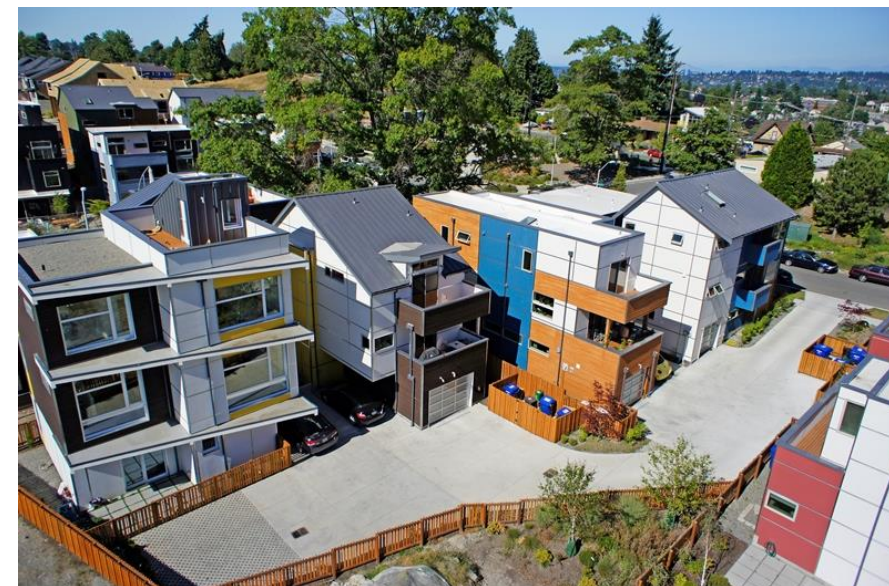




Residential Provisions of the 2021 IECC

- Overview of IECC Structure
- Summary of what changed between 2018 and 2021 IECC
- Focus on key energy related changes in the 2021 IECC
 - Envelope
 - Lighting
 - HVAC
 - SHW
 - Performance Path/Energy Rating Index (ERI)
 - Appendix RB for Zero Energy Homes

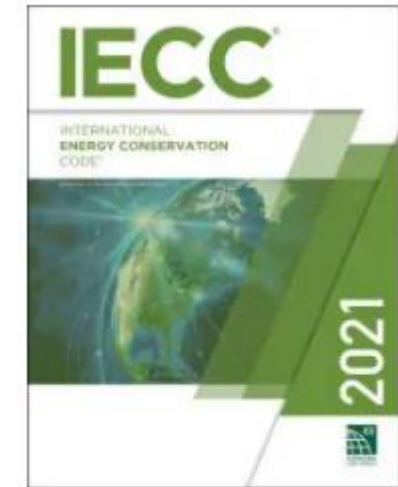


The Family of I-Codes

- ✓ International Building Code
- ✓ International Mechanical Code
- ✓ International Fuel Gas Code
- ✓ International Property Maintenance Code
- ✓ International Fire Code
- ✓ International Zoning Code
- ✓ International Plumbing Code
- ✓ International Existing Building Code
- ✓ International Private Sewage Disposal Code
- ✓ International Performance Code
- ✓ International Residential Code
- ✓ **International Energy Conservation Code**
- ✓ International Wildlife-Urban Interface Code
- ✓ ICC Performance Code for Buildings and Facilities
- ✓ International Green Construction Code



- Energy codes and standards set minimum efficiency requirements for new and renovated buildings, assuring reductions in energy use and emissions over the life of the building. Energy codes are a subset of building codes, which establish baseline requirements and govern building construction.
- Code buildings are more comfortable and cost-effective to operate, assuring energy, economic and environmental benefits.

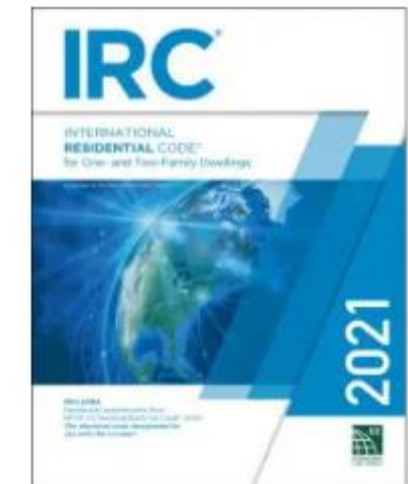


Relationship Between IRC & IECC

- ✓ IECC addresses only energy
- ✓ IRC addresses all topics (*structural, plumbing, etc.*)
 - Allows builder to carry only one code book
 - Chapter 11 covers energy efficiency
- ✓ As of 2015, IECC consolidated with IRC energy chapter (actually a change to the IRC, not the IECC).
- ✓ IECC addresses both residential and commercial; IRC addresses subset of residential, detached one- and two-family dwellings and townhouses 3 stories or fewer



VS



IECC Terminology

✓ Prescriptive

- Component-specific requirements that can be lessened or eliminated in trade for compensating improvements elsewhere

✓ Total Building Performance/Energy Rating Index

- Compares annual energy performance compared to a standard reference home.

– **Note: Unlike simulated performance path, ERI path is not directly based on the prescriptive requirements**

- Some elements have “hard limits” AKA “trade-off limits” or “backstops”
- Puts limits on how far a component-specific prescriptive requirement can be reduced in trade-offs against other components



Structure of the IECC



Commercial Section

Ch. 1 Scope and Application /
Administrative and Enforcement
Ch. 2 Definitions
Ch. 3 General Requirements
Ch. 4 Commercial Energy Efficiency
Ch. 5 Existing Buildings
Ch. 6 Referenced Standards
Appendices
Index



Residential Section

Ch. 1 Scope and Application /
Administrative and Enforcement
Ch. 2 Definitions
Ch. 3 General Requirements
Ch. 4 Residential Energy Efficiency
Ch. 5 Existing Buildings
Ch. 6 Referenced Standards
Appendices
Index

Climate-Specific Requirements (mostly envelope)

- ✓ Roofs, walls, foundations R-values/U-factors
- ✓ U-factors of windows, doors, skylights
- ✓ Solar Heat Gain Coefficient
- ✓ Air leakage rate
- ✓ Duct leakage rate

Performance Based Alternatives

- ✓ Performance Compliance
- ✓ Energy Rating Index Compliance

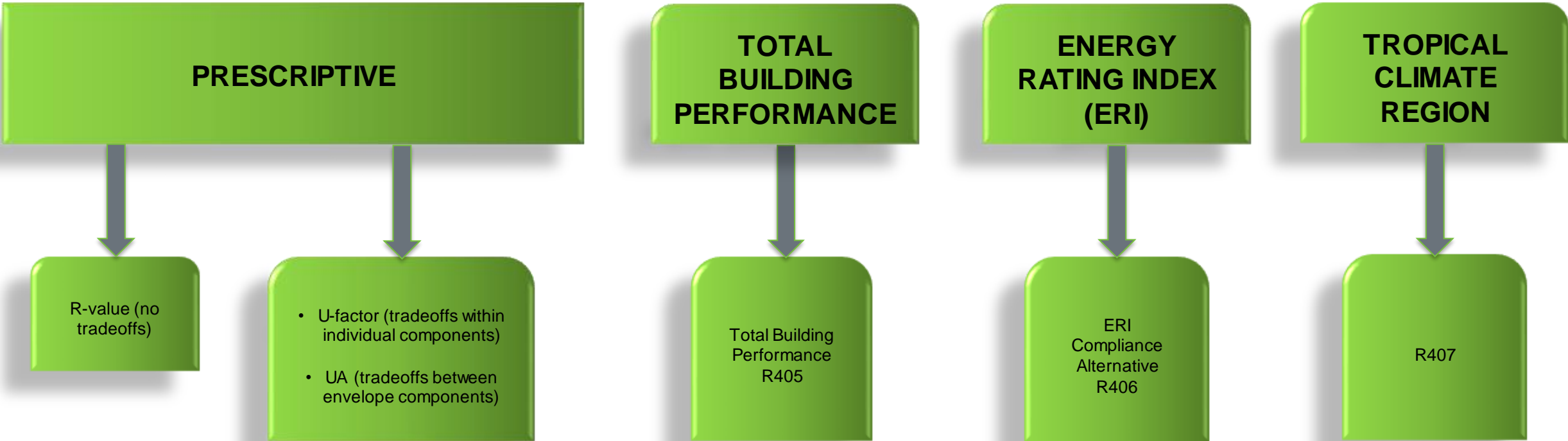
Other Requirements (sometimes climate-specific)

