



Residential Requirements of the 2009 International Energy Conservation Code

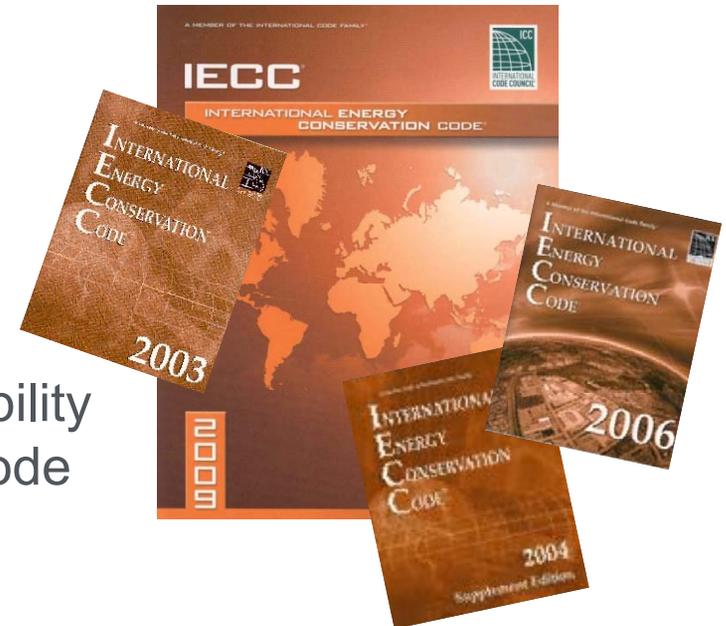
August 2010

PNNL-SA-65859

The Family of I-Codes



- International Building Code
- International Mechanical Code
- International Fuel Gas Code
- International Property Maintenance Code
- International Fire Code
- International Zoning Code
- International Plumbing Code
- Code Requirements for Housing Accessibility
- International Private Sewage Disposal Code
- ICC Electrical Code
- International Residential Code
- International Energy Conservation Code



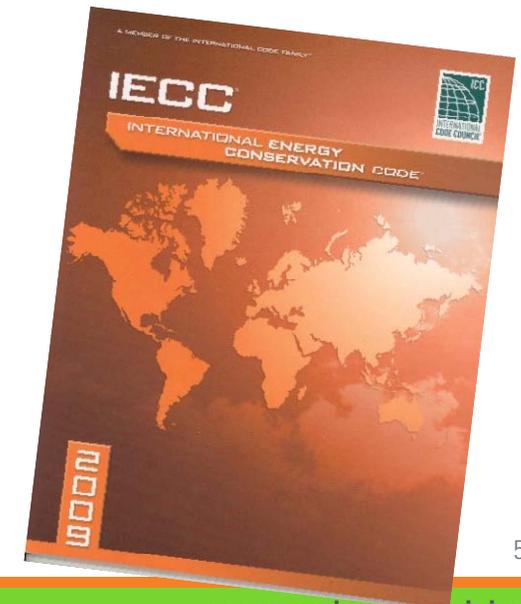
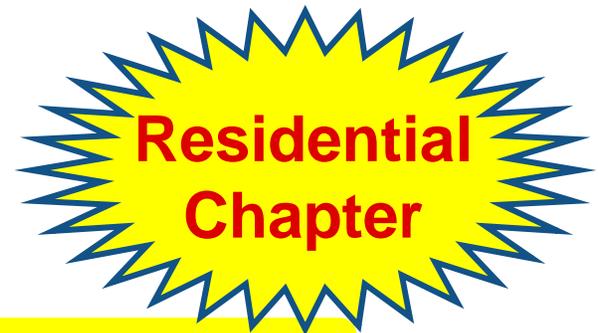
- IECC addresses only energy
- IRC addresses all topics (structural, plumbing, etc.)
 - Allows builder to carry only one code book
 - Chapter 11 covers energy efficiency
- IRC allows compliance with IECC as an alternative to Chapter 11
- IECC addresses both residential and commercial; IRC addresses subset of residential detached one- and two-family dwellings and townhouses 3 stories or fewer
- Energy requirements in IRC and IECC almost identical
 - IRC requires 0.35 SHGC in Climate Zones 1-3; IECC requires 0.30
 - IRC has less stringent foundation requirements in northern zones
 - Other minor differences

What's Changed Since IECC 2006?

- Some envelope requirements more stringent
- New requirements added
 - Building envelope tightness verification
 - Duct leakage pressure test
 - Lighting efficacy limits
 - Pool controls and covers
 - Snow melt controls
- Moisture control requirements (e.g., vapor retarders) moved to IRC
- No mechanical trade-offs allowed
- A few performance path assumptions changed

Structure of the IECC

- Chapter 1 Administrative
- Chapter 2 Definitions
- Chapter 3 Climate Zones
- **Chapter 4 Residential Energy Efficiency**
- Chapter 5 Commercial Energy Efficiency
- Chapter 6 Referenced Standards





Residential Buildings:

- IECC has one- and two-family R-2, R-3, R-4 ≤ 3 stories
- All buildings that are not “residential” by definition are “commercial”
- Includes additions, alterations, renovations and repairs

- Very low energy use buildings (<3.4 Btu/h-ft² or 1 watt/ft²)
- Buildings (or portions of) that are neither heated nor cooled
- Existing buildings (Section 101.4.1)
 - Electrical power, lighting, and mechanical systems still apply
- Buildings designated as historic (Section 101.4.2)

Scope - Additions, Alterations, Renovations, Repairs



- Code applies to any new construction
- Unaltered portion(s) do not need to comply
- Additions can comply alone or in combination with existing building
- Replacement fenestration that includes both glazing and sash must meet
 - 0.30 SHGC in Climate Zones 1-3
 - U-factors in all Zones

Scope - Additions, Alterations, Renovations, Repairs

- Exceptions
 - Storm windows over existing fenestration
 - Glass-only replacements
 - Exposed, existing ceiling, wall or floor cavities if already filled with insulation
 - Where existing roof, wall or floor cavity isn't exposed
 - Reroofing for roofs where neither sheathing nor insulation exposed
 - Insulate above or below the sheathing
 - Roofs without insulation in the cavity
 - Sheathing or insulation is exposed
 - Provided installed interior lighting power isn't increased and
 - < 50% of luminaires in a space are replaced
 - Only bulb and ballast within existing luminaires in a space are replaced
- Any nonconditioned space that is altered to become conditioned space is required to be brought into full compliance with code.

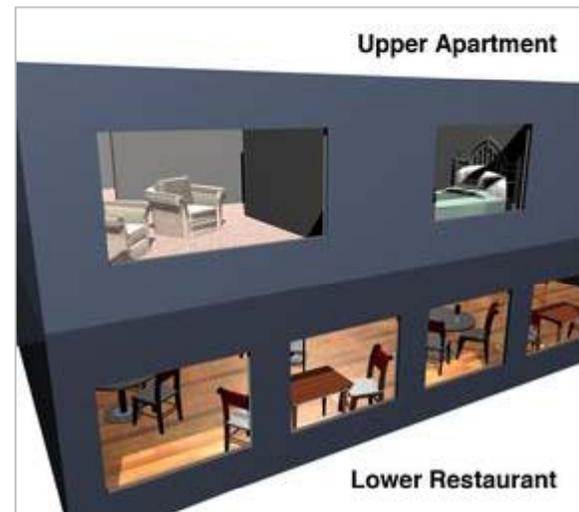
- Any nonconditioned space that is altered to become conditioned space shall be required to be brought into full compliance with this code

Examples:

- Converting a garage to a family room
- Heating a basement

Scope - Mixed Use Buildings

- Treat the residential occupancy under the applicable residential code
- Treat the commercial occupancy under the commercial code



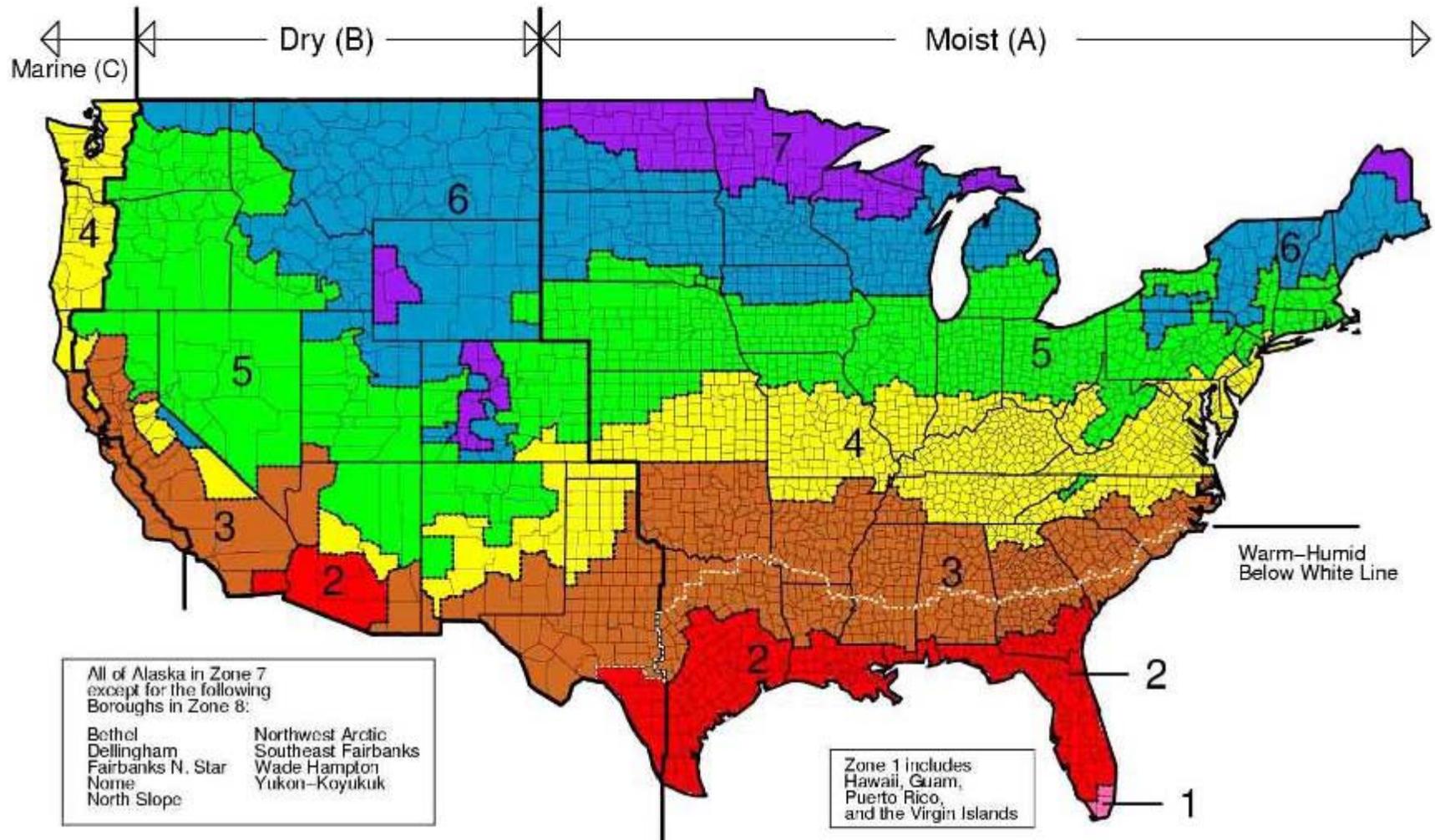
Climate-Specific Requirements:

