Area equals width times height of the rough opening. Include sidelights with windows.

Exempt door - unglazed doors, untested or tested:

For Base Path 1door 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.

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 Base Path 1 or Proposed Alternative calculations. Use net door area: total door area minus exempted glazing area.

In Base Path 1, 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-0.40).

For Proposed Alternate 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.

No glazing exemption 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-0.40) in the 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 Alternate.

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 Alternate.

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(2) worksheet, but do not include it in Base Path 1 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 Base Path. 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 Base Path 1. Enter excess opaque door area under "Exterior Doors" (U-0.20). Excess glazed area must be included as windows and may preclude use of the line B window trade-off.

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 Base Path 1, enter net door area under "Exterior Door" (U-0.20). Enter glazed area in excess of 2.5 ft^2 as "Window" (U-0.40).

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

Untested doors: For Base Path 1, enter net door area under "Exterior Door" (U-0.20) in Base Path. Enter glazed area in excess of 2.5 ft^2 as "Window" (U-0.40).

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.

Deduct entire door area from gross wall area.

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.

Deduct entire door area from gross wall area. Minimum component requirement for the main entry door is U-0.54.

Other exterior doors

Area equals width times height of rough opening. Deduct other door area from gross wall area.

Minimum component requirement is U-0.54. An unglazed, untested wood door has a default U-factor of 0.54.

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 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.

Basement walls

Basement walls are not included in Table N1104.1(2) 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(2) thermal performance calculations.

Footnote b

Footnote b indicates that performance trade-offs are limited to building components listed in Table N1104.1(2). Furnace efficiency, duct insulation and passive and active solar heating are not considered in thermal performance calculations.

TABLE N1104.1(3)— 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(3) — 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.

Footnote e to Table N1104.1(2) states U-factors calculated using standard ASHRAE methodology may be used. Consult the Oregon Building Codes Division 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(2) thermal performance calculations:

In Example 1, the builder is using windows that exceed code standards and wants to do trade-offs with other building components.

In Example 2, window area is less than 13 percent of floor area. The builder is taking advantage of the line B window trade-off.

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

Example 4 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 5 shows how to do calculations when the exempt door exceeds the 28 square feet limit.

Example 6 shows how to treat untested glazing in thermal performance calculations.

Example 1
Builder trades window performance against other measures

More efficient windows make it possible to decrease vault, wall, floor, and slab R-values. A less efficient skylight (0.60) may also be used.

Heated Floor Area
Slab 674
Crawl 1672
Total 2301 Ft²

$\frac{\text{Window Area}}{\text{Floor Area}} \quad \frac{327}{2301} = 14$

TABLE N1104.1(2)
RESIDENTIAL THERMAL PERFORMANCE CALCULATIONS

BUILDING COMPONENTS[b]	Base Path 1[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	0.033	13.43	R-21	407	0.047	19.13
Conventional wood-framed walls	1754	0.060	105.24	R-19 std	1754	0.065	114.01
Windows[g]							
A. If glazing area is greater than 13 percent of heated space floor area	Take-off area 327	0.40	130.5	–	327	0.32	104.64
B. If glazing is less than 13 percent of heated space floor area and trade-off is desired	13% of floor area	0.40	–	–	–	–	–
Skylights	16	0.50	8.0	–	16	0.60	9.6
Exterior doors	17	0.20	3.4	Insul	17	0.19	3.23
Underfloor	1627	0.032	52.06	R-21	1627	0.035	56.95
Slab edge	117′	(perimeter ft. =) F=0.52[h]	60.84	R-10	117′	0.54	63.18
		CODE UA =	434.6			**Proposed UA[i] =**	431.65

Example 2
Line B window trade off

Reducing window area to 13 percent or less gives the Proposed Alternate a compliance advantage over Base Path 1

$\frac{\text{Window Area}}{\text{Floor Area}} \quad \frac{276}{2301} = 12\%$ Therefore use Windows line B

Base Path Wall Area: 2118 Gross Wall – (299 Windows+37 Doors)=1782 Ft²
Proposed Alternative Wall Area:
2118 – (276 Windows + 37 Doors)=1805 Ft²

TABLE N1104.1(2)
RESIDENTIAL THERMAL PERFORMANCE CALCULATIONS

BUILDING COMPONENTS[b]	Base Path 1[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	0.033	13.43	R-21	407	0.047	19.13
Conventional wood-framed walls	1754	0.060	105.24	R-21 std	1805	0.060	108.3
Windows[g]							
A. If glazing area is greater than 13 percent of heated space floor area	Take-off area	0.40	–	–	–	–	–
B. If glazing is less than 13 percent of heated space floor area and trade-off is desired	13% of floor area 299	0.40	119.6	–	276	0.40	110.4
Skylights	16	0.50	8.0	–	16	0.60	9.6
Exterior doors	17	0.20	3.4	Insul	17	0.19	3.23
Underfloor	1627	0.032	52.06	R-25	1627	0.032	52.06
Slab edge	117′	(perimeter ft. =) F=0.52[h]	60.84	R-15	117′	0.52	60.84
		CODE UA =	425.16			**Proposed UA[i] =**	424.44

Example 3

Home exceeds prescriptive R-30 vault area limit

When R-30 vault area exceeds 50 percent of the floor area, enter vault in excess of 50 percent as flat ceiling for Base Path 1.

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(2)
RESIDENTIAL THERMAL PERFORMANCE CALCULATIONS

BUILDING COMPONENTS[b]	Base Path 1[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 Windows[g]	857 = 296 1151 2447	0.031 0.033 0.060	35.73 37.98 146.82	R-49 std R-30 R-19 std	857 1447 2497	0.0245 0.033 0.065	21.43 47.75 159.05
A. If glazing area is greater than 13 percent of heated space floor area	Take-off area 327	0.40	130.8	–	327	0.34	111.18
B. If glazing is less than 13 percent of heated space floor area and trade-off is desired	13% of floor area	0.40	–	–	–	–	–
Skylights Exterior doors Underfloor Slab edge	16 17 1627 117'	0.50 0.20 0.032 (perimeter ft. =) F=0.52[h]	8.0 3.4 52.06 60.84	– Insul R-25 R-10	16 17 1627 117'	0.60 0.19 0.032 0.54	9. 3.23 52.06 63.18
		CODE UA =	475.64			**Proposed UA[i] =**	467.48

Example 4

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 Base Path 1.

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(2)
RESIDENTIAL THERMAL PERFORMANCE CALCULATIONS

BUILDING COMPONENTS[b]	Base Path 1[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 Windows[g]	857 = 264 1151 2447	0.031 0.033 0.060	35.73 37.98 146.82	R-38 R-30 R-21 std	857 1447 2447	0.031 0.033 0.060	26.57 46.70 146.82
A. If glazing area is greater than 13 percent of heated space floor area	Take-off area 327 + 2	0.40	131.6	–	327	0.39	127.53
B. If glazing is less than 13 percent of heated space floor area and trade-off is desired	13% of floor area	0.40	–	–	–	–	–
Skylights Exterior doors Underfloor Slab edge	46 17 1627 117'	0.50 0.20 0.032 (perimeter ft. =) F=0.52[h]	23.0 3.4 52.06 60.84	– Insul R-25 R-15	48 17 1627 117'	0.50 0.19 0.032 0.52	24.0 3.23 52.06 60.84
		CODE UA =	490.45			**Proposed UA[i] =**	487.75

Example 5
Exterior door exceeds 28 square feet allowance

When an exterior door area exceeds 28 square feet and the door is wood, enter excess area as exterior door for Base Path 1.

Actual Door is 40 Ft²
Door Area Qualifying as Exempt 28 Ft²
Excess Area to Other Door: 40 – 28 = 12 Ft²

TABLE N1104.1(2)
RESIDENTIAL THERMAL PERFORMANCE CALCULATIONS

BUILDING COMPONENTS[b]	Base Path 1[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-49 std*	*1965*	*0.028*	*49.13*
Vaulted ceilings[f]	*407*	0.033	*13.43*	*R-30*	*407*	*0.033*	*13.43*
Conventional wood-framed walls	*1734*	0.060	*104.04*	*R-21 std*	*1734*	*0.060*	*104.04*
Windows[g]							
A. If glazing area is greater than 13 percent of heated space floor area	Take-off area *327*	0.40	*130.8*	–	*327*	*0.40*	*130.8*
B. If glazing is less than 13 percent of heated space floor area and trade-off is desired	13% of floor area	0.40	–	–	–	–	–
Skylights	*16*	0.50	*8.0*	–	*16*	*0.50*	*8.0*
Exterior doors	*17+12*	0.20	*5.8*	*Insul*	*17*	*0.20*	*3.4*
				Wood	*12*	*0.54*	*6.48*
Underfloor	*1627*	0.032	*52.06*	*R-25*	*1627*	*0.032*	*52.06*
Slab edge	*117'*	(perimeter ft. =) F=0.52[h]	*60.84*	*R-15*	*117'*	*0.52*	*60.84*
		CODE UA =	*435.88*			**Proposed UA[i] =**	*428.18*