- ✓ Infiltration control
- ✓ Duct insulation, sealing & testing, no use of building cavities
- ✓ HVAC controls
- ✓ Piping Insulation and circulating service hot water requirements
- ✓ Equipment sizing
- ✓ Dampers
- ✓ Lighting



**ADDITIONAL ENERGY EFFICIENCY
R401.2.5**

+ one option below



Here's a summary

- Updated climate zone map to align with ASHRAE 169-2013
- Additional efficiency options
- Several increases in R-value (and corresponding decreases in U-factor)
 - Wood frame wall insulation in CZ 4-5
 - Slab insulation and depth in CZ 3-5
 - Ceiling insulation in CZ 2-8
- Reductions in U-factor
 - Fenestration in CZ 2-4
 - Fenestration U-factor of 0.32 for CZ 4C, 5-8 above 4000 ft elevation
- Alternative options for
 - Wood frame walls
 - Basement walls
 - Crawlspace walls

- New fenestration SHGC requirement in CZ 4C and 5
- Maximum air leakage rate set to 5.0 ACH50 for tradeoffs
- Lowered area-weighted maximum U-factor and SHGC
- Removed duct testing exception for ducts in conditioned space
- All permanently installed lighting fixtures to have high-efficacy lighting sources
- Exterior lighting in low-rise multifamily buildings must comply with Section C405.4 Exterior Lighting Power Requirements
- Exterior lighting controls
 - Manual on/off switches with automatic shutoff
 - Photosensor controls
 - Timer switch
 - Automatic shutoff allowing override to return to normal control within 24 hours

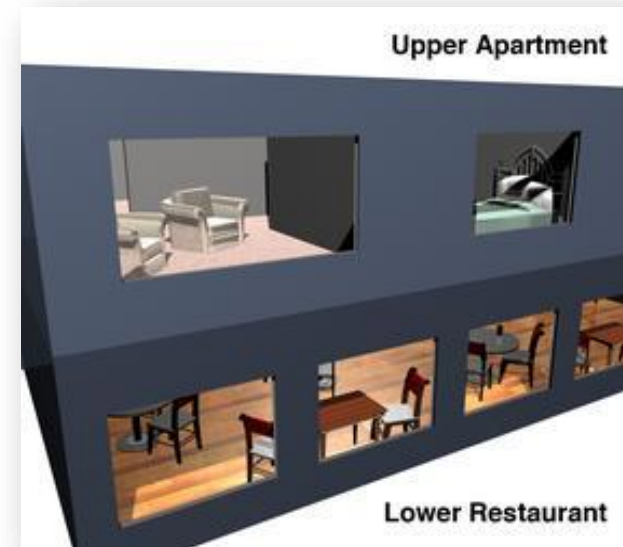
2021 IECC Detailed Slides

Scope

Section R101.4.1 - Mixed Residential and Commercial Buildings

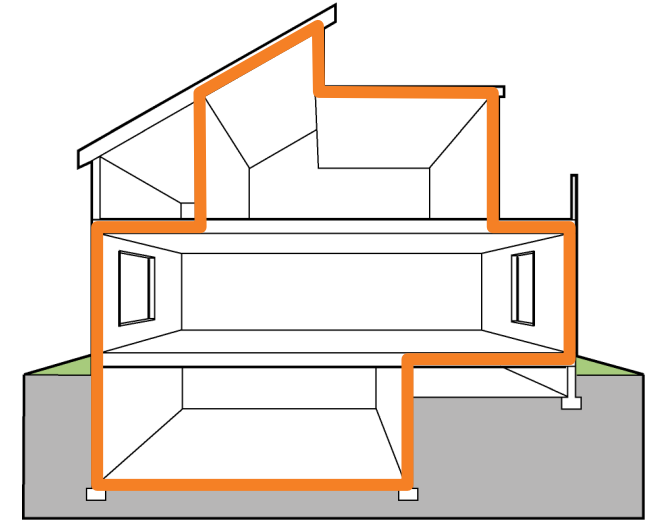
Section R101.5 - Compliance

- ✓ Treat the residential building portion under the applicable residential code
- ✓ Treat the commercial building portion under the commercial code
- ✓ Code Official has final authority
 - Compliance materials, software, worksheets



- The code is not intended to prevent installation of any material or prohibit design or method of construction that is not specifically prescribed in this code
- Such material, equipment, or design shall be approved by the code official
 - Code official to state reasons in writing

- ✓ Documentation shall be prepared by a registered design professional (where required)
- ✓ Electronic media can be used
- ✓ Information required:
 - ✓ Insulation materials and R-values
 - ✓ Fenestration U-factors, SHGC
 - ✓ Area-weighted U-factor and SHGC calculations
 - ✓ Mechanical, SWH, equipment types, sizes, and efficiencies
 - ✓ Equipment and system controls
 - ✓ Duct sealing, duct and pipe insulation and location
 - ✓ Air sealing details



The building thermal envelope shall be represented

- ✓ Fees, R104
- ✓ Inspections, R105
 - ✓ Work remains visible and accessible for inspection
- ✓ Notice of Approval, R106
- ✓ Code Validity, R107
 - Portions of code deemed to be illegal or void shall not affect the remainder of the code
- ✓ Referenced codes and standards, R108
 - Considered part of the requirements of the code, but IECC provisions take precedence
- ✓ Stop Work Order, R109
 - ✓ Authority of code official
 - ✓ Failure to Comply subject to fine
- ✓ Means of Appeals, R110

- Construction work for which a permit is required is subject to inspection by code official or designated agent
- Required inspections include:
 - Footing and foundation
 - Framing and rough-in
 - Plumbing rough-in
 - Mechanical rough-in
 - Final

Codes and standards listed in Chapter 5 are considered part of the requirements of this code to the “prescribed extent of each such reference and as further regulated in Sections R108.1.1 and R108.1.2”

- Conflicts, R108.1.1 – where differences occur between this code and the referenced codes and standards, provisions of this code apply
- Provisions in reference codes and standards, R108.1.2 – “where the extent of the reference to a referenced code or standard includes subject matter that is within the scope of this code, the provisions of this code, as applicable, shall take precedence over the provisions in the referenced code or standard”

- ✓ Permanently posted on a wall in the space where the furnace is located, a utility room or an approved location inside the building
- ✓ 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 and SHGC for fenestration
 - Area-weighted U-factor and SHGC calculations
 - Results from any required duct system and building envelope air leakage testing
 - HVAC efficiencies and types
 - SWH equipment
 - If applicable, PV panel details
 - If applicable, ERI score
 - Code edition and compliance path

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

Climate-Specific Requirements:

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

Non-climate Specific Requirements:

- ✓ Infiltration control
- ✓ Duct insulation, sealing & testing, no use of building cavities
- ✓ HVAC controls
- ✓ Piping Insulation and circulating service hot water requirements
- ✓ Equipment sizing
- ✓ Dampers
- ✓ Lighting