- Foundations
 - Basements
 - Slabs
 - Crawlspace
- Above grade walls
- Skylights, windows, and doors
- Roofs
- Solar Heat Gain Coefficient in warm climates

Universal Requirements (apply everywhere):

- Duct insulation and sealing
- Infiltration control

Climate Zones for the 2009 IECC



Overview of Residential Code Requirements

- Focus is on building envelope
 - Ceilings, walls, windows, floors, foundations
 - Sets insulation and fenestration levels, and solar heat gain coefficients
 - Infiltration control - caulk and seal to prevent air leaks
- Ducts – seal and insulate
- Limited space heating, air conditioning, and water heating requirements
 - Federal law sets most equipment efficiency requirements, not the I-codes
- No appliance requirements
- Lighting equipment – 50% of lamps to be high-efficacy lamps

Insulation and Fenestration Requirements by Climate Zone

Table 402.1.1
Insulation and Fenestration Requirements by Component

| CLIMATE ZONE | FENESTRATION U-FACTOR ^b | SKYLIGHT ^b U-FACTOR | GLAZED FENESTRATION ^{b,e} SHGC | CEILING R-VALUE | WOOD FRAME WALL R-VALUE | MASS WALL R-VALUE ⁱ | FLOOR R-VALUE | BASEMENT ^c WALL R-VALUE | SLAB ^d R-VALUE & DEPTH | CRAWL SPACE ^c WALL R-VALUE |
|-----------------|------------------------------------|--------------------------------|---|-----------------|-------------------------|--------------------------------|-----------------|------------------------------------|-----------------------------------|---------------------------------------|
| 1 | 1.20 | 0.75 | 0.30 | 30 | 13 | 3 / 4 | 13 | 0 | 0 | 0 |
| 2 | 0.65 ^j | 0.75 | 0.30 | 30 | 13 | 4 / 6 | 13 | 0 | 0 | 0 |
| 3 | 0.50 ^j | 0.65 | 0.30 | 30 | 13 | 5 / 8 | 19 | 5 / 13 ^f | 0 | 5 / 13 |
| 4 except Marine | 0.35 | 0.60 | NR | 38 | 13 | 5 / 10 | 19 | 10 / 13 | 10, 2ft | 10 / 13 |
| 5 and Marine 4 | 0.35 | 0.60 | NR | 38 | 20 or 13+5 ^h | 13 / 17 | 30 ^g | 10 / 13 | 10, 2 ft | 10 / 13 |
| 6 | 0.35 | 0.60 | NR | 49 | 20 or 13+5 ^h | 15 / 19 | 30 ^g | 15 / 19 | 10, 4 ft | 10 / 13 |
| 7 and 8 | 0.35 | 0.60 | NR | 49 | 21 | 19 / 21 | 38 ^g | 15 / 19 | 10, 4 ft | 10 / 13 |

^a *R*-values are minimums, *U*-factors and SHGC are maximums, *R*-19 batts compressed into a nominal 2 x 6 framing cavity such that the *R*-value is reduced by *R*-1 or more shall be marked with the compressed batt *R*-value in addition to the full thickness *R*-value.

^b The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.

^c "15/19" means *R*-15 continuous insulated sheathing on the interior or exterior of the home or *R*-19 cavity insulation at the interior of the basement wall. "15/19" shall be permitted to be met with *R*-13 cavity insulation on the interior of the basement wall plus *R*-5 continuous insulated sheathing on the interior or exterior of the home. "10/13" means *R*-10 continuous insulated sheathing on the interior or exterior of the home or *R*-13 cavity insulation at the interior of the basement wall.

^d *R*-5 shall be added to the required slab edge *R*-values for heated slabs. Insulation depth shall be the depth of the footing or 2 feet, whichever is less in Zones 1 through 3 for heated slabs.

^e There are no SHGC requirements in the Marine Zone.

^f Basement wall insulation is not required in warm-humid locations as defined by Figure 301.1 and Table 301.1.

^g Or insulation sufficient to fill the framing cavity, *R*-19 minimum.

^h "13+5" means *R*-13 cavity insulation plus *R*-5 insulated sheathing. If structural sheathing covers 25 percent or less of the exterior, insulating sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25 percent of exterior, structural sheathing shall be supplemented with insulated sheathing of at least *R*-2.

ⁱ The second *R*-value applies when more than half the insulation is on the interior of the mass wall.

^j For impact rated fenestration complying with Section R301.2.1.2 of the *IRC* or Section 1608.1.2 of the *IBC*, maximum *U*-factor shall be 0.75 in Zone 2 and 0.65 in Zone 3.

- U-factor Alternative
 - Similar to Prescriptive R-Value but uses U-factors instead.
 - Allows for innovative or less common construction techniques such as structural insulated panels or advanced framing
 - Allows no trade offs between building components
- Total UA Alternative
 - Same as U-factor alternative but allows trade-offs across all envelope components
 - Primary approach used in REScheck software

UA – U factor x area of assembly

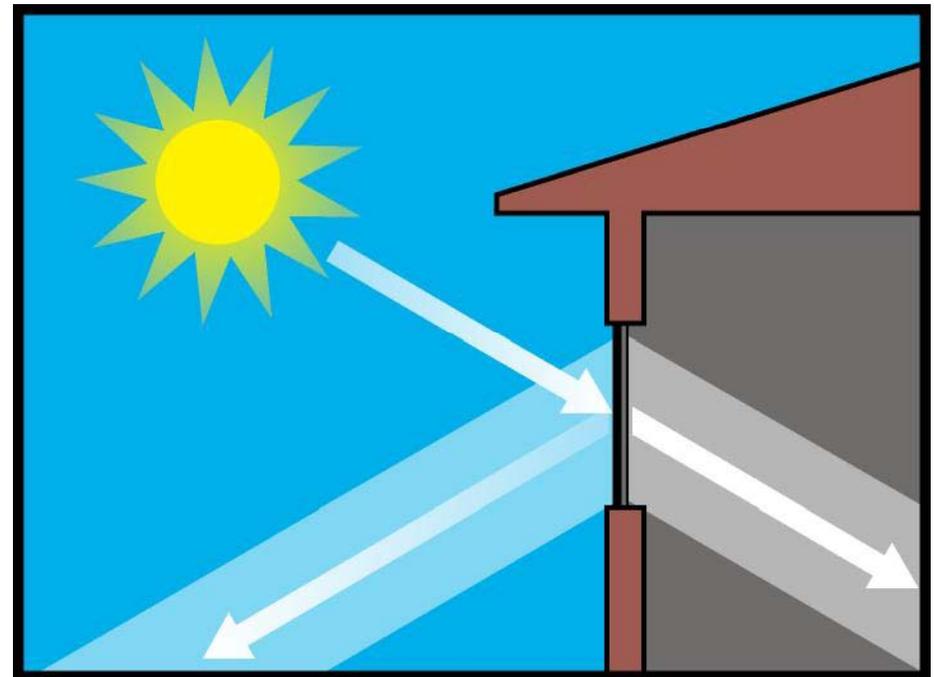
- Hard limits on U-factor in northern U.S. (cannot be exceeded, even in trade-offs)

| Climate Zones | U-Factor Maximum |
|---------------|------------------|
| 4-5 | 0.48 |
| 6-8 | 0.40 |

- U-0.75 for skylights in Zones 4-8
- These are based on building average; U-factors of individual windows or skylights can be higher if maximum area-weighted average is below these limits.

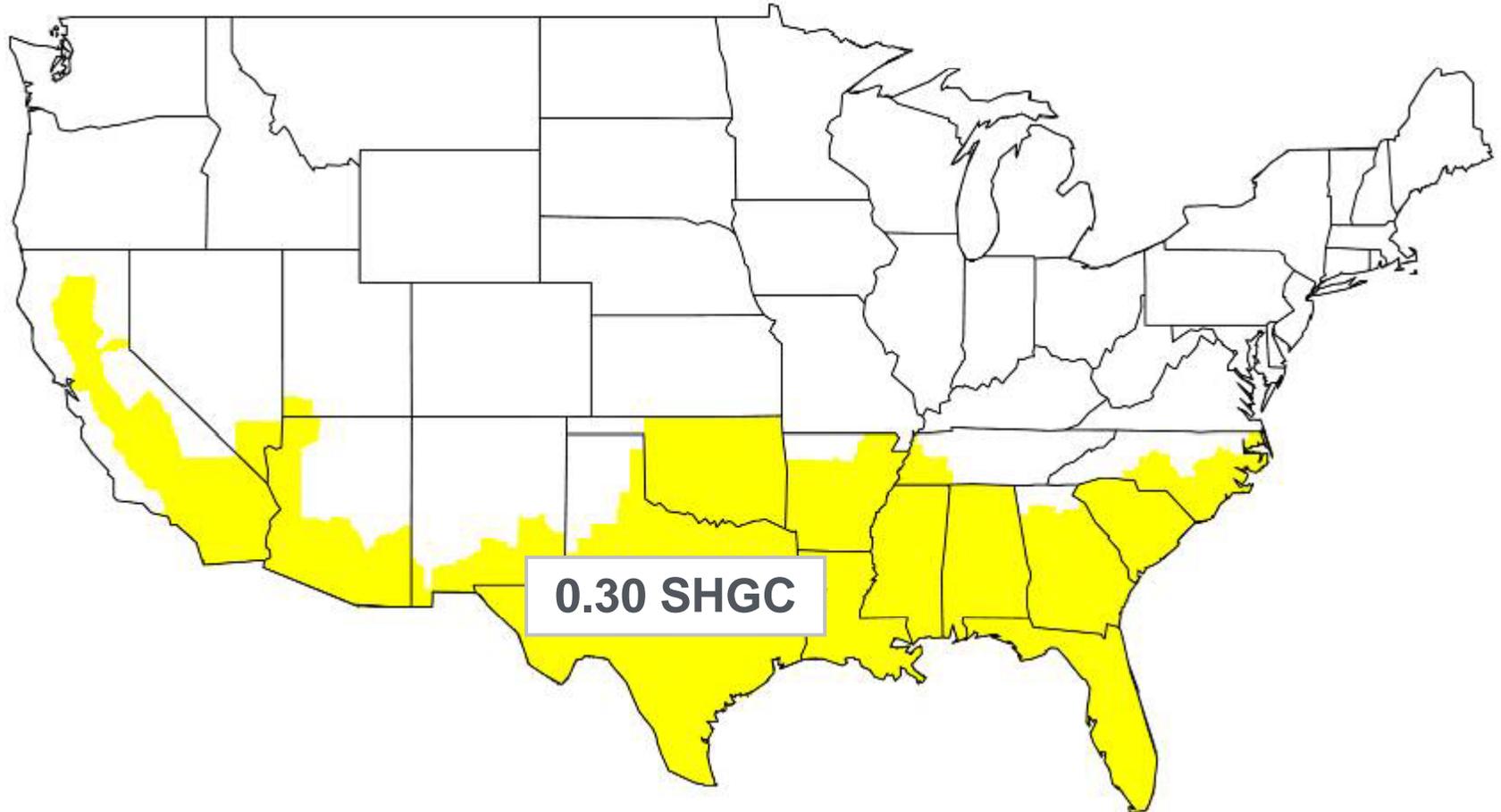
Fenestration Trade-off Limits, cont'd.