Example 6
House with untested door sidelight

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

Untested Sideliite 12 Ft²
Default U-Value = 0.54 (Wood Frame, 1/2" Air Space, Clear Glass)

TABLE N1104.1(2)
RESIDENTIAL THERMAL PERFORMANCE CALCULATIONS

BUILDING COMPONENTS[b]	Base Path 1[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*	*60.92*
Vaulted ceilings[f]	*407*	0.033	*13.43*	*R-30*	*407*	*0.033*	*13.43*
Conventional wood-framed walls	*1754*	0.060	*105.24*	*R-21A*	*1754*	*0.057*	*99.98*
Windows[g]							
A. If glazing area is greater than 13 percent of heated space floor area	Take-off area *327*	0.40	*130.8*	–	*315* *12*	*0.40* *0.54*	*126.0* *6.48*
B. If glazing is less than 13 percent of heated space floor area and trade-off is desired	13% of floor area	0.40	–	–	–	–	–
Skylights	*16*	0.50	*8.0*	–	*16*	*0.60*	*9.*
Exterior doors	*17*	0.20	*3.4*	*Insul*	*17*	*0.19*	*3.23*
Underfloor	*1627*	0.032	*52.06*	*R-25*	*1627*	*0.032*	*52.06*
Slab edge	*117'*	(perimeter ft. =) F=0.52[h]	*60.84*	*R-15*	*117'*	*0.52*	*60.84*
		CODE UA =	*434.68*			**Proposed UA[i] =**	*431.11*

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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 Bryan Boe, Oregon State University Extension Energy Program and updated and revised by Alan Seymour, Oregon Dept of Energy for the Oregon Building Codes Division. Illustrations are by Gene Stevenson. Funding was provided by Northwest Energy Efficiency Alliance, Portland General Electric, Northwest Natural Gas, Pacific Power and Light, Bonneville Power Administration, Cascade Natural Gas, WP Natural Gas, and Idaho Power.

Oregon BUILDING CODES DIVISION

OREGON STATE UNIVERSITY EXTENSION SERVICE

Recessed Lights

This pamphlet is one in a series that describes residential energy conservation requirements of the Oregon Residential Specialty Code and the Structural Specialty Code for Group R buildings three stories and less in height. Other pamphlets in this series may be obtained from Oregon Dept of Energy at www.oregon.gov/energy/ or local building departments or from Oregon Building Codes Division.

The Oregon residential energy 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.

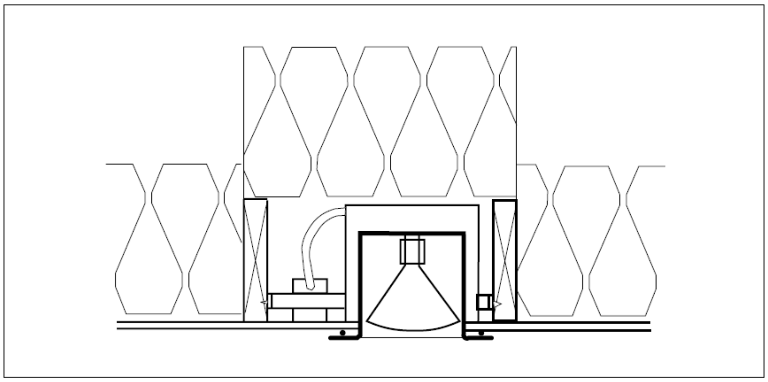
Recessed lights act as chimneys for heat loss and moisture transfer into attic spaces. Thus the restriction also has energy and moisture control benefits.

An exception to the recessed light restriction is allowed if the fixture is “IC-” (insulation cover-) rated. IC-rated lights are typically “double can” fixtures, with one can inside another. The outer can (in contact with insulation) is tested to make sure it remains cool enough to avoid a fire hazard.

Look closely at product literature for the IC rating. The IC rating is also stamped on the fixture. If you do not see “IC,” the fixture cannot be installed in cavities 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 and above the fixture. Code does not require replacing non-IC rated lights in existing buildings.

Figure 1:
IC-Rated recessed light



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Oregon BUILDING CODES DIVISION

OREGON STATE UNIVERSITY EXTENSION SERVICE

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 the Structural Specialty Code for Group R buildings three stories and less in height. Other pamphlets in this series may be obtained from Oregon Dept of Energy at www.oregon.gov/energy/ or local building departments or from Oregon Building Codes Division.