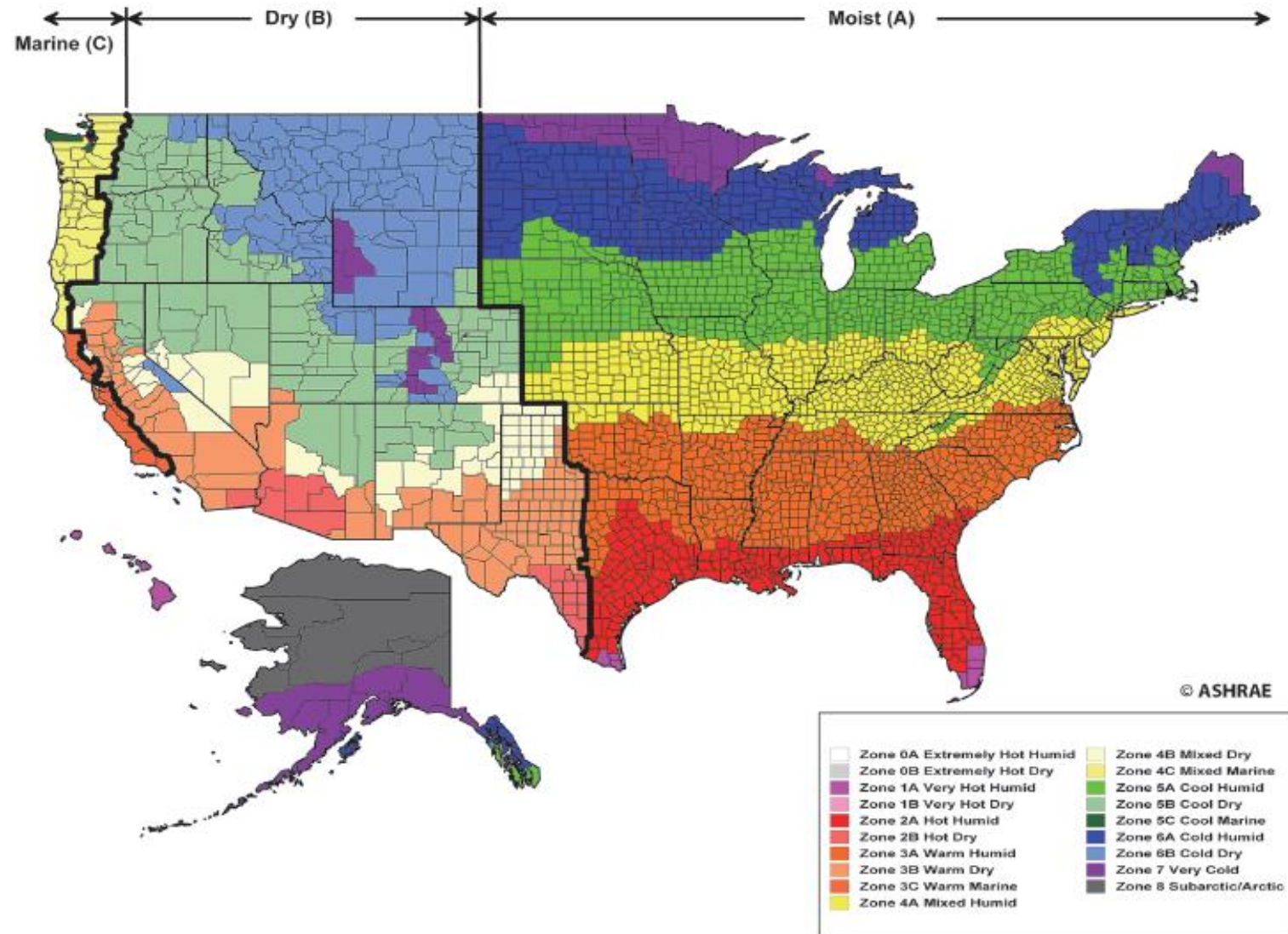
IECC Terminology

- ✓ "Climate Zone" has two components
 - Nine temperature-oriented zones (0-8)
 - Three named moisture regimes (moist, dry, marine)
 - Theoretically $8 \times 3 = 24$ distinct zones, but only 15 occur in U.S.
- ✓ Two additional climate specifications influence requirements
 - Warm-Humid line delineates counties that are warm-humid as defined by ASHRAE, with exceptions (affects only bsmt reqm'ts)
 - The "Tropical Climate Zone" (not a separate zone) defines areas in which simplified/relaxed requirements apply under some conditions

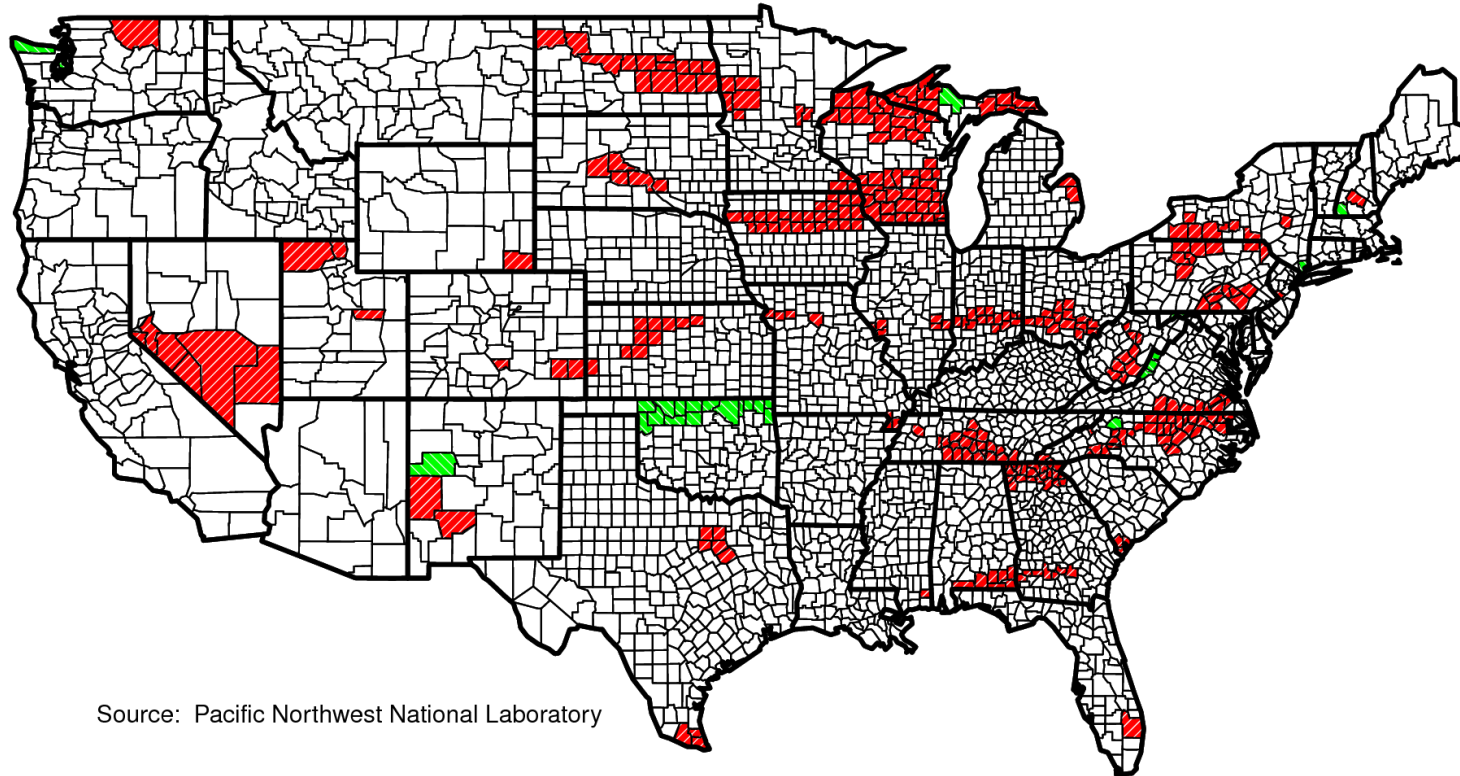
Climate Zones in the U.S. are entirely geographical

- ✓ Defined along state/county lines
- ✓ International locations defined by local climate data (mean Temp, precipitation, humidity, etc.)