- Hard limit on Solar Heat Gain Coefficient in southern U.S. (Zones 1-3)
 - SHGC cannot exceed 0.50, even in performance trade-offs



Solar Heat Gain Coefficient

Locations with Window SHGC Requirements



Requirements by Climate Zone (U-Factor Table)

**Table 402.1.3
Equivalent U-Factors**

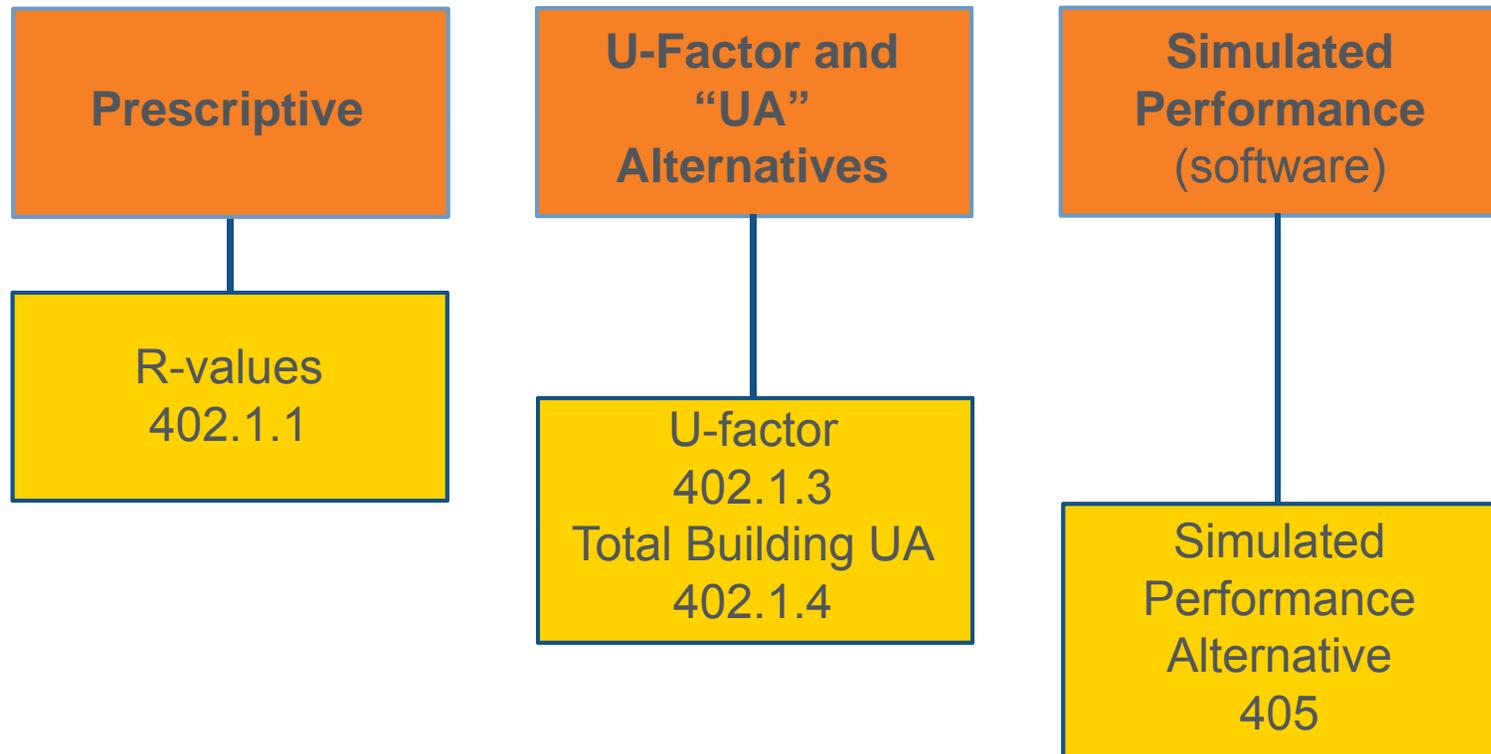
| CLIMATE ZONE | FENESTRATION U-FACTOR | SKYLIGHT U-FACTOR | CEILING U-FACTOR | FRAME WALL U-FACTOR | MASS WALL U-FACTOR ^b | FLOOR U-FACTOR | BASEMENT WALL U-FACTOR ^d | CRAWL SPACE WALL U-FACTOR ^c |
|-----------------|-----------------------|-------------------|------------------|---------------------|---------------------------------|----------------|-------------------------------------|--|
| 1 | 1.20 | 0.75 | 0.035 | 0.082 | 0.197 | 0.064 | 0.360 | 0.477 |
| 2 | 0.65 | 0.75 | 0.035 | 0.082 | 0.165 | 0.064 | 0.360 | 0.477 |
| 3 | 0.50 | 0.65 | 0.035 | 0.082 | 0.141 | 0.047 | 0.091 ^c | 0.136 |
| 4 except Marine | 0.35 | 0.60 | 0.030 | 0.082 | 0.141 | 0.047 | 0.059 | 0.065 |
| 5 and Marine 4 | 0.35 | 0.60 | 0.030 | 0.057 | 0.082 | 0.033 | 0.059 | 0.065 |
| 6 | 0.35 | 0.60 | 0.026 | 0.057 | 0.060 | 0.033 | 0.050 | 0.065 |
| 7 and 8 | 0.35 | 0.60 | 0.026 | 0.057 | 0.057 | 0.028 | 0.050 | 0.065 |

^a. Nonfenestration *U*-factors shall be obtained from measurement, calculation or an approved source.

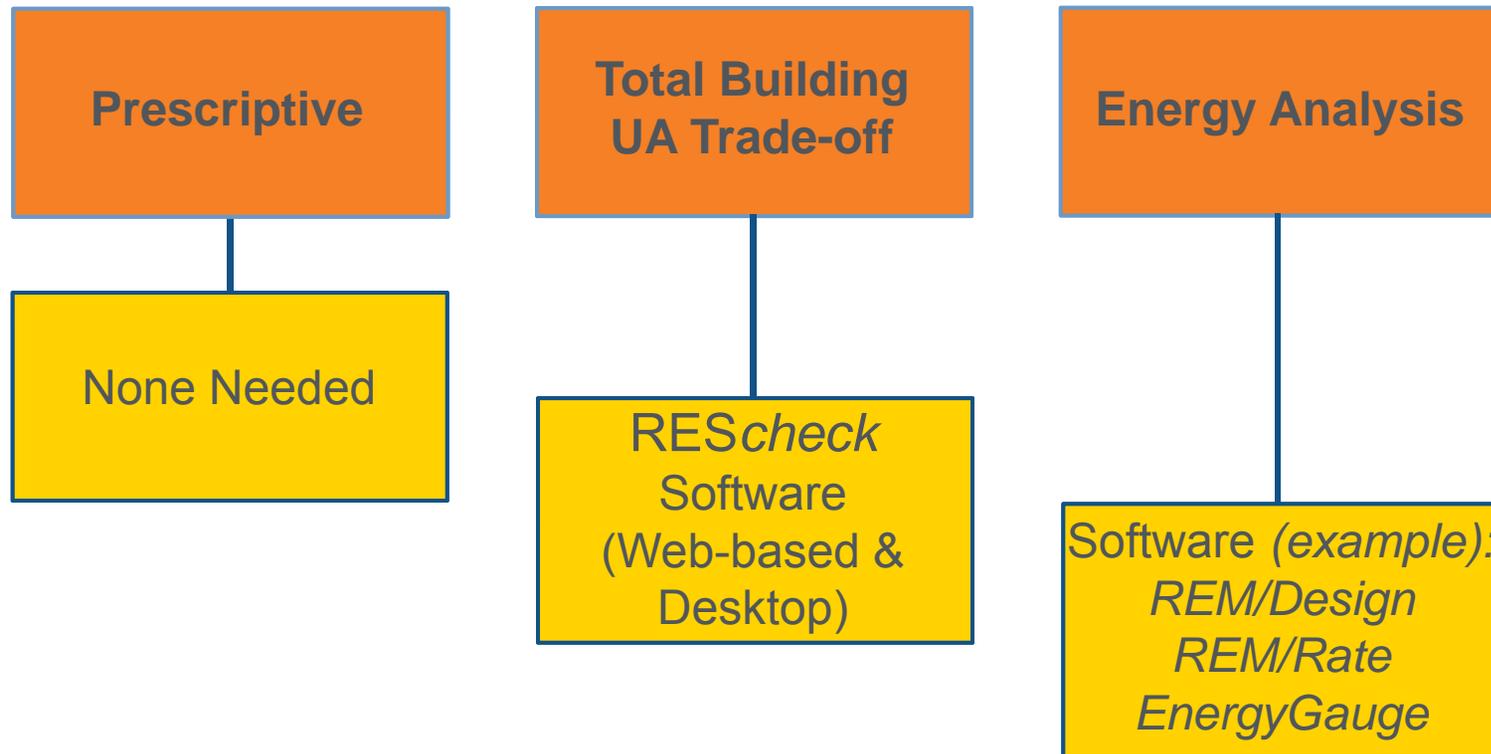
^b. When more than half the insulation is on the interior, the mass wall *U*-factors shall be a maximum of 0.17 in Zone 1, 0.14 in Zone 2, 0.12 in Zone 3, 0.10 in Zone 4 except Marine, and the same as the frame wall *U*-factor in Marine Zone 4 and Zones 5 through 8.

^c. Basement wall *U*-factor of 0.360 in warm-humid locations as defined by Figure 301.1 and Table 301.2.