Energy 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

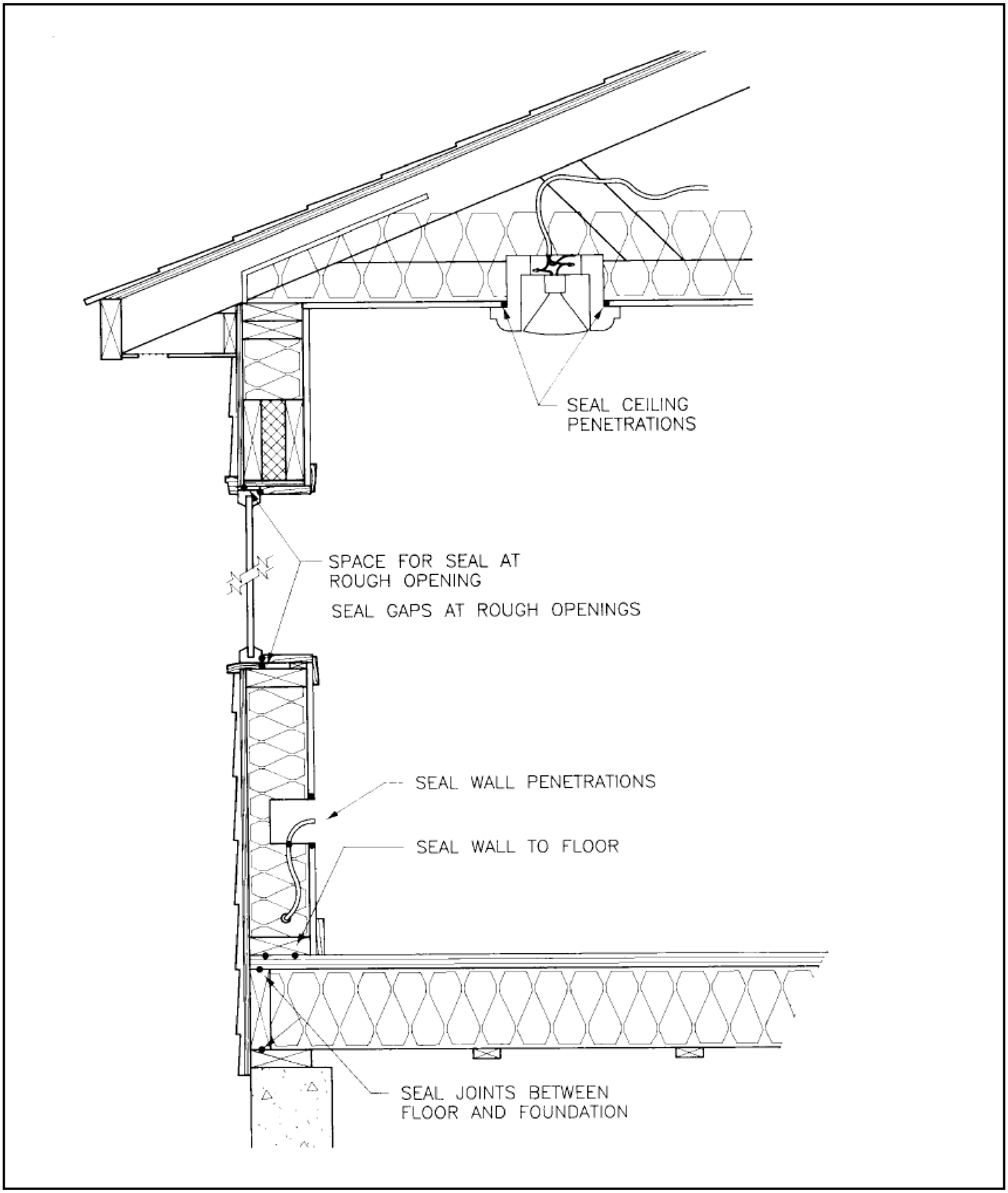


Figure 2:
Sealing the tub penetration

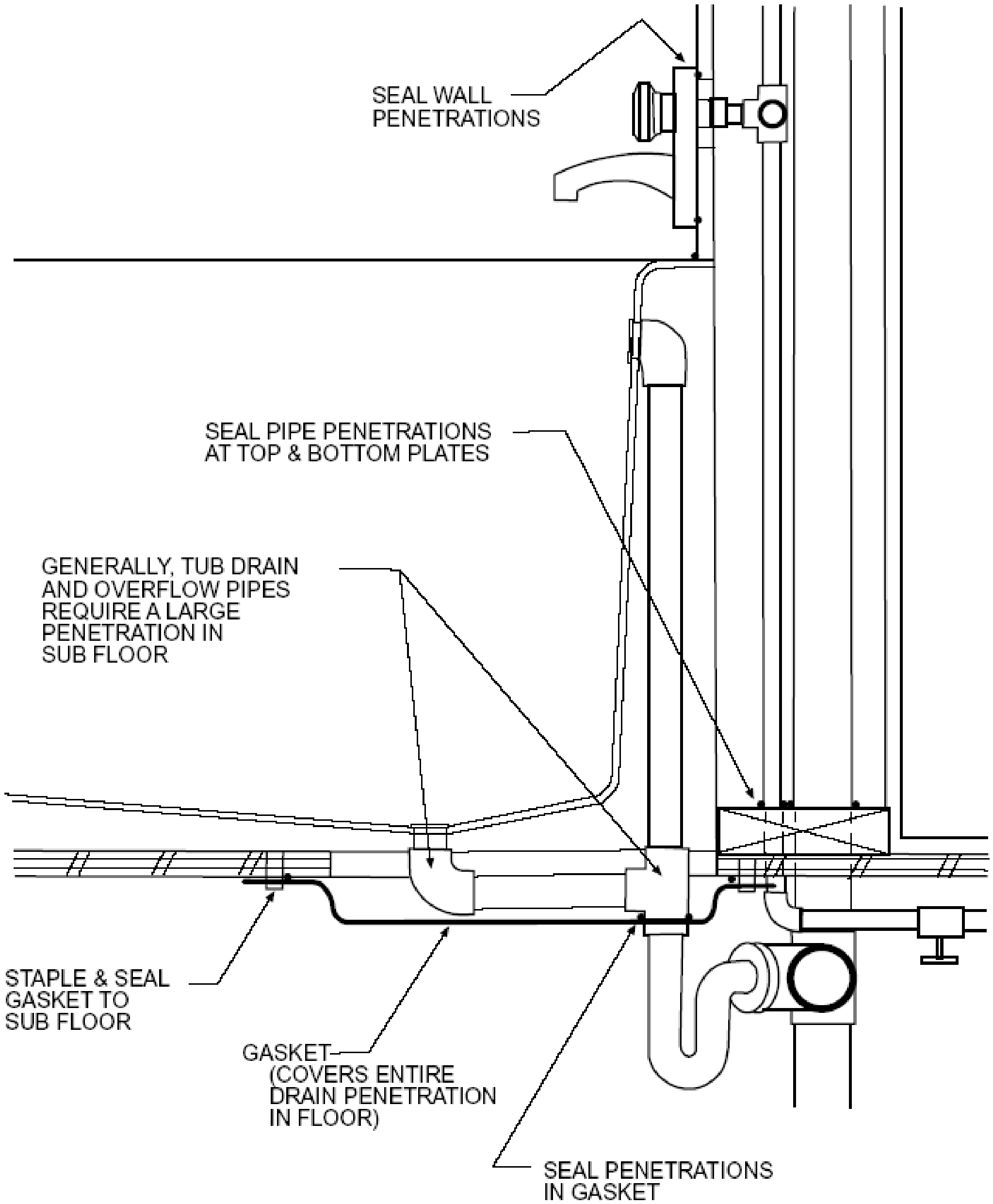
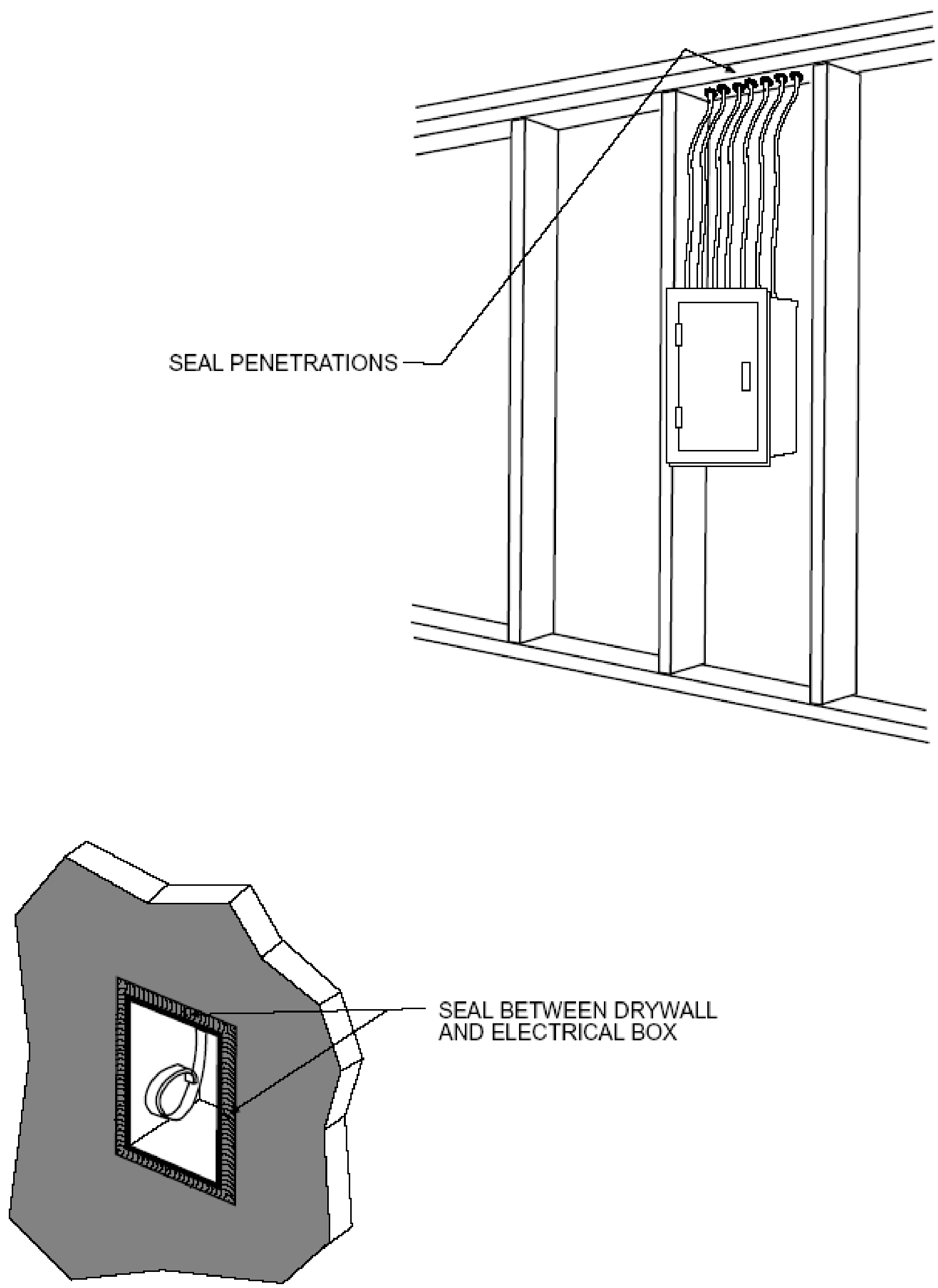


Figure 3:
Sealing electrical penetrations



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.