Climate Zones for the 2021 IECC



Counties that are reassigned to warmer zones have generally less stringent code requirements



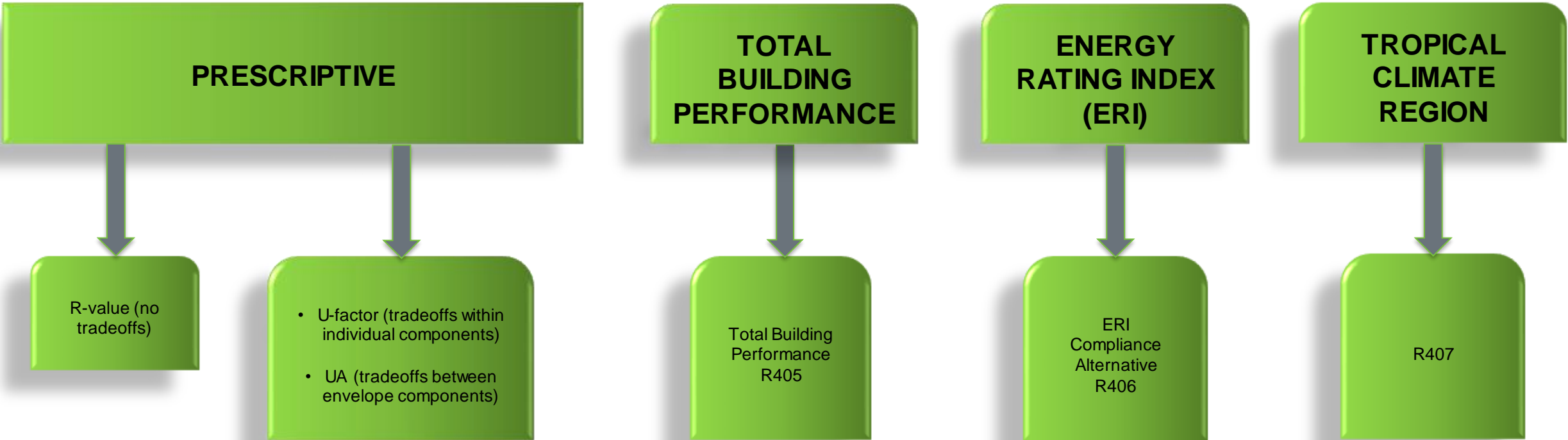
Source: Pacific Northwest National Laboratory

Red: Counties moving to warmer zones
Green: Counties moving to colder zones

- ✓ Focus is on building envelope
 - Ceilings, walls, windows, opaque doors, floors, foundations
 - Sets insulation and fenestration levels, and solar heat gain coefficients
 - Infiltration control - caulk and seal to prevent air leaks, and test
- ✓ Ducts, air handlers, filter boxes – seal, insulate, and test
- ✓ 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 – 100% of lamps to be high-efficacy lighting sources
 - ✓ Excluding kitchen appliance lighting fixtures

**ADDITIONAL ENERGY EFFICIENCY
R401.2.5**

+ one option below



U-factor

- ✓ 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

- ✓ Also uses U-factors in lieu of R-values, but allows trade-offs across all envelope components
 - Primary approach used in REScheck software
 - UA – U-factor x area of assembly

Building Thermal Envelope consists of:

- ✓ **Fenestration**
- ✓ Ceilings
- ✓ Walls
 - Above grade
 - Below grade
 - Mass walls
- ✓ Floors
- ✓ Slabs
- ✓ Crawl Spaces

Exceptions:

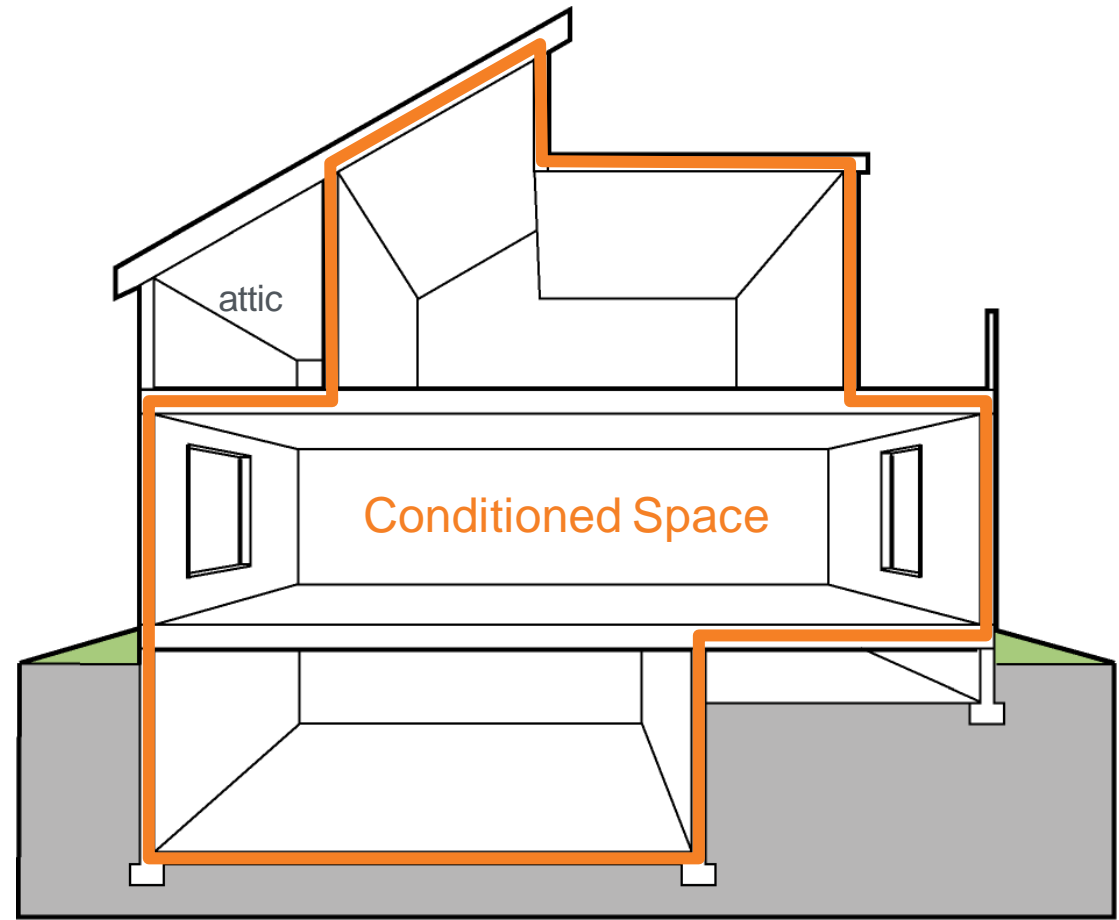
Low energy usage

< 3.4 Btu/h/sq.ft. OR

1 watt/sq.ft. of floor area OR

unconditioned spaces OR

log homes designed in accordance with ICC 400



- ✓ If insulation is full height uncompressed over exterior wall top plate
 - ✓ R-30 allowed for up to 500 ft² or 20% total insulated ceiling area, whichever is less, where
 - ✓ Required insulation levels exceed R-30 in the interstitial space above a ceiling and below structural roof deck
 - ✓ Design of roof/ceiling assembly does not provide sufficient amount of space to meet higher levels

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

For air permeable insulations in vented attics, a baffle shall be installed

- ✓ Adjacent to soffit and eave vents
- ✓ To maintain a **net free area** opening \geq size of vent
- ✓ To extend over top of attic insulation
- ✓ May be of any solid material
- ✓ **Installed to the outer edge of exterior wall top plate**

Where soffit venting isn't continuous, baffles installed to prevent ventilation air in the eave soffit from bypassing the baffle

Insulate to same R-value for wall or ceiling in Table 402.1.3

- e.g., required ceiling insulation = R-38, then attic hatch must be insulated to R-38

Exceptions:

- Vertical doors that provide access can meet Table R402.1.3
- Horizontal pull-down, stair-type access hatches separating conditioned from unconditioned spaces in CZ 0-4 – with additional restrictions