IECC Compliance - Three Options

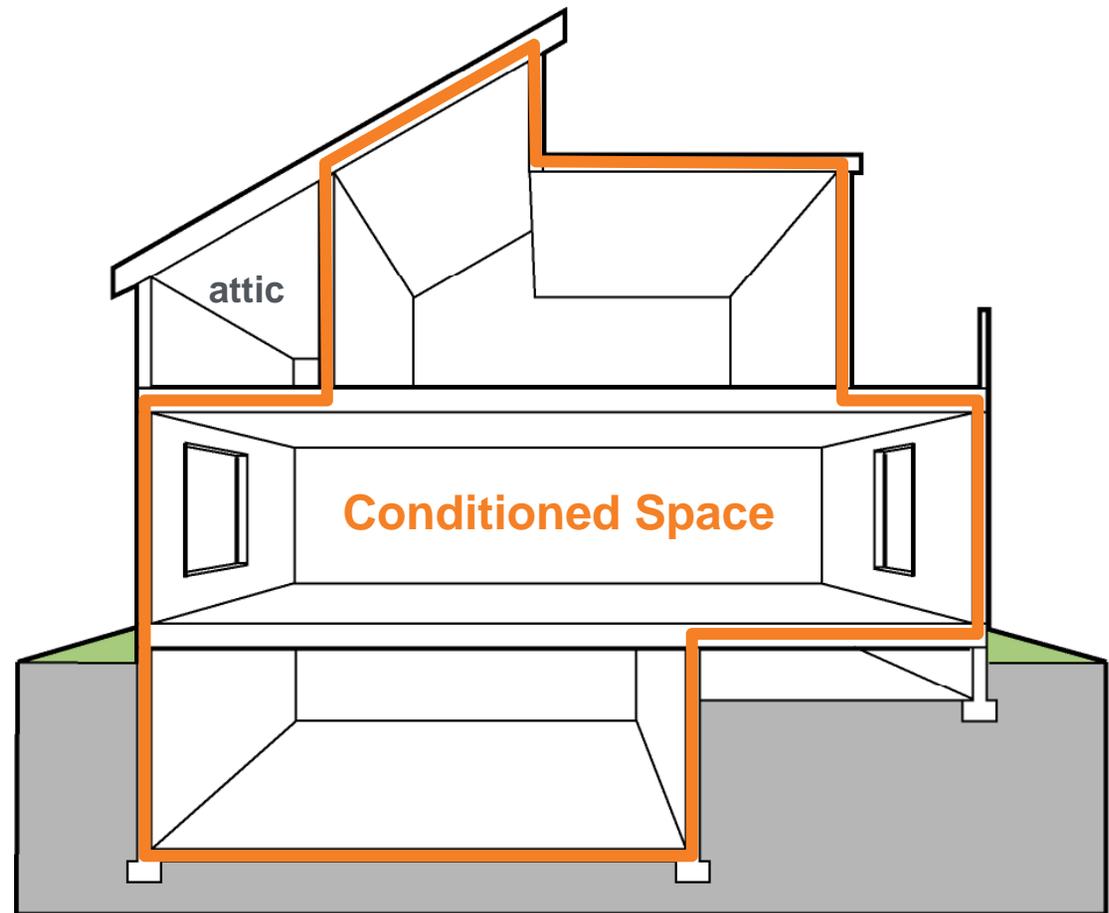


Code Compliance Tools

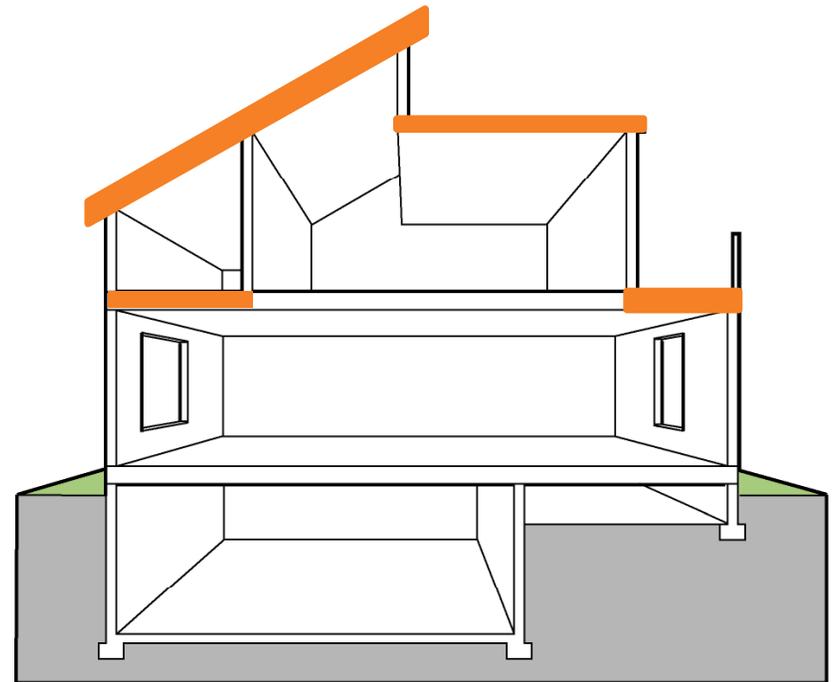


Building Envelope Specific Requirements

- Building Envelope consists of:
 - Ceilings
 - Walls
 - Above grade
 - Below grade
 - Mass walls
 - Fenestration
 - Floors
 - Slab
 - Crawl space

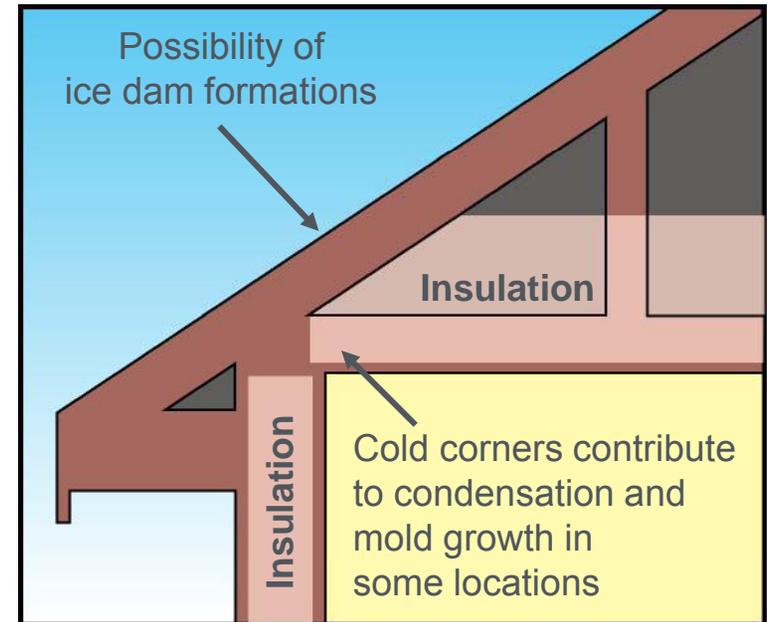


- Requirements based on
 - Assembly type
 - Continuous insulation
 - Insulation between framing (cavity insulation)
- Meet or exceed R-values

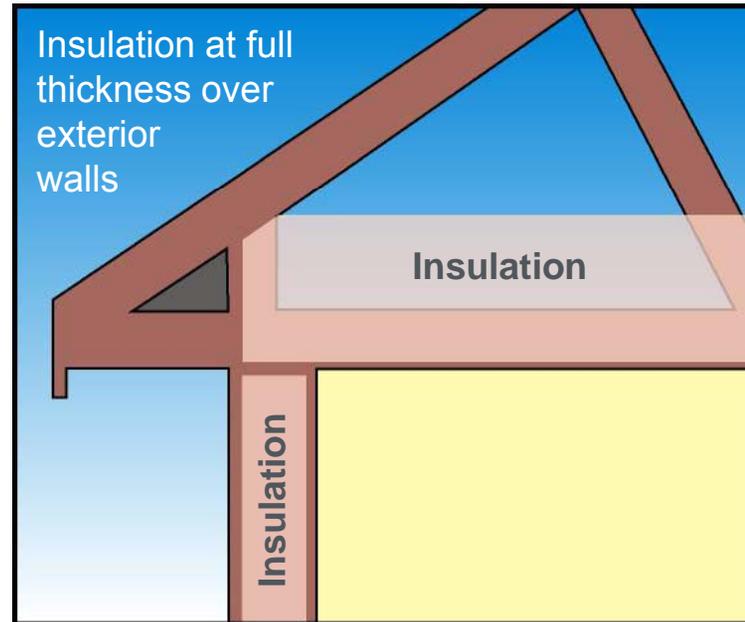


Ceilings with Attics

- Ceiling insulation requirements in R-value table assume standard truss systems



Ceilings with Attics, Cont'd.



Prescriptive R-value path encourages raised heel truss (aka, energy truss)

- If insulation is full height over exterior wall top plate
 - R-30 complies where R-38 is required
 - R-38 complies where R-49 is required

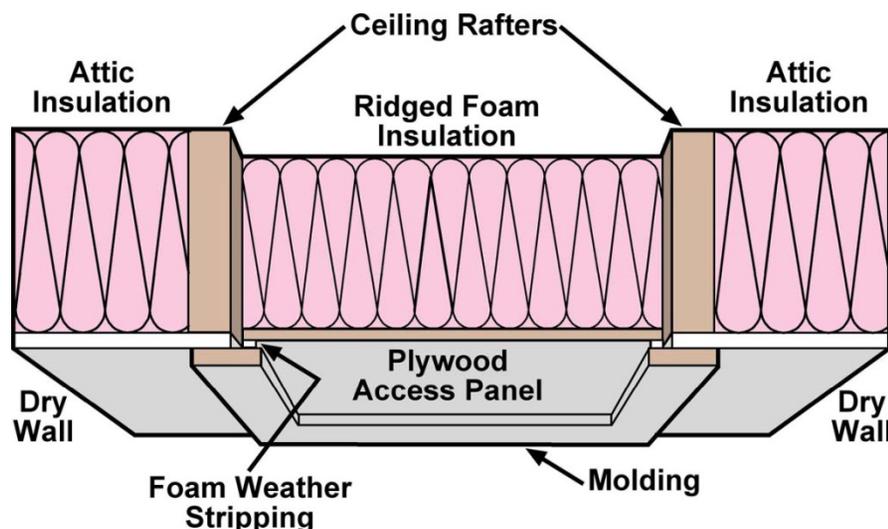
Note: This allowance ONLY applies to the R-value prescriptive path, not the U-factor or Total UA alternatives

Ceilings without Attics (e.g., vaulted)

- Where Insulation levels are required $> R-30$
- Not sufficient amount of space to meet higher levels
- R-30 allowed for 500 ft² or 20% total insulated ceiling area, whichever is less

Access Hatches and Doors (Prescriptive)

- Weatherstrip and insulate doors from conditioned spaces to unconditioned spaces (e.g., attics and crawl spaces)
 - Insulate to level equivalent to surrounding surfaces
 - e.g., required ceiling insulation = R-38, then attic hatch must be insulated to R-38
- Provide access to all equipment that prevents damaging or compressing the insulation
- Install a wood framed or equivalent baffle or retainer when loose fill insulation is installed



Walls Covered by IECC

- Exterior above-grade walls
- Attic kneewalls
- Skylight shaft walls
- Perimeter joists
- Basement walls
- Garage walls (shared with conditioned space)