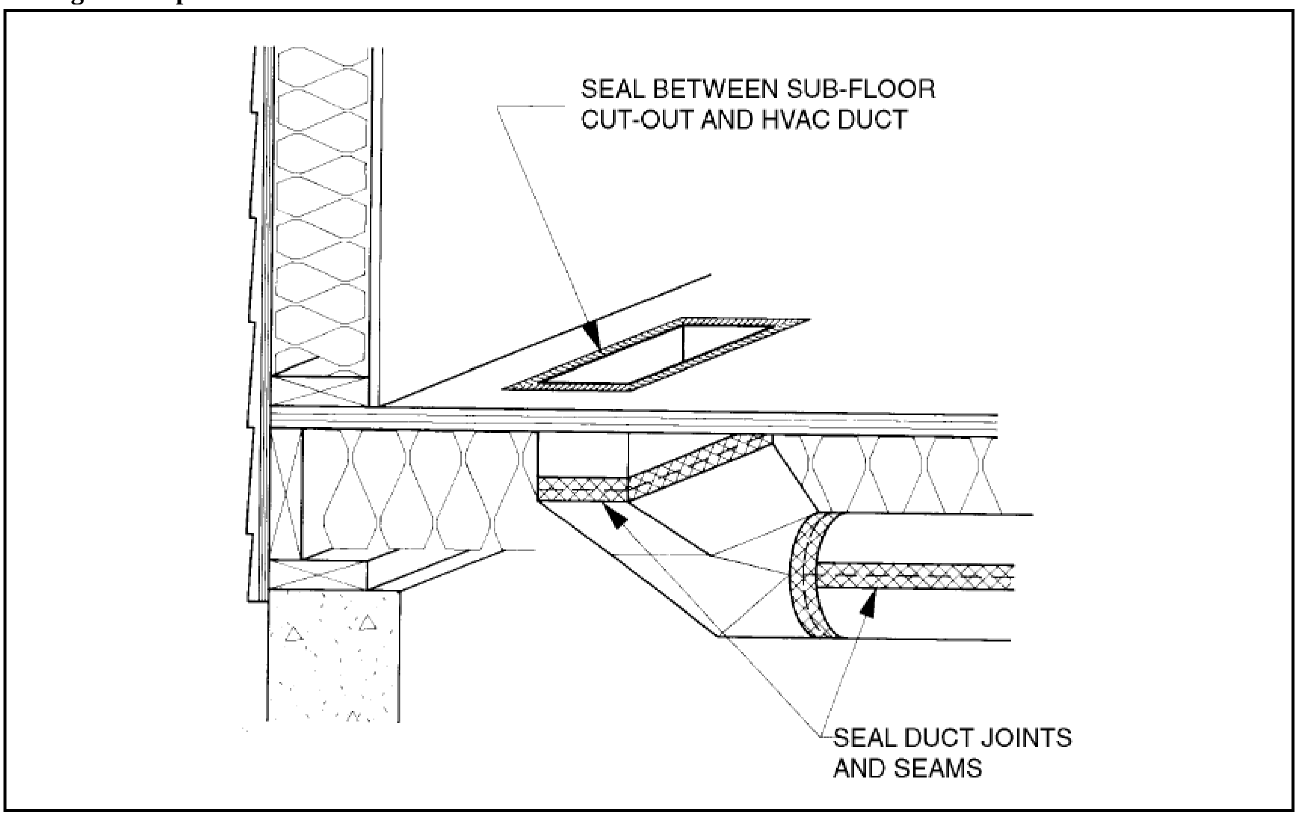
Joints between the wall and ceiling

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.

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Oregon BUILDING CODES DIVISION

OREGON STATE UNIVERSITY EXTENSION SERVICE

Moisture Control Measures

This pamphlet is one in a series that describes residential energy conservation requirements of the Oregon Residential Specialty Code and the Structural Specialty Code for Group R buildings three stories and less in height. Other pamphlets in this series may be obtained from Oregon Dept of Energy at www.oregon.gov/energy/ or local building departments or from Oregon Building Codes Division.

Moisture control measures required by the Oregon Residential Energy 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. Polyethylene sheets may serve as vapor retarders for unfaced insulation. 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

Energy 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 or polyethylene sheets 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.

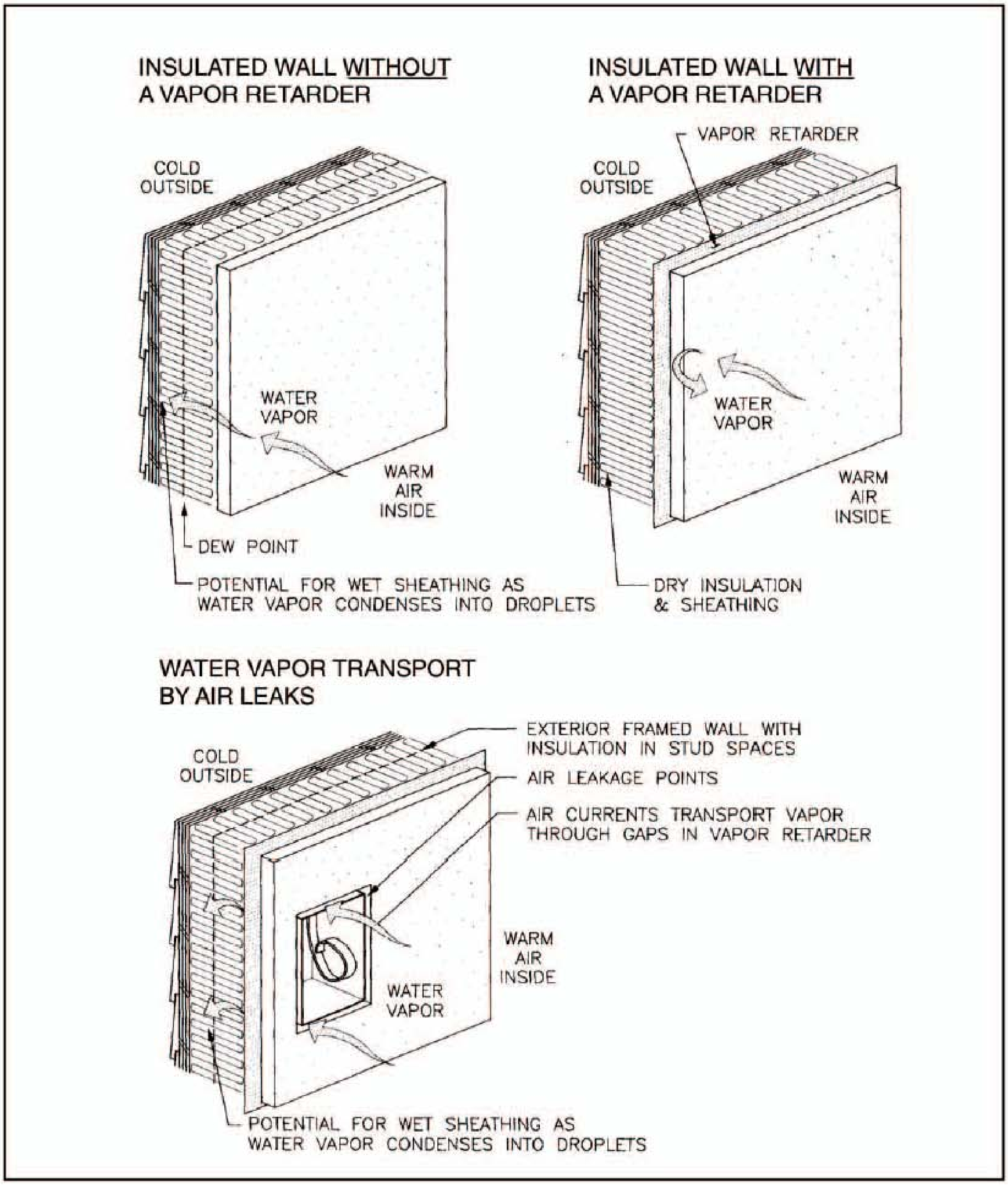
Don't confuse the floor vapor barrier with the ground moisture barrier. They are two separate code requirements.

Slab floors do not require vapor retarders.

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 0.5 perm vapor retarder is required in ceilings without attic spaces above them, such as single rafter vaults. Polyethylene sheets meet this requirement and can be used with unfaced batts. Foil faced batts also meet this requirement. If faced batts are used, code requires that flanges be lapped and stapled at framing members to provide a more continuous barrier to moisture penetration. Some, but not all, vapor retarder paints have a tested perm rating of 0.5 or less. 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.

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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.

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

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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.

Combustion air requirements

Energy 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.

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How to Show Energy Code Information on the Plan

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Using prescriptive options

The following drawings show typical components of residential buildings and energy code details for each path in Table N1104.1(1), "Prescriptive Compliance Paths for Residential Buildings." The drawings are examples and show only energy code details.

Use the drawings and Table N1104.1(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(2), "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 "Base Path" code measures.

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Figure 1:
Energy Code details for prescriptive path 1