Access Hatches and Door Insulation Installation and Retention

Section R402.2.4.1

Weatherstrip and insulate **vertical or horizontal access hatches and** doors from conditioned spaces to unconditioned spaces (*e.g., attics and crawl spaces*)

Provide access to all equipment that prevents damaging or compressing the insulation

Install a wood framed or equivalent baffle or retainer or dam when loose fill insulation is installed

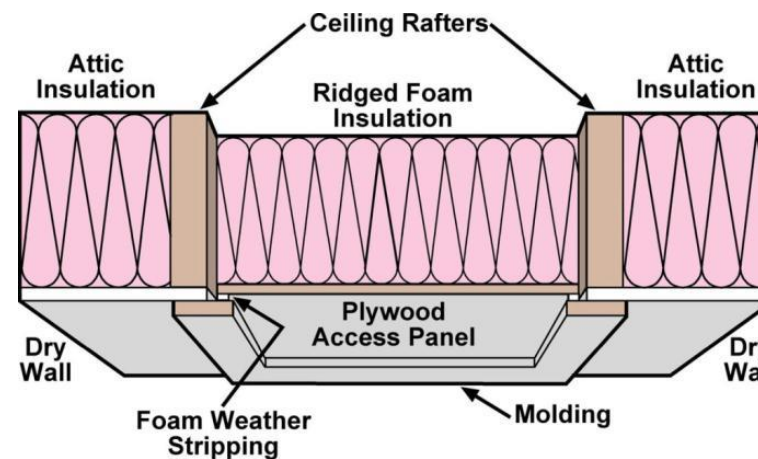


Table R402.2.6 (PARTIAL TABLE)
Steel-Frame Ceiling, Wall and Floor Insulation
(R-Value)

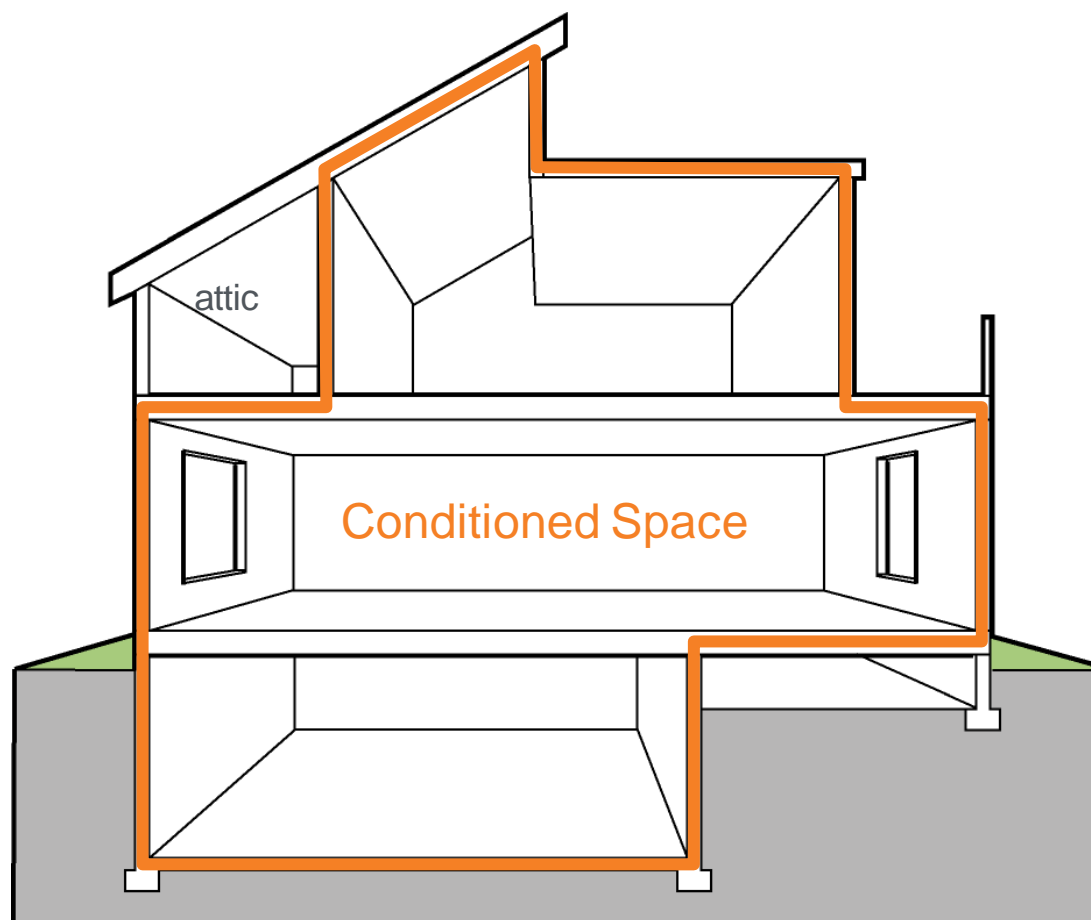
Table keys on the wood-frame requirement for the corresponding building component

Wood Frame R-value Requirement	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
R-49	R-38 + 5
Steel Joist Ceilings ^b	
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

- ✓ “R-X + R-Y” means R-X cavity plus R-Y continuous
- ✓ In ceilings, insulation that exceeds the height of the framing must cover the framing

Building Envelope consists of:

- ✓ Fenestration
- ✓ Ceilings
- ✓ **Walls**
 - Above grade
 - Below grade
 - Mass walls
- ✓ Fenestration
- ✓ Floors
- ✓ Slabs
- ✓ Crawl Spaces