Above Grade Walls

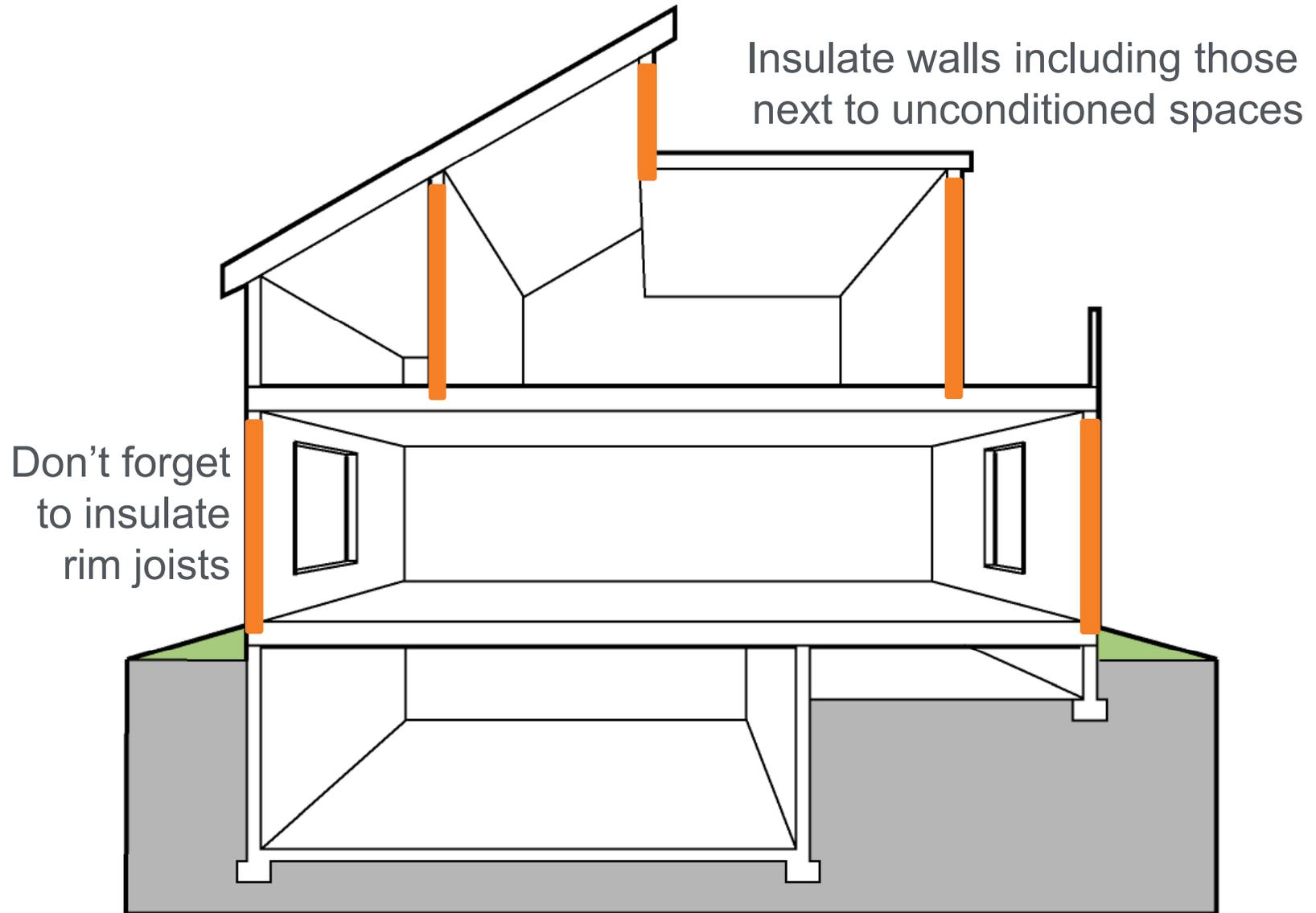


TABLE 402.1.1
INSULATION AND FENESTRATION REQUIREMENTS BY CLIMATE ZONE

| CLIMATE ZONE | FENESTRATION U-FACTOR ^b | SKYLIGHT ^b U-FACTOR | GLAZED FENESTRATION SHGC ^{b, e} | CEILING R-VALUE | WOOD FRAME WALL R-VALUE | MASS WALL R-VALUE ⁱ |
|--------------|------------------------------------|--------------------------------|--|-----------------|-------------------------|--------------------------------|
| 1 | 1.2 | 0.75 | 0.30 | 30 | 13 | 3/4 |
| 2 | 0.95 ^j | 0.75 | 0.30 | 30 | 13 | 4/6 |
| 3 | 0.95 ^j | 0.75 | 0.30 | 30 | 13 | 5/8 |
| 4 | 0.95 ^j | 0.75 | 0.30 | 38 | 13 | 5/10 |
| 5 | 0.95 ^j | 0.75 | 0.30 | 38 | 20 or 13+5 ^h | 13/17 |
| 6 | 0.95 ^j | 0.75 | 0.30 | 49 | 20 or 13+5 ^h | 15/19 |
| 7 | 0.95 ^j | 0.75 | 0.30 | 49 | 21 | 19/21 |

Required R-value can be met with any combination of cavity or continuous insulation

Exception in zones 5-6: R-13 cavity plus R-5 sheathing meets R-20 requirement

**Table 402.2.5
Steel-Frame Ceiling, Wall and Floor Insulation
(R-Value)**

- Ceilings, walls, and floors
- Exceptions
 - Climate Zones 1 and 2 ci can be reduced to R-3 for 24” o.c. walls

| Wood Frame R-value | Cold-Formed Steel Equivalent R-value |
|-----------------------------|---|
| Steel Truss Ceilings | |
| R-30 | R-38 or R-30 + 3 or R-26 + 5 |
| R-38 | R-49 or R-38 + 3 |
| R-49 | R-38 + 5 |
| Steel Joist Ceilings | |
| R-30 | R-38 in 2x4, or 2x6, or 2x8 R-49 any framing |
| R-38 | R-49 2x4, or 2x6, or 2x8, or 2x10 |
| Steel Framed Wall | |
| R-13 | R-13 + 5 or R-15 +4, or R-21 +3 or R-0+10 |
| R-19 | R-13 + 9 or R-19 +8 or R-25 +7 |
| R-21 | R-13 +10 or R-19 +9 or R-25 +8 |
| Steel Joist Floor | |
| R-13 | R-19, 2x6 R-19 + 6 in 2x8 or 2x10 |
| R-19 | R-19 + 6 in 2x6 R-19 +12 in 2x8 or 2x10 |

Steel Frame Walls (and ceilings, floors)

Table 402.2.5
Steel-Frame Ceiling, Wall and Floor Insulation
(R-Value)

| Wood Frame R-value | Cold-Formed Steel Equivalent R-value ^a |
|---|--|
| Steel Truss Ceilings^b | |
| R-30 | R-38 or R-30 + 3 or R-26 + 5 |
| R-38 | R-49 or R-38 + 3 |
| Steel Joist Floor | |
| R-13 | R-13 + 5 or R-15 + 4, or R-21 + 3 or R-19 + 6 in 2x6 |
| R-19 | R-13 + 9 or R-19 + 8 or R-25 + 7 |
| R-21 | R-13 + 10 or R-19 + 9 or R-25 + 8 |
| R-13 | R-19, 2x6 R-19 + 6 in 2x8 or 2x10 |
| R-19 | R-19 + 6 in 2x6 R-19 + 12 in 2x8 or 2x10 |

Table keys on the wood-frame requirement for the corresponding building component

- “R-X + Y” means R-X cavity plus R-Y continuous
- Exception: In climate zones 1 and 2, the continuous R-value can be reduced to R-3 for walls on 24” centers
- In ceilings, insulation that exceeds the height of the framing must cover the framing

**TABLE 402.1.1
INSULATION AND FENESTRATION REQUIREMENTS BY CLIMATE ZONE**

| CLIMATE ZONE | FENESTRATION U-FACTOR ^b | SKYLIGHT ^b U-FACTOR | GLAZED FENESTRATION SHGC ^{b, e} | CEILING R-VALUE | WOOD FRAME WALL R-VALUE | MASS WALL R-VALUE ⁱ |
|-----------------|------------------------------------|--------------------------------|--|-----------------|-------------------------|--------------------------------|
| 1 | 1.2 | 0.75 | 0.30 | 30 | 13 | 3/4 |
| 2 | 0.65 ^j | 0.75 | 0.30 | 30 | 13 | 4/6 |
| 3 | | | | | 13 | 5/8 |
| 4 except Marine | | | | | 13 | 5/10 |
| 5 and Marine 4 | | | | | 20 or 13-5 ^h | 13/17 |
| 6 | | | | | 20 or 13-5 ^h | 15/19 |
| 7 and 8 | | | | | 21 | 19/21 |

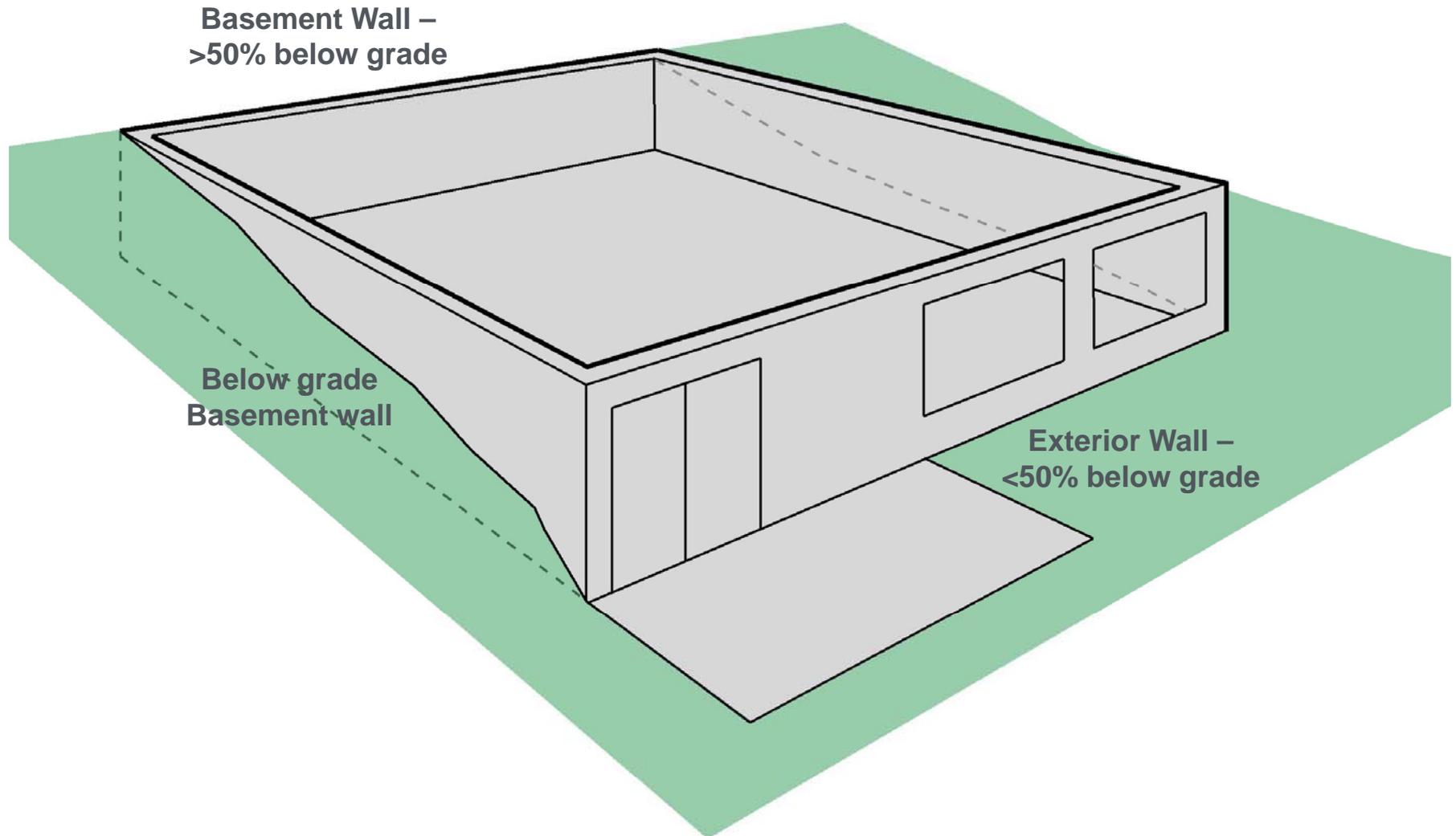
Second (higher) number applies when more than half the R-value is on the interior of the mass (i.e., when the thermal mass is insulated from the conditioned space)