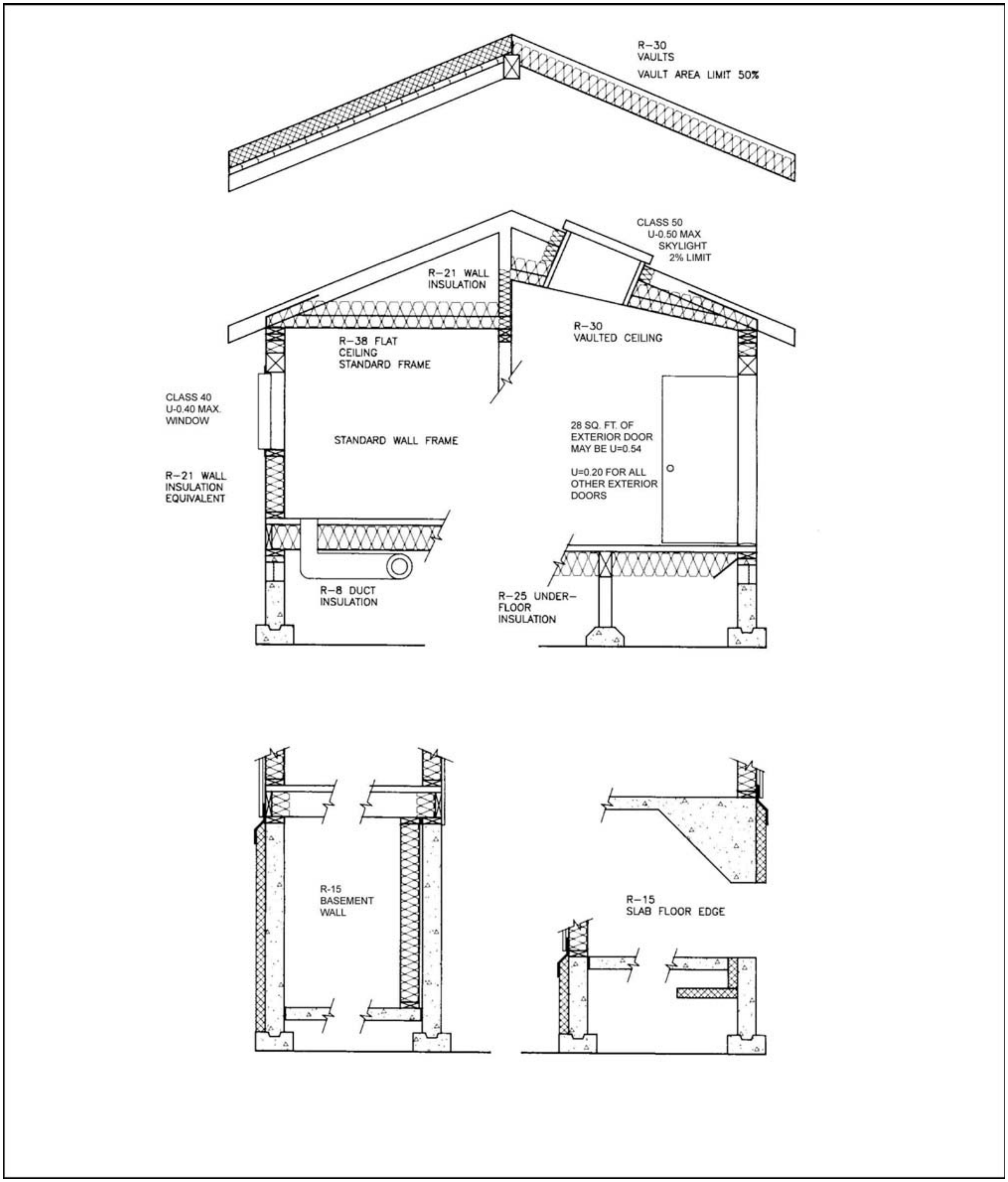
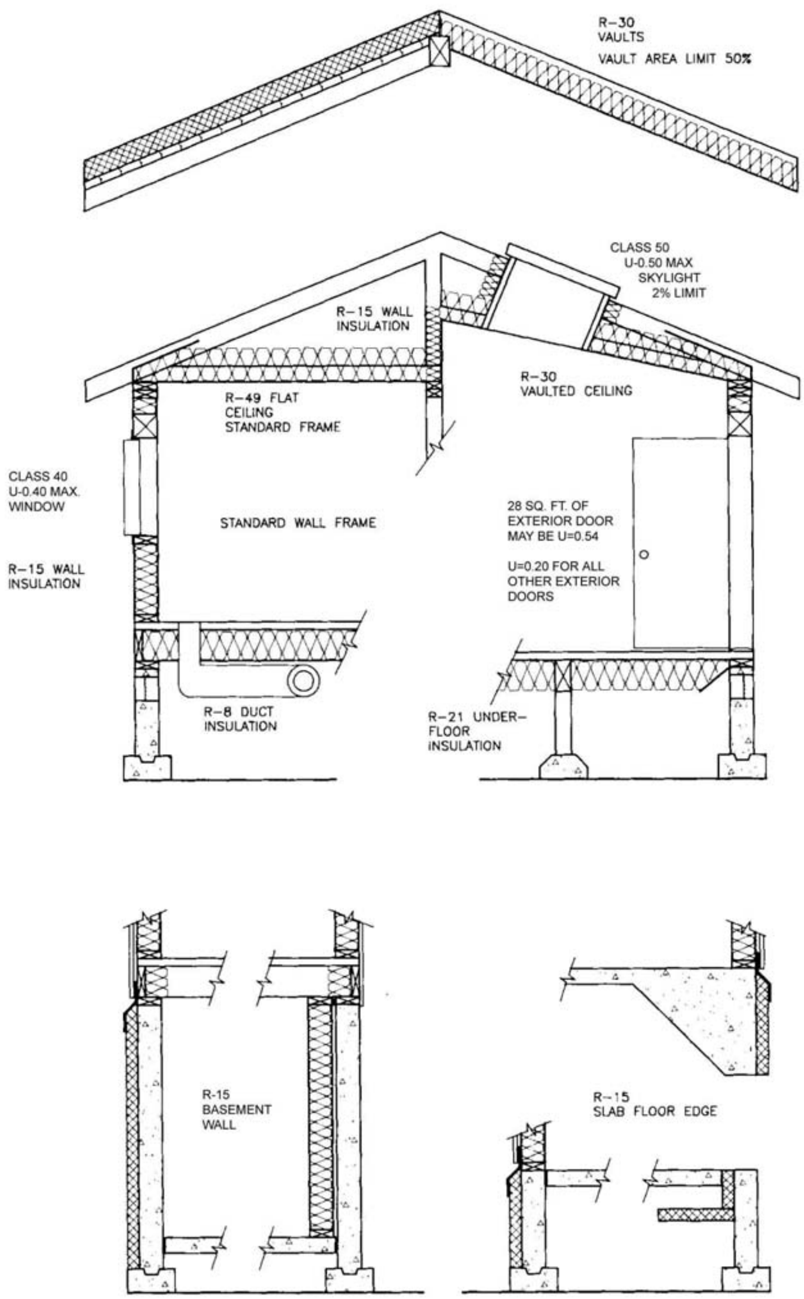


Figure 2:
Energy Code details for prescriptive path 2 - Sun Tempered



- Street orientation within 30° of true