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

Above Grade Walls

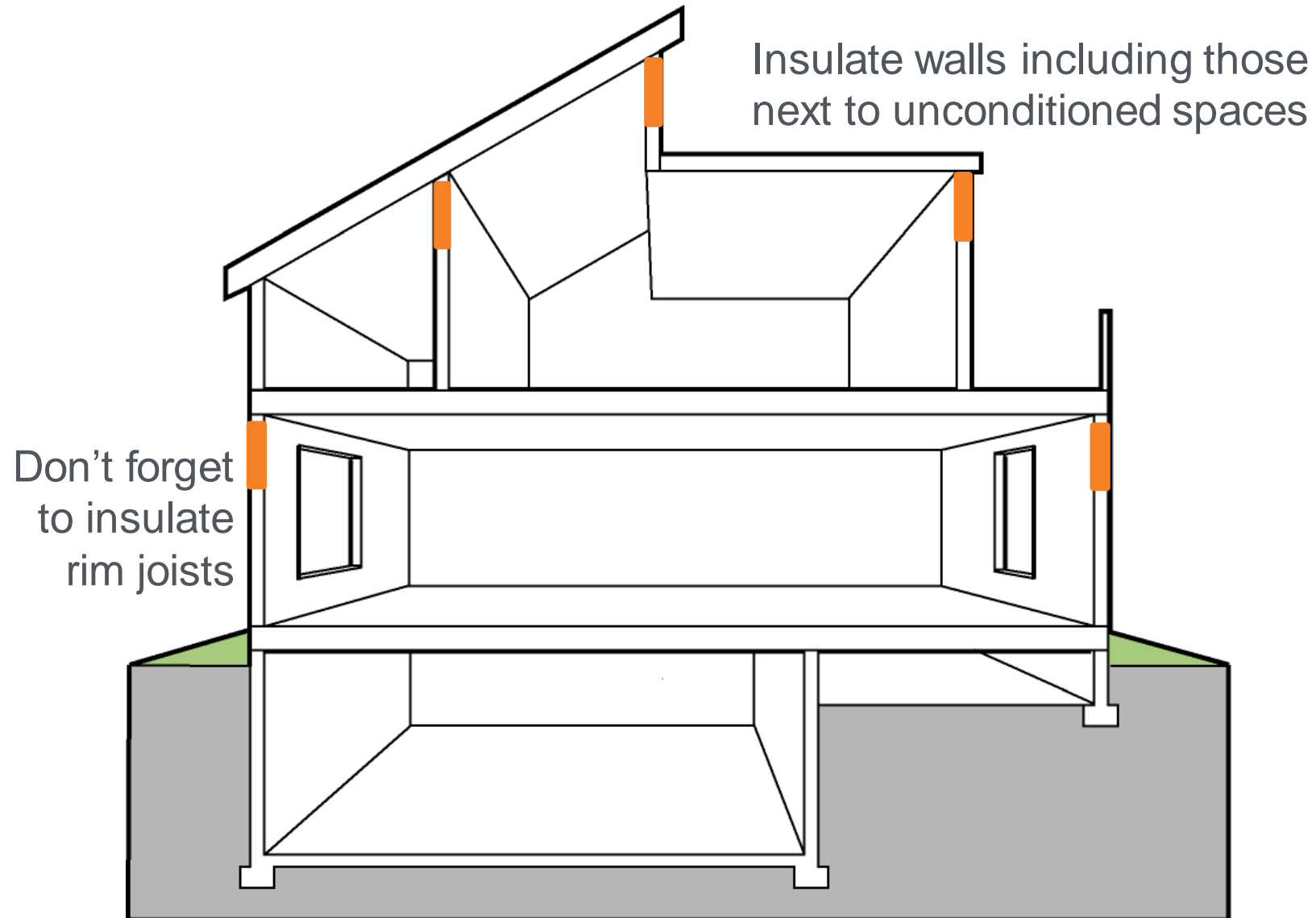


Table R402.1.3 (PARTIAL)
INSULATION AND FENESTRATION REQUIREMENTS BY
COMPONENT

CLIMATE ZONE	...	WOOD FRAME WALL R-VALUE
0		13 or 0 + 10
1		13 or 0 + 10
2		13 or 0 + 10
3		20 or 13+5ci or 0+15

First value is cavity insulation, second is continuous insulation so. Therefore, as an example, “13+5” means R-13 cavity insulation plus R-5 continuous insulation

- R-value labeled on product package
- Indicated on certification
- Installer signature and date
- Posted on site in conspicuous location
- Thermal resistance (R-value) determined in accordance with ASTM C 1363

Table R402.2.6
Steel-Frame Ceiling, Wall and Floor Insulation
(R-Value)

Wood Frame R-value Requirement	Cold-Formed Steel Equivalent R-value ^a
	Steel
R-30	
R-38	
R-49	
Table keys on the wood-frame requirement for the corresponding building component	
✓ “R-X + R-Y” means R-X cavity plus R-Y continuous	
Steel Framed Wall	
R-13	R-13 + 4.2 or R-21 + 2.8 or R-0 + 9.3 or R-15 + R-3.8 or R-21 + 3.1
R-13 + R-5	R-0 + 15 or R-13 + 8 or R-15 + 8.5 or R-19 + 8 or R-21 + 7

Mass Walls

Section R402.2.5

What type

- ✓ Concrete block, concrete, insulated concrete form (ICF), masonry cavity, brick (other than brick veneer), adobe, compressed earth block, rammed earth, solid timber, **mass timber or solid logs**
- ✓ Any other walls having a heat capacity ≥ 6 Btu/ft.²/°F

Provisions

- ✓ Are assumed to be above grade walls



Table R402.1.3
INSULATION AND FENESTRATION REQUIREMENTS BY
COMPONENT

Climate Zone	...	Mass Wall R-Value
0		3/4
1		3/4
2		4/6
3		8/13
4 except Marine		8/13
5 and 4 Marine		13/17

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)

Building Envelope consists of:

- ✓ Fenestration
- ✓ Ceilings
- ✓ Walls
 - Above grade
 - Below grade
 - Mass walls
- ✓ **Floors**
- ✓ Slabs
- ✓ Crawl Spaces

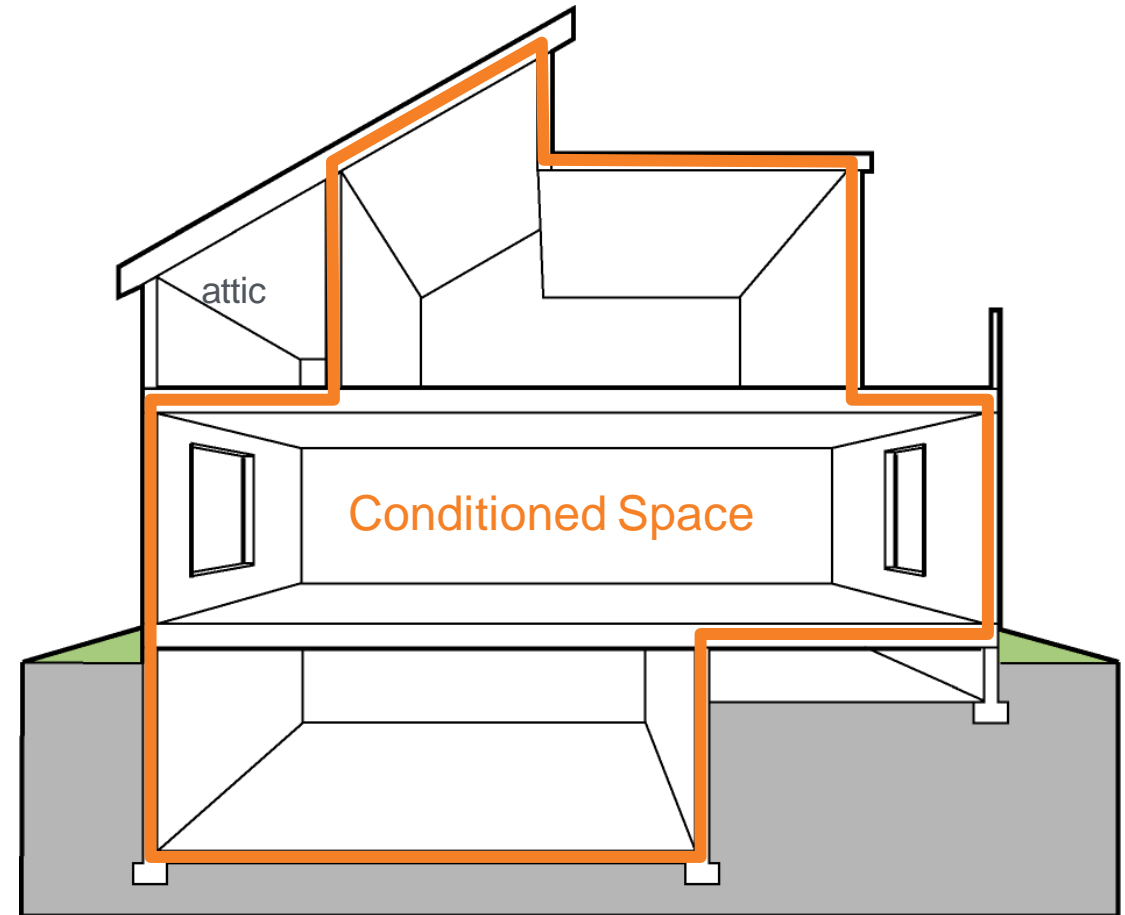


Table R402.1.3 (PARTIAL)
INSULATION AND FENESTRATION REQUIREMENTS BY
COMPONENT

CLIMATE ZONE	...	FLOOR R-VALUE
0		13
1		13
2		13
3		19

Floors (Over Unconditioned Space)

Section 402.2.7

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

Climate Zones	R-Value
0-2	13
3-4ab	19
4c-6	30*
7-8	38*



Three options for floor cavity insulation:

1. Insulation must maintain permanent contact with underside of subfloor decking per manufacturer's instructions to maintain required R-value or readily fill the available cavity space
2. Cavity insulation in contact with the top side of sheathing (insulation to extend from bottom of the top of all perimeter floor framing members and framing members to be air sealed
3. A combination of cavity and continuous insulation installed so cavity insulation is in contact with top side of continuous insulation that is installed on the underside of the floor framing. Combined R-value to equal required floor R-value. Insulation to extend from bottom to the top of all perimeter floor framing members and framing members to be air sealed.