- What type
 - Concrete block, concrete, insulated concrete form (ICF), masonry cavity, brick (other than brick veneer), earth, and solid timber/logs
- Provisions
 - At least 50% of the required R-value must be on the exterior or integral to the wall to use values in Table 402.1.3
 - When more than half the insulation is on the interior, the mass wall U-factors:

| Climate Zones | U-Factor Maximum |
|-----------------|--------------------------------|
| 1 | 0.17 |
| 2 | 0.14 |
| 3 | 0.12 |
| 4 except Marine | 0.10 |
| 4 Marine | same as above grade frame wall |
| 5-8 | same as above grade frame wall |



Defining Below-Grade Walls



**TABLE 402.1.1
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT^a**

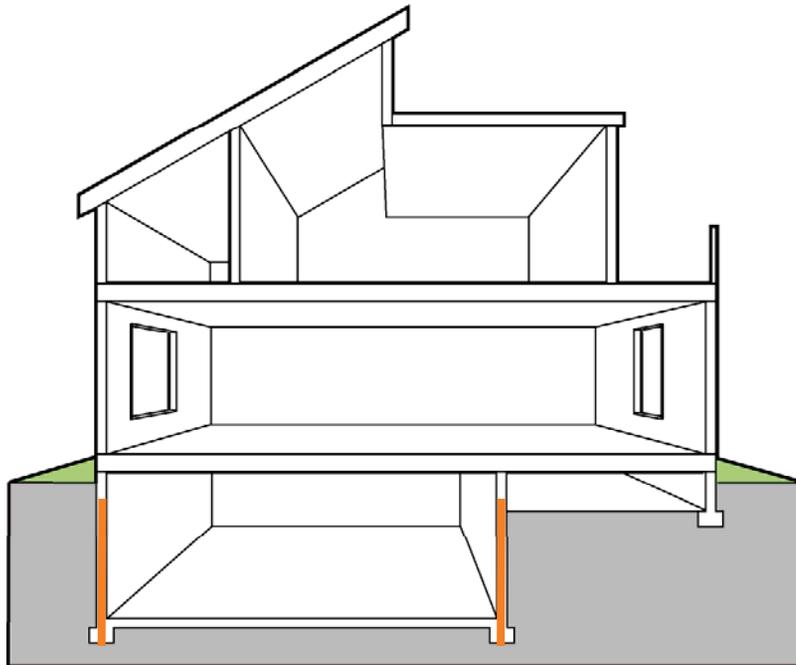
| CLIMATE ZONE ^b | SKYLIGHT ^b U-FACTOR | GLAZED FENESTRATION SHGC ^{b, e} | CEILING R-VALUE | WOOD FRAME WALL R-VALUE | MASS WALL R-VALUE ⁱ | FLOOR R-VALUE | BASEMENT ^c WALL R-VALUE |
|---------------------------|-----------------------------------|---|--------------------|----------------------------|-----------------------------------|------------------|--|
| 1 | 0.75 | 0.30 | 30 | 13 | 3/4 | 13 | 0 |
| 2 | 0.75 | 0.30 | 30 | 13 | 3/4 | 13 | 0 |
| 3 | 0.65 | 0.30 | 30 | 13 | 3/4 | 19 | 5/13 ^f |
| 4 | 0.60 | 0.30 | 30 | 13 | 3/4 | 19 | 10/13 |
| 5 | 0.60 | 0.30 | 30 | 13 | 3/4 | 30 ^g | 10/13 |
| 6 | 0.60 | 0.30 | 30 | 13 | 3/4 | 30 ^g | 15/19 |
| 7 | 0.60 | 0.30 | 30 | 13 | 3/4 | 38 ^g | 15/19 |

- “X/Y” means R-X continuous or R-Y cavity
- 15/19 requirement can be met with R-13 cavity (interior) plus R-5 continuous (exterior)
- In zone 3, no insulation required in warm-humid counties

Below-Grade Walls

- $\geq 50\%$ below grade
- Otherwise treat as above- grade wall

| Climate Zones | R-Value |
|---------------|---------|
| 1-2 | 0 |
| 3 | 5/13 |
| 4-5 | 10/13 |
| 6-8 | 15/19 |



- Insulated from top of basement wall down to 10 ft below grade or basement floor, whichever is less

- Doors and windows
 - NFRC rating or default table
 - If no labeled U-factor and SHGC, use default table
 - No glass area limits
 - Exemptions (prescriptive path only)
 - Up to 15 ft² of glazing per dwelling unit (Section 402.3.3)
 - One side-hinged opaque door assembly up to 24 ft² (Section 402.3.4)

Fenestration – Area-weighted Average

- Can be used to satisfy U-factor and SHGC requirements
- Subject to hard limits, even in trade-offs

Floors Over Unconditioned Space

**TABLE 402.1.1
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT**

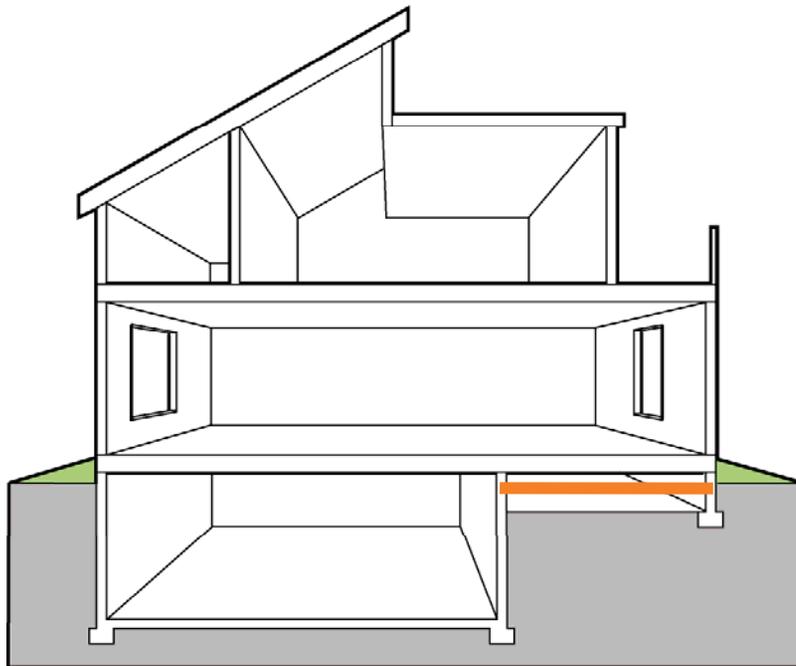
| | FENESTRATION U-FACTOR ^b | SKYLIGHT ^b U-FACTOR | GLAZED FENESTRATION SHGC ^{b, e} | CEILING R-VALUE | WOOD FRAME WALL R-VALUE | MASS WALL R-VALUE ⁱ | FLOOR R-VALUE |
|---|---------------------------------------|-----------------------------------|--|--------------------|-------------------------------|--------------------------------------|------------------|
| | 1.2 | 0.75 | 0.30 | 30 | 13 | 3/4 | 13 |
| | 0.65 ^j | 0.75 | 0.30 | 30 | 13 | 4/6 | 13 |
| | 0.50 ^j | 0.65 | 0.30 | 30 | 13 | 5/8 | 19 |
| t | 0.35 | 0.60 | NR | 38 | 13 | 5/10 | 19 |
| 4 | 0.35 | 0.60 | NR | 38 | 13 ^h | 13/17 | 30 ^g |
| | 0.35 | 0.60 | NR | 38 | 15 ^h | 15/19 | 30 ^g |
| | 0.35 | 0.60 | NR | 38 | 19 ^h | 19/21 | 38 ^g |

Exception: If framing members are too small to accommodate R-30, insulation that fills the framing cavity, not less than R-19, complies

Floors over Unconditioned Space

- Unconditioned space includes unheated basement, vented crawlspace, or outdoor air

| Climate Zones | R-Value |
|---------------|---------|
| 1-2 | 13 |
| 3-4ab | 19 |
| 4c-6 | 30* |
| 7-8 | 38* |



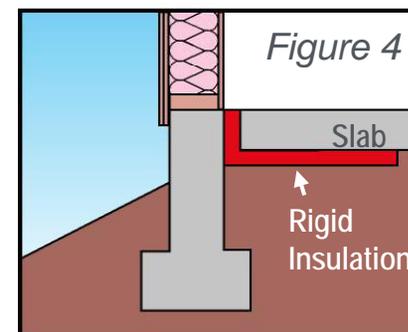
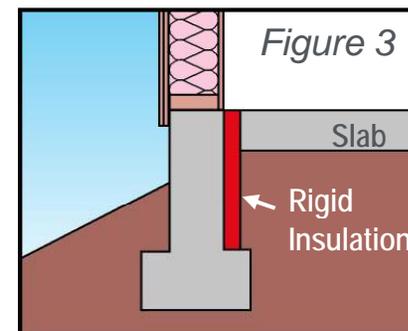
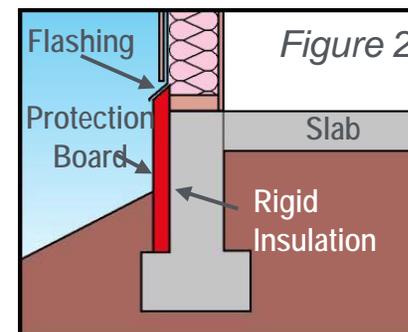
- Insulation must maintain permanent contact with underside of subfloor

* Exception:

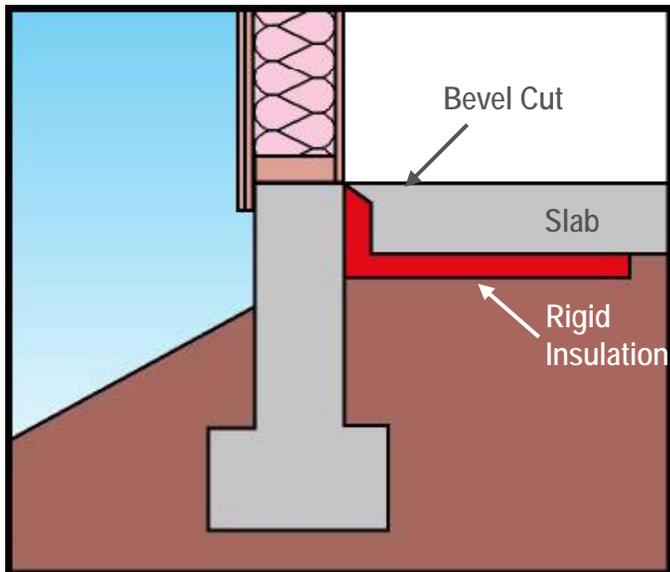
Climate Zones 4c-8
R-19 permitted if cavity completely filled