east/west or approved alternative
- 50 percent south glazing

Figure 3:
Energy Code details for prescriptive path 3

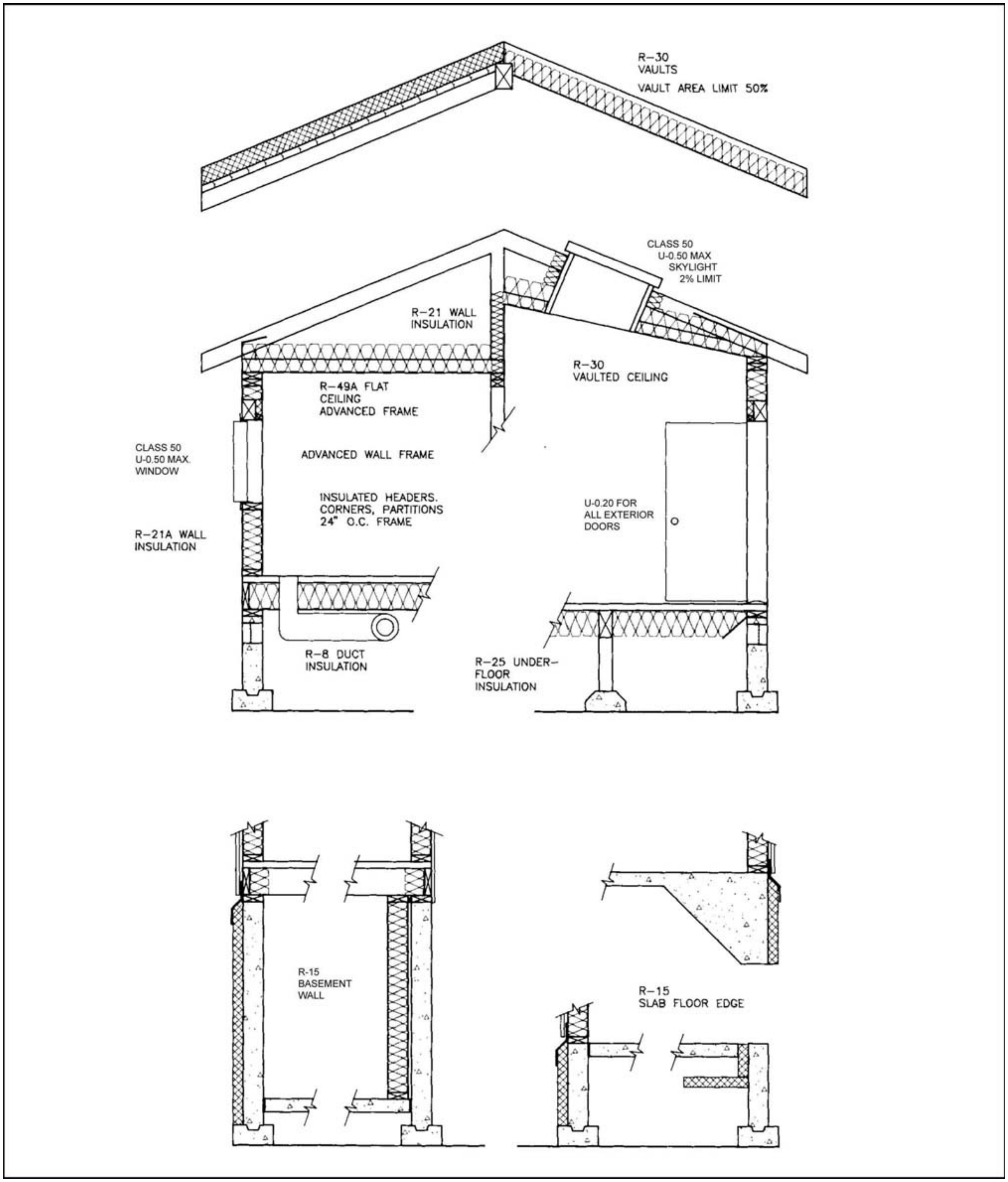
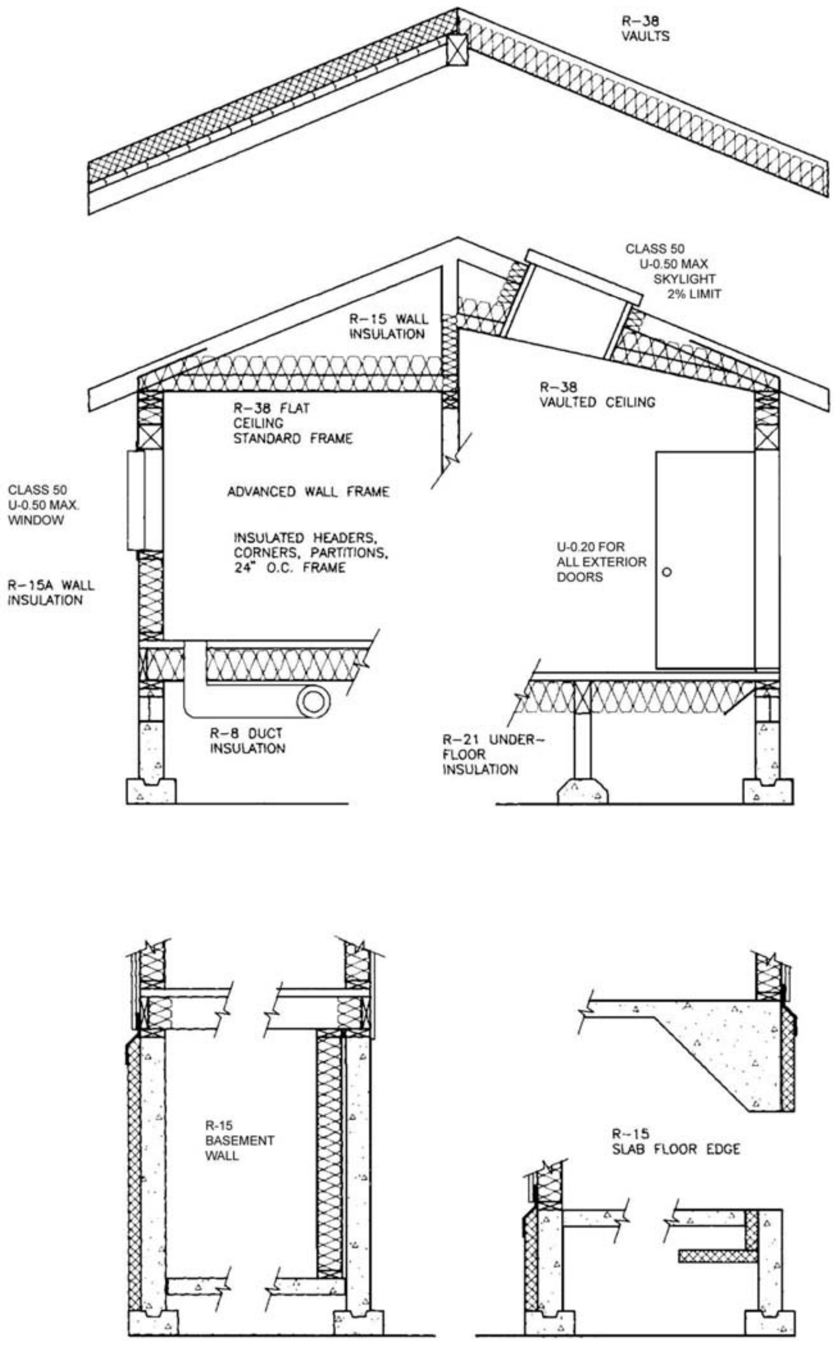