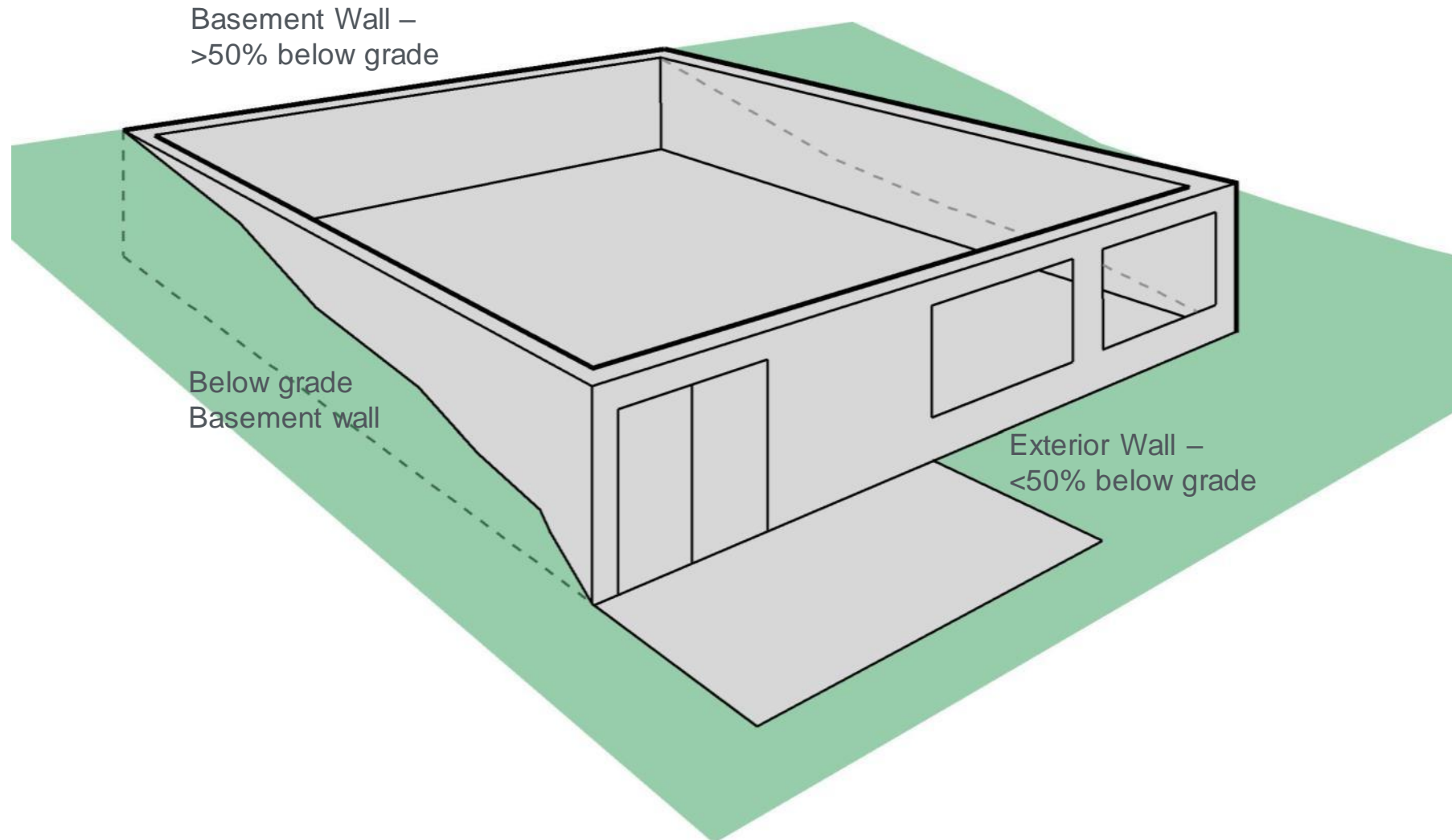
Table R402.2.6
Steel-Frame Ceiling, Wall and Floor Insulation
(R-Value)

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

Wood Frame R-value Requirement	Cold-Formed Steel-Frame Equivalent R-value ^a
Steel Joist Floor ^b	
R-13	R-19 in 2x6, or R-19 + 6 in 2x8 or 2x10
R-19	R-19 + 6 in 2x6, or R-19 + 12 in 2x8 or 2x10

✓ “R-X + R-Y” means R-X cavity plus R-Y continuous

Defining Below-Grade Walls

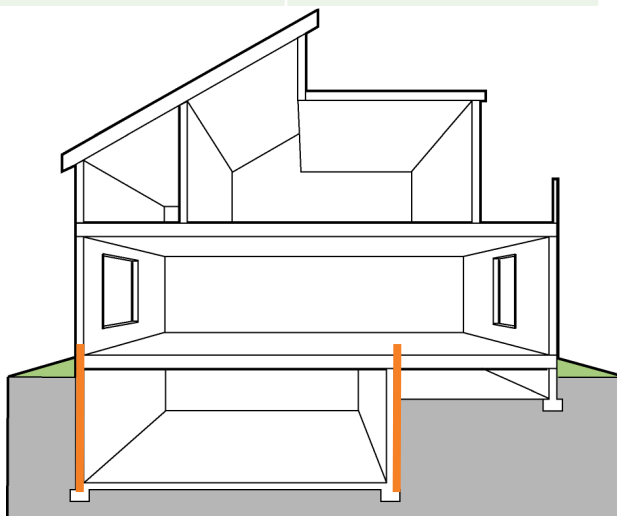


Basement Walls

Section R402.2.8

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

Climate Zones	R-Value
0-2	0
3	5/13
4ab	10/13
4c-8	15/19 or 13 + 5



- “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 (footnote f)

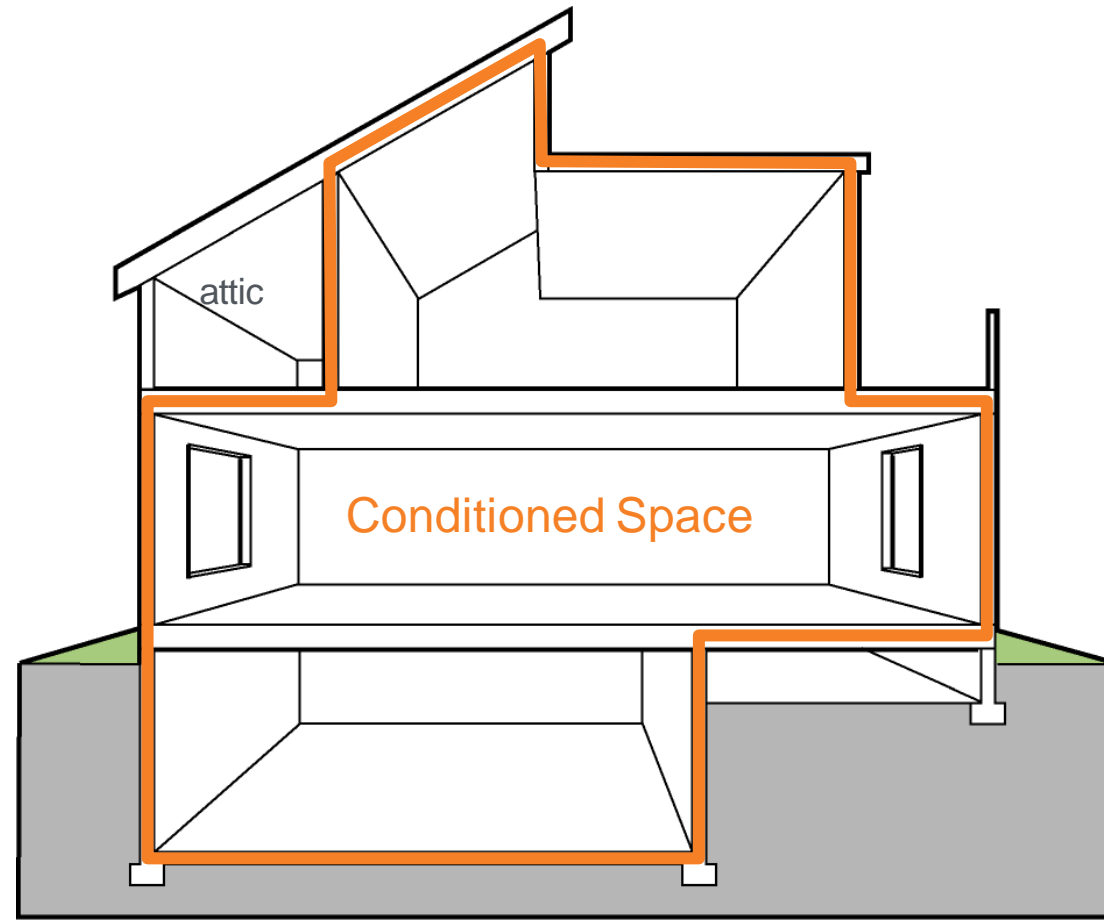


Insulated from top of basement wall down to 10 ft below grade or basement floor, whichever is less