Slab Edge Insulation

- Applies to slabs with a floor surface < 12 inches below grade
 - R-10 (typically 2 inches) insulation in Zones 4 and above
 - Must extend downward from top of slab a minimum of 24" (Zones 4 and 5) or 48" (Zones 6, 7, and 8)
 - Insulation can be vertical or extend horizontally under the slab or out from the building
 - Insulation extending outward must be under 10 inches of soil or pavement
- An additional R-5 is required for heated slabs
- Insulation depth of the footing or 2 feet, whichever is less in Zones 1-3 for heated slabs

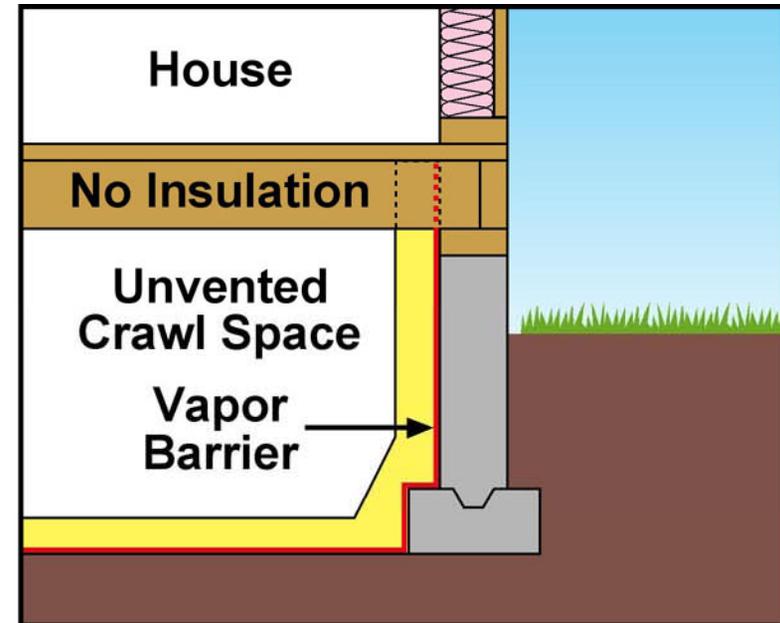
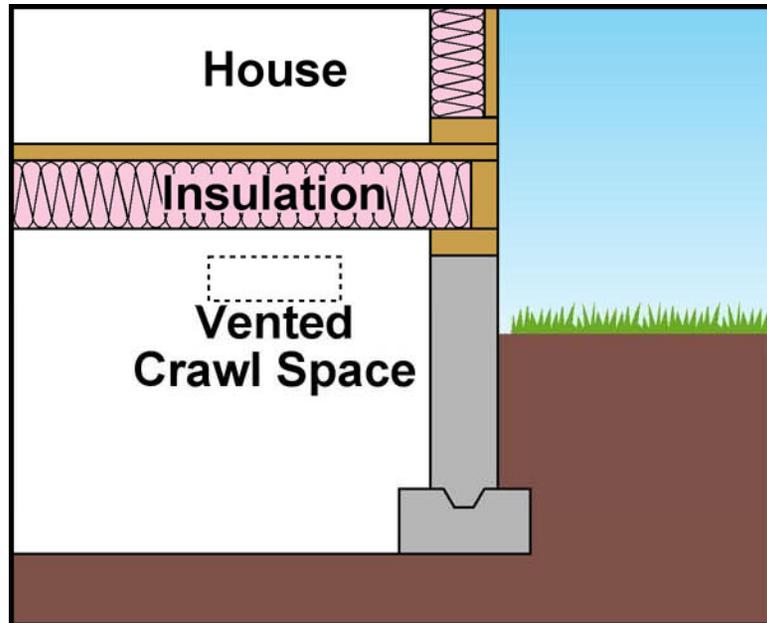


Slab Edge Insulation



Crawlspace Wall Insulation

- Implies an unvented crawlspaces (aka, conditioned crawlspace)
 - Space must be mechanically vented or receive minimal supply air (see Section R408 of the IRC)
 - Exposed earth must be covered with a continuous Class I vapor retarder



Vented Crawlspace Requirements:

- The raised floor over the crawlspace must be insulated.
- A vapor retarder may be required as part of the floor assembly.
- Ventilation openings must exist that are equal to at least 1 square foot for each 150 square feet of crawlspace area and be placed to provide cross-flow (*IRC 408.1, may be less if ground vapor retarder is installed*).
- Ducts in crawlspace must be sealed and have R-6 insulation.

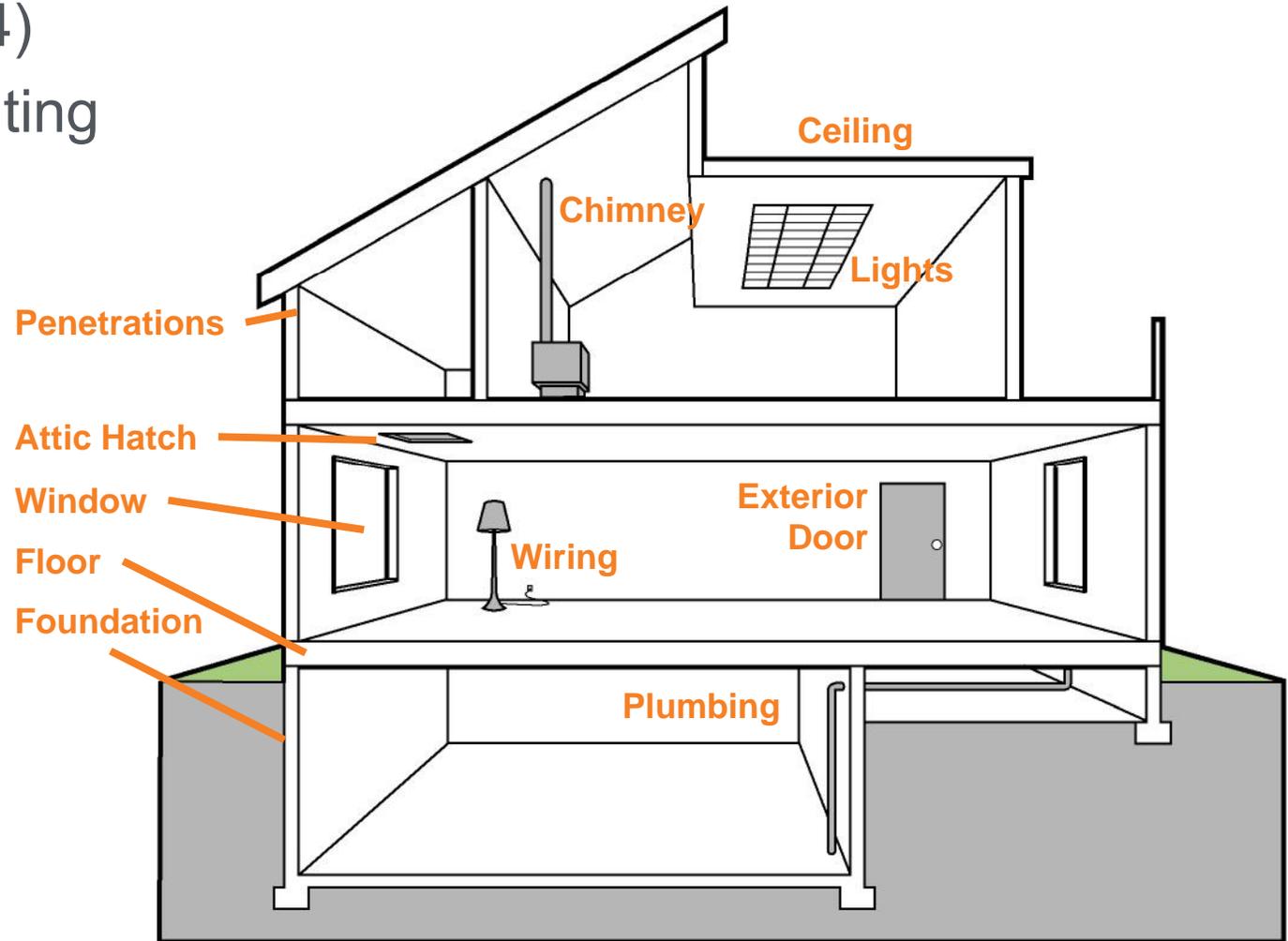
Unvented Crawlspace Requirements:

- The crawlspace ground surface must be covered with an approved vapor retarder (*e.g., plastic sheeting*).
- Crawlspace walls must be insulated to the R-value requirements specific for crawlspace walls (*IECC Table 402.1.1*).
- Crawlspace wall insulation must extend from the top of the wall to the inside finished grade and then 24" vertically or horizontally.
- Crawlspace must be mechanically vented (*1 cfm exhaust per 50 square feet*) or conditioned (*heated and cooled as part of the building envelope*).
- Ducts are inside conditioned space and therefore don't need to be insulated.

- Requires computer software with specified capabilities (local official may approve other tools)
- Includes both envelope and some systems, but not HVAC or water heater efficiency
- Allows greatest flexibility
 - Can trade-off tight duct systems
- Defines compliance based on equivalency of calculated energy or energy cost
- Section 405 specifies “ground rules”
 - These will generally be “hidden” in compliance software calculation algorithms
 - Very similar ground rules are used in home federal tax credits and ENERGY STAR Home guidelines

Mandatory Requirements – Air Leakage

- Building thermal envelope (Section 402.4)
- Recessed lighting
- Fenestration
- Fireplaces



- Two options to demonstrate compliance
 - Whole-house pressure test
 - Air leakage <7 ACH when tested at pressure differential of 0.2 inches w.c.
Testing may occur any time after rough in and installation of building envelope penetrations
 - Field verification of items listed in Table 402.4.2.