Figure 4:
Energy Code details for prescriptive path 4 - Sun Tempered



- Street orientation within 30° of true east/west or approved alternative
- 50 percent south glazing

Figure 5:
Energy Code details for prescriptive path 5

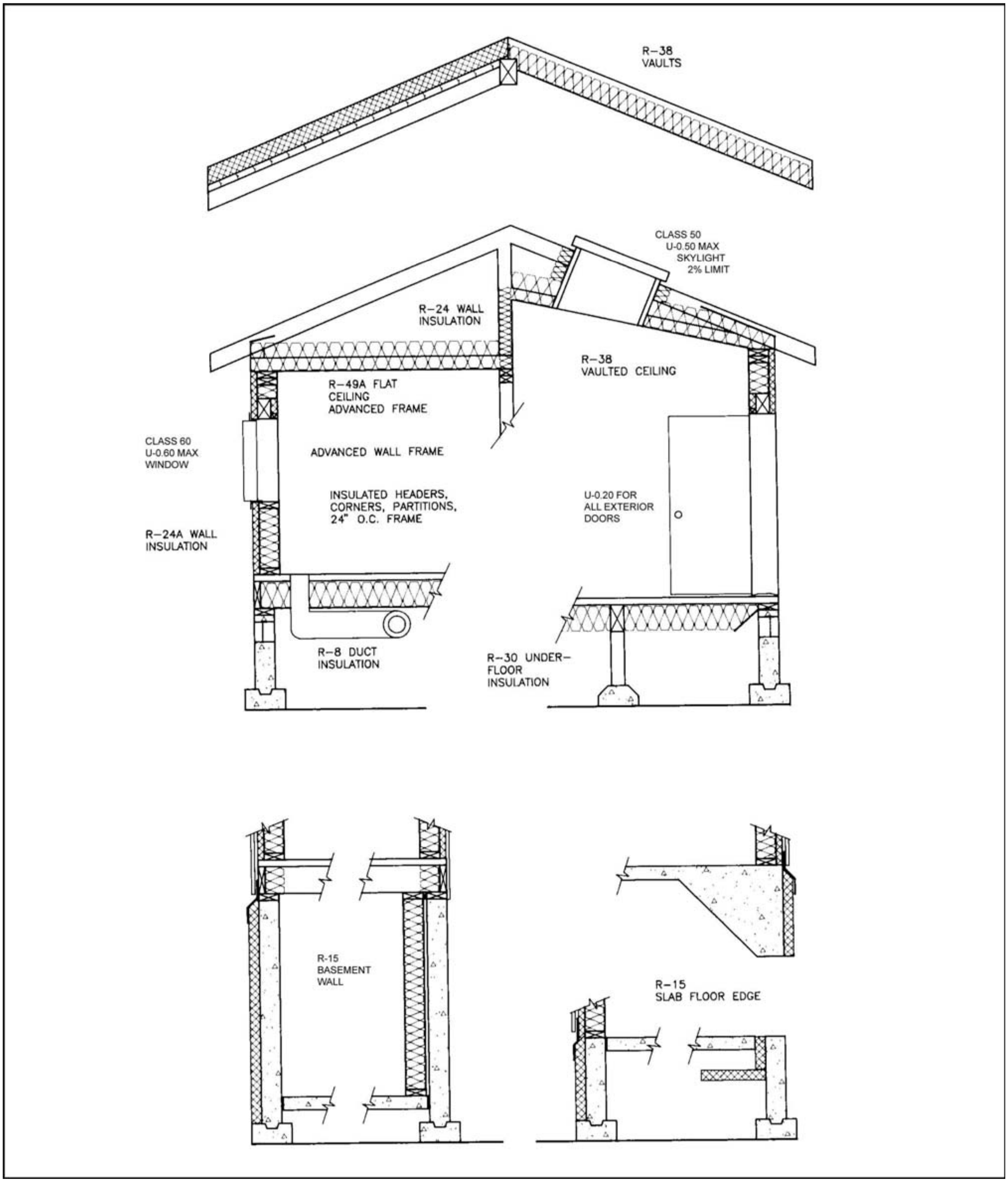
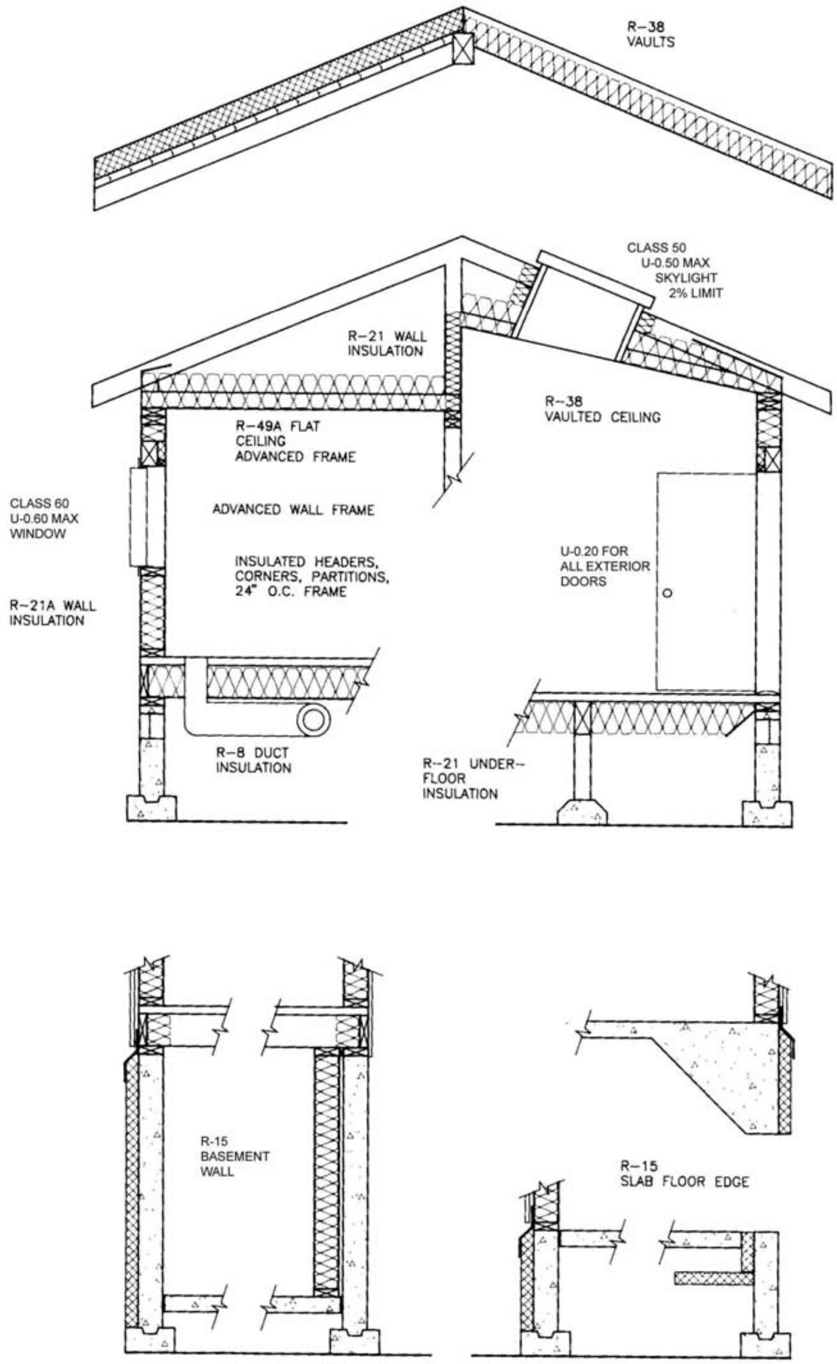
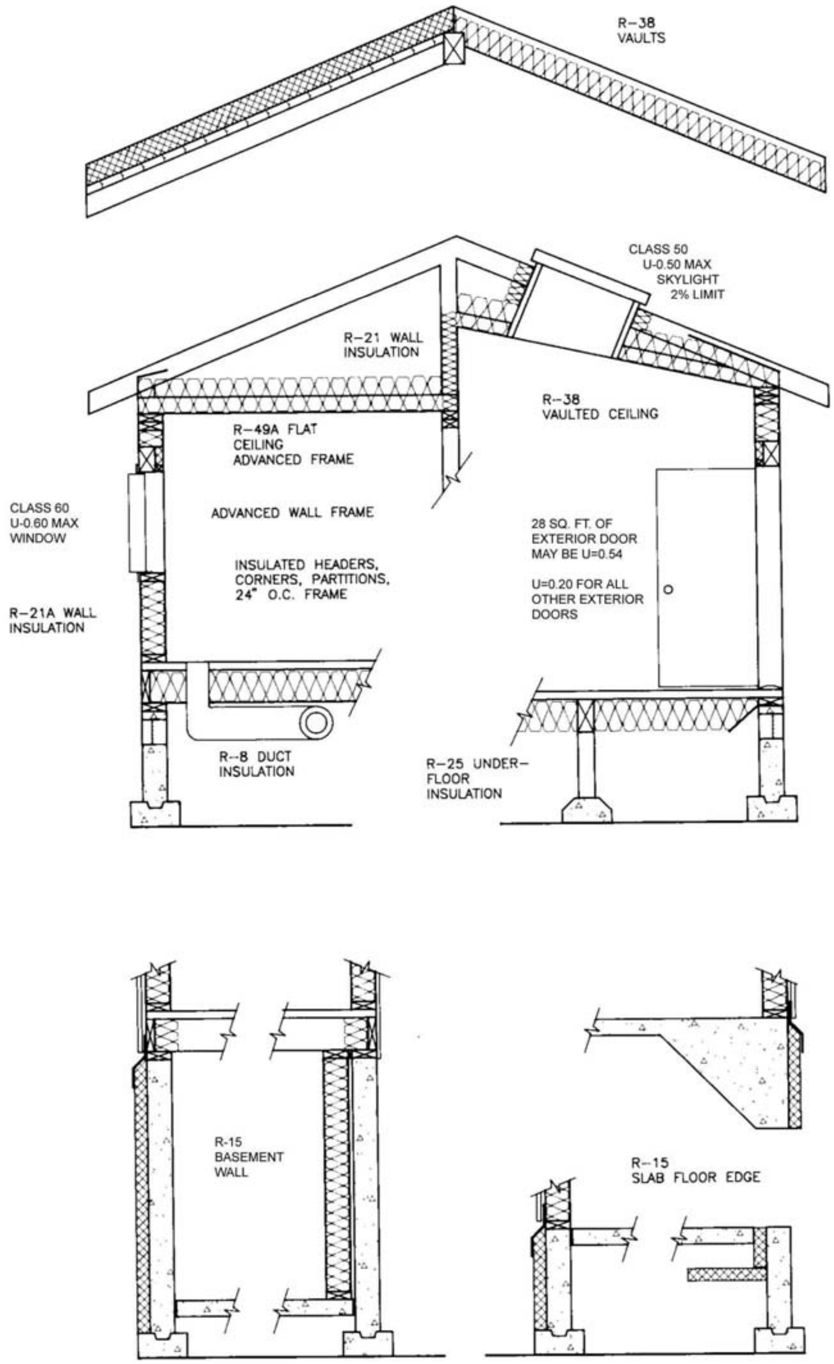


Figure 6:
Energy Code details for prescriptive path 6 - Sun Tempered



- Street orientation within 30° of true east/west or approved alternative
- 50 percent south glazing

Figure 7:
Energy Code details for prescriptive path 7 - Sun Tempered



- Street orientation within 30° of true east/west or approved alternative
- 50 percent south glazing