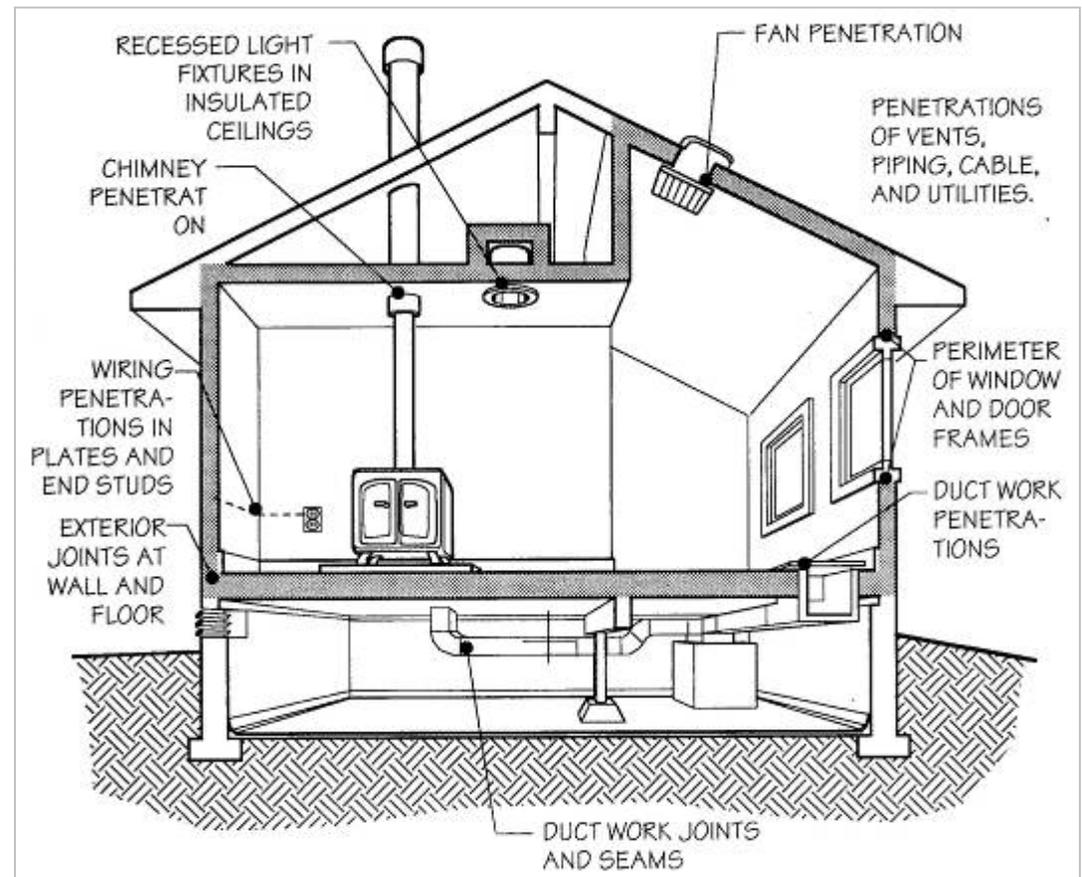
Air Leakage Control

- Building thermal envelope
 - Durably sealed
 - Caulked
 - Gasketed
 - Weatherstripped
 - Air barrier material
 - Suitable film or solid material



Areas for Air Leakage (Infiltration)

- Windows and doors
- Between sole plates
- Floors and exterior wall panels
- Plumbing
- Electrical
- Service access doors or hatches
- Recessed light fixtures
- Rim joist junction



Recessed Lighting Fixtures

- Type IC rated and labeled as meeting ASTM E 283 when tested at 1.57 psf (75 Pa) pressure differential with no more than 2.0 cfm of air movement
- Sealed with a gasket or caulk between the housing and interior wall or ceiling covering



Windows, sliding glass doors and skylights

- Air filtration rate ≤ 0.3 cfm/ft²
- Swinging doors
 - ≤ 0.5 cfm/ft²
- Exceptions
 - Site-built windows, skylights, and doors

- New wood-burning fireplaces shall have gasketed doors and outdoor combustion air.



- Equipment efficiency set by Federal law, not the I-Codes



Mandatory Requirements Systems (Section 403)

- Controls
- Heat pump supplementary heat
- Ducts
 - Sealing (Mandatory)
 - Insulation (Prescriptive)
- HVAC piping insulation
- Circulating hot water systems
- Ventilation
- Equipment sizing
- Systems serving multiple dwelling units
- Snow melt controls
- Pools

- If primary heating system is a forced-air furnace
 - At least one programmable thermostat/dwelling unit
 - Capability to set back or temporarily operate the system to maintain zone temperatures
 - down to 55°F (13°C) or
 - up to 85°F (29°C)
 - Initially programmed with:
 - heating temperature set point no higher than 70°F (21°C) and
 - cooling temperature set point no lower than 78°F (26°C)



- Prevent supplementary electric-resistance heat when heat pump can meet the heating load
- Exception
 - During defrost

- Insulation (Prescriptive)
 - Supply ducts in attics: R-8
 - All other ducts: R-6
- Sealing (Mandatory)
 - Joints and seams shall comply with IRC, Section M1601.4.1
- Building framing cavities shall not be used as supply ducts



Duct Location Examples

| Location | Requirement |
|--------------------------|-------------|
| Attic | R-8 |
| Conditioned Space | - |
| Vented Crawl Space | R-6 |
| Conditioned Crawl Space | - |
| Basement – Conditioned | - |
| Basement – Unconditioned | R-6 |
| Exterior Walls | R-6 |

- All ducts, air handlers, filter boxes and building cavities used as ducts shall be sealed (Section 403.2.2)
- Duct tightness shall be verified *by either* –
 - Post construction test
 - Leakage to outdoors: ≤ 8 cfm/per 100 ft² of conditioned floor area
or
 - Total leakage: ≤ 12 cfm/per 100 ft² of conditioned floor area
 - tested at a pressure differential of 0.1 in w.g. (25Pa) across entire system, including manufacturer’s air handler enclosure
 - All register boots taped or otherwise sealed
 - OR – Rough-in test
 - Total leakage ≤ 6 cfm/per 100 ft² of conditioned floor area
 - tested at a pressure differential of 0.1 in w.g. (25Pa) across roughed-in system, including manufacturer’s air handler enclosure
 - all register boots taped or otherwise sealed
 - if air handler not installed at time of test
 - » Total air leakage ≤ 4 cfm/per 100 ft²

Exceptions: Duct tightness test is not required if the air handler and all ducts are located within conditioned space

Piping Insulation

- R-3 required on
 - HVAC systems
 - Exception: Piping that conveys fluids between 55 and 105°F
- R-2 required on
 - All circulating domestic hot water systems
 - Systems also require a readily accessible manual switch



- Ventilation
 - Outdoor air intakes and exhausts shall have automatic or gravity dampers that close when the ventilation system is not operating
- Equipment Sizing
 - IECC references Section M1401.3 of the IRC
 - Load calculations determine the proper capacity (size) of equipment
 - Goal is big enough to ensure comfort but no bigger
 - Calculations shall be performed in accordance with ACCA Manual J or other approved methods

- Snow- and ice-melting system controls
 - Automatic shutoff when pavement temperature is $> 50^{\circ}\text{F}$ and no precipitation is falling
 - Automatic or manual shutoff when outdoor temperature is $> 40^{\circ}\text{F}$

- Pool heaters
 - with a readily accessible on-off switch
 - fired by natural gas not allowed to have continuously burning pilot lights
- Time switches to automatically turn off and on heaters and pumps according to a preset schedule installed on swimming pool heaters and pumps.
 - Exceptions
 - Public health standards requiring 24-hour pump operation
 - Pumps operating pools with solar-waste-heat recovery heating systems



- On heated pools
 - If heated to $>90^{\circ}\text{F}$, vapor-retardant pool cover at least R-12
 - Exception: If $>60\%$ of energy from site-recovered or solar energy source

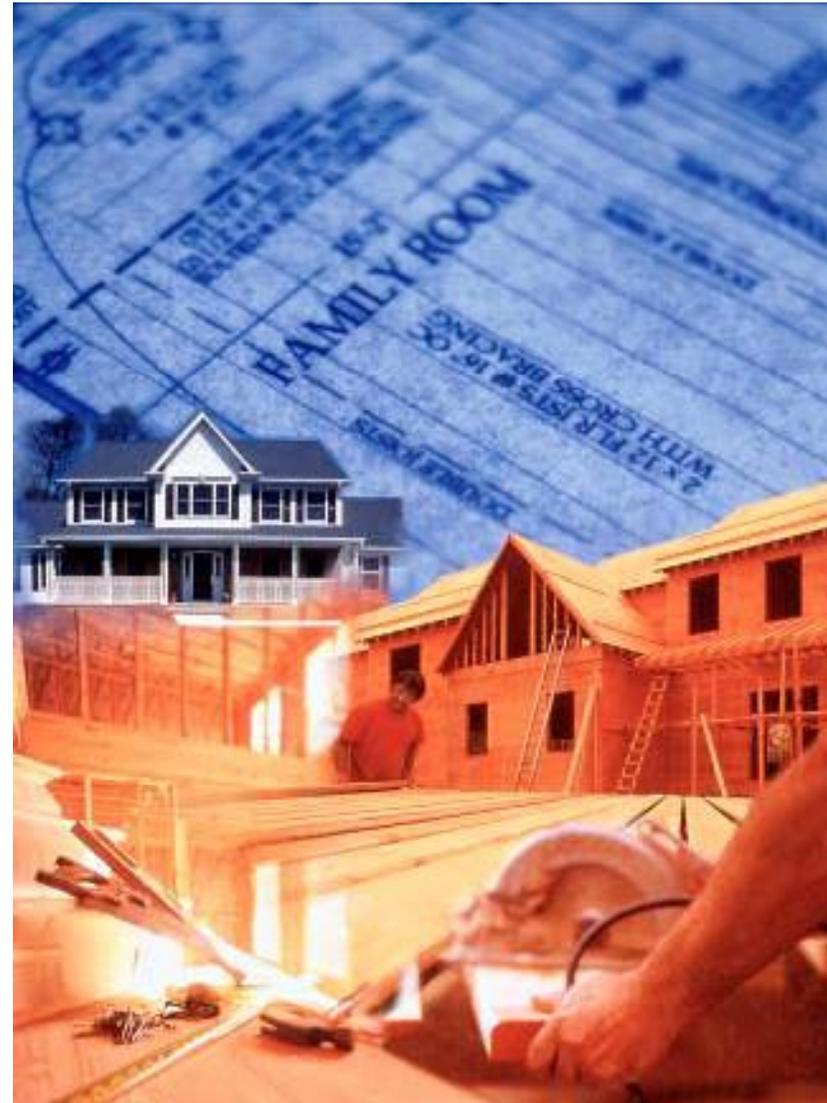
- Systems serving multiple dwelling units shall comply with Sections 503 and 504 in lieu of Section 403

- A minimum of 50 percent of the lamps in permanently installed lighting fixtures shall be high-efficacy lamps



Compliance/Documentation/ Inspections

- Code Official has final authority
 - Software, worksheets
 - Above Code Programs
- Electronic media can be used
- Construction work for which a permit is required is subject to inspection
- Certificate is required



- Code Officials Inspection
 - Successive and final inspections, and reinspections if necessary
- Code Validity
 - Code deemed to be illegal or void shall not affect the remainder of the code
- Codes and standards considered part of the requirements of the code
 - Provisions take precedence
- Fees
 - Must be paid before permit is issued
 - Required in accordance with schedule

- Permanently posted on or in the electrical distribution panel
- Don't cover or obstruct the visibility of other required labels
- Includes the following:
 - R-values of insulation installed for the thermal building envelope, including ducts outside conditioned spaces
 - U-factors for fenestration
 - SHGC for fenestration
 - HVAC efficiencies and types
 - SWH equipment

- Certificate lists “gas-fired unvented room heater”, “electric furnace”, or “baseboard electric heater”, rather than listing an efficiency for those heating types

- Treat as a stand-alone building
- Additions must meet the prescriptive requirements in Table 402.1.1 (or U-factor or total UA alternatives)



Sunrooms

Less stringent insulation
R-value and glazing
U-factor requirements

Sunroom definition:

- One story structure
- Glazing area >40% glazing of gross exterior wall and roof area
- Separate heating or cooling system or zone
- Must be thermally isolated (closeable doors or windows to the rest of the house)
- Can always meet Table 402.1.1 requirements with unlimited glass



Sunroom Requirements

- Ceiling Insulation
 - Zones 1-4 R-19
 - Zones 5-8 R-24
- Wall Insulation
 - All zones R-13
- Fenestration U-Factor
 - Zones 4-8 0.50
- Skylight U-Factor
 - Zones 4-8 0.75