Figure 8:
Energy Code details for prescriptive path 8

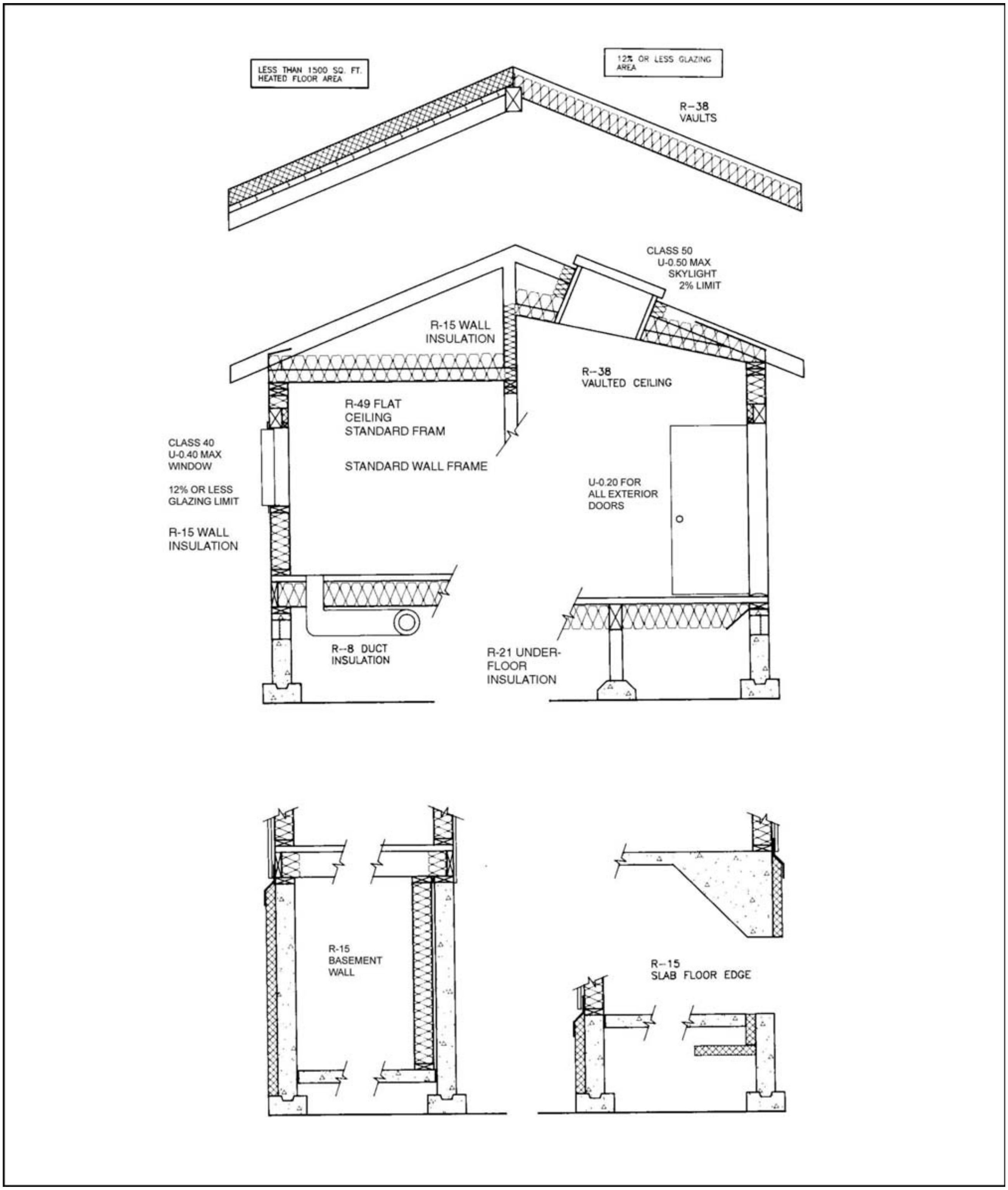


Figure 9:
Energy Code details for prescriptive path 9

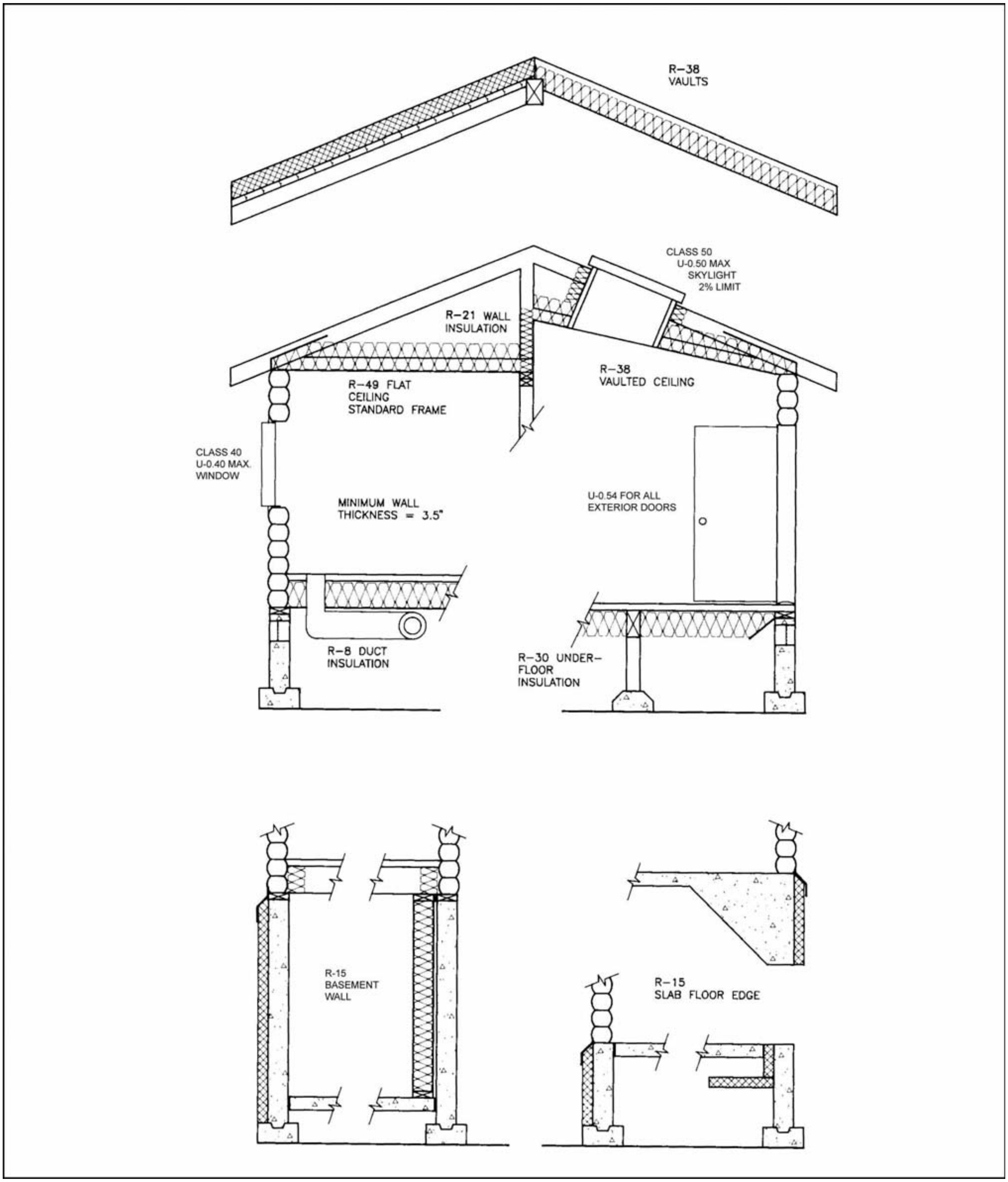
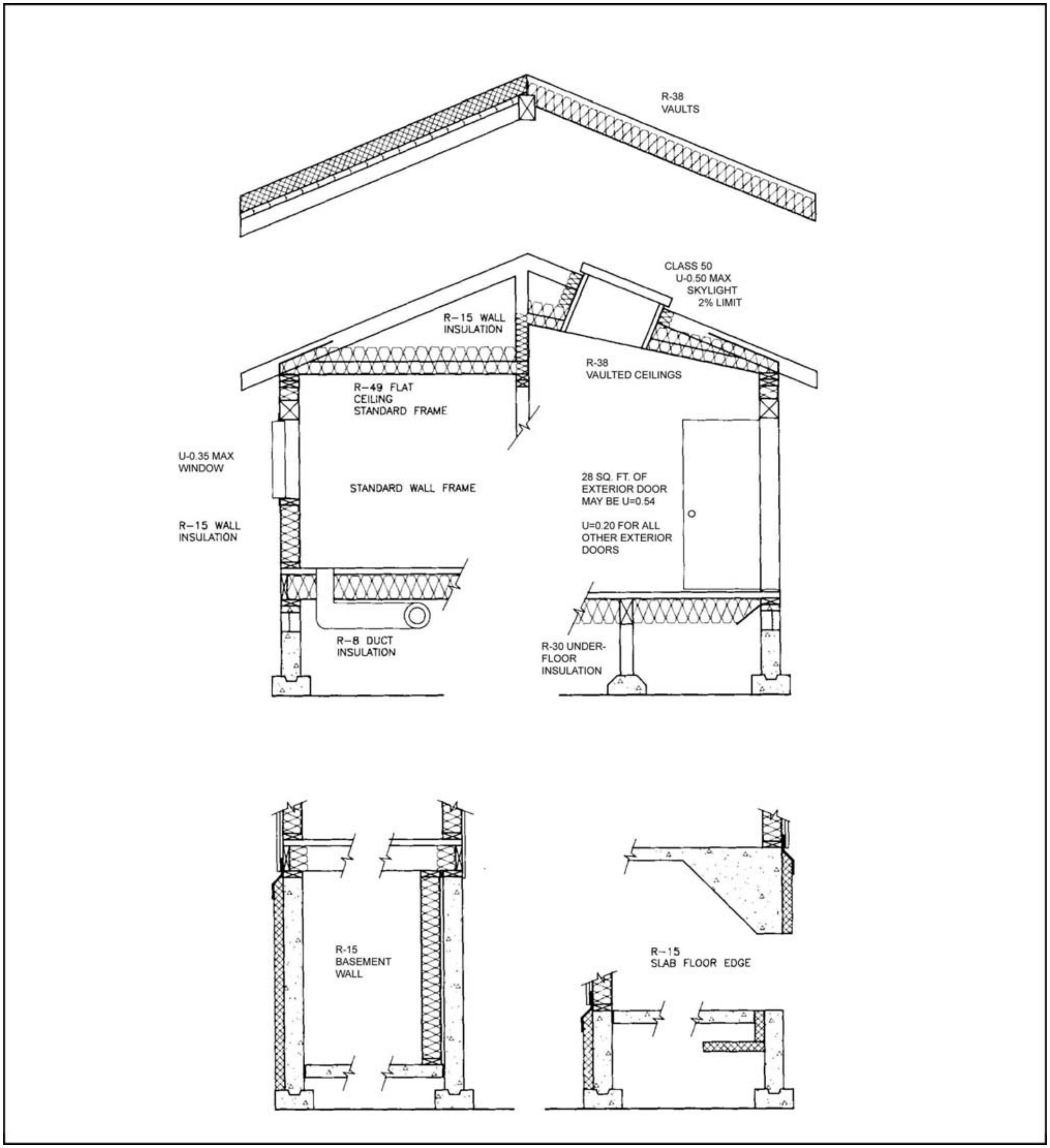


Figure 10:
Energy Code details for prescriptive path 10



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R-Value Codes for Unfaced Insulation Batts

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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
38	HD*	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

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