Building Envelope Specific Requirements

Building Envelope consists of:

- ✓ Fenestration
- ✓ Ceilings
- ✓ Walls
 - Above grade
 - Below grade
 - Mass walls
- ✓ Floors
- ✓ **Slabs**
- ✓ Crawl Spaces

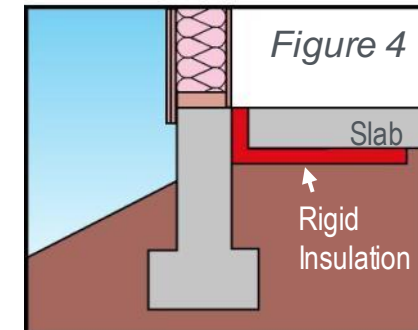
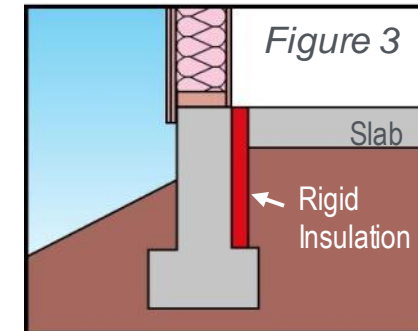
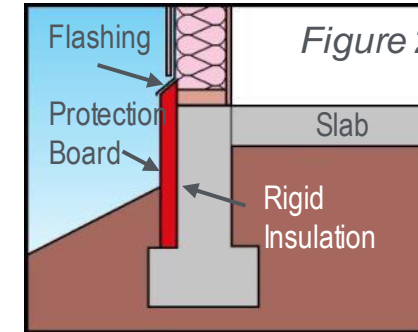


Slab Edge Insulation

Section R402.2.9

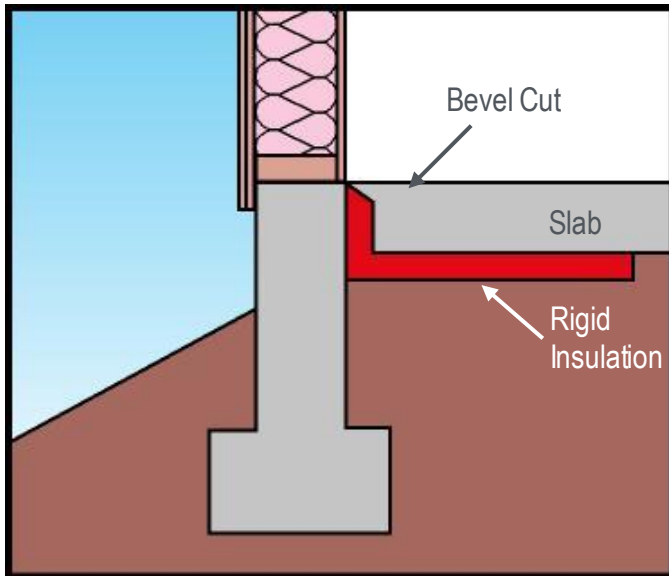
Applies to slabs with a floor surface < 12 inches below grade

- ✓ R-10 insulation in Zones 4 and above
- ✓ Must extend downward from top of slab a minimum of 24" (Zones 3) or 48" (Zones 4-8)
- ✓ 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



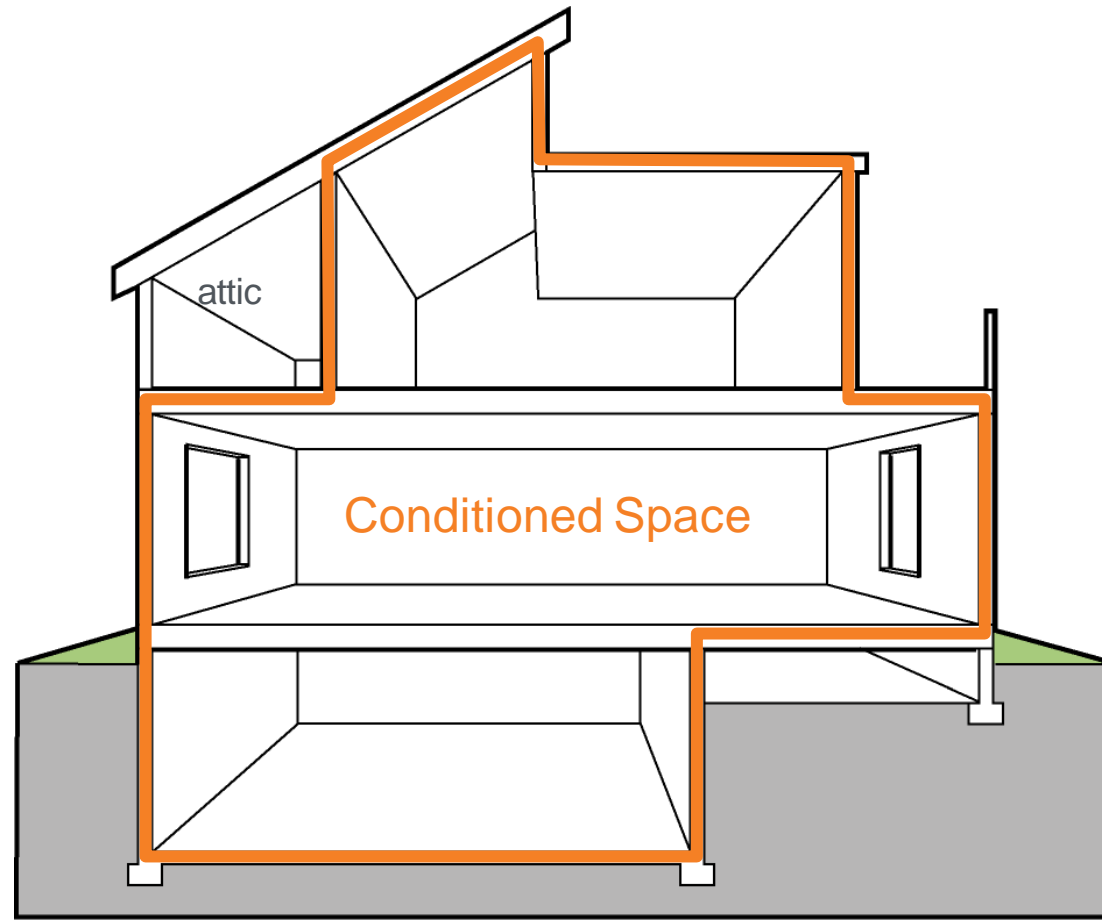
Slab Edge Insulation

Section R402.2.9



Building Envelope consists of:

- ✓ Fenestration
- ✓ Ceilings
- ✓ Walls
 - Above grade
 - Below grade
 - Mass walls
- ✓ Floors
- ✓ Slabs
- ✓ **Crawl Spaces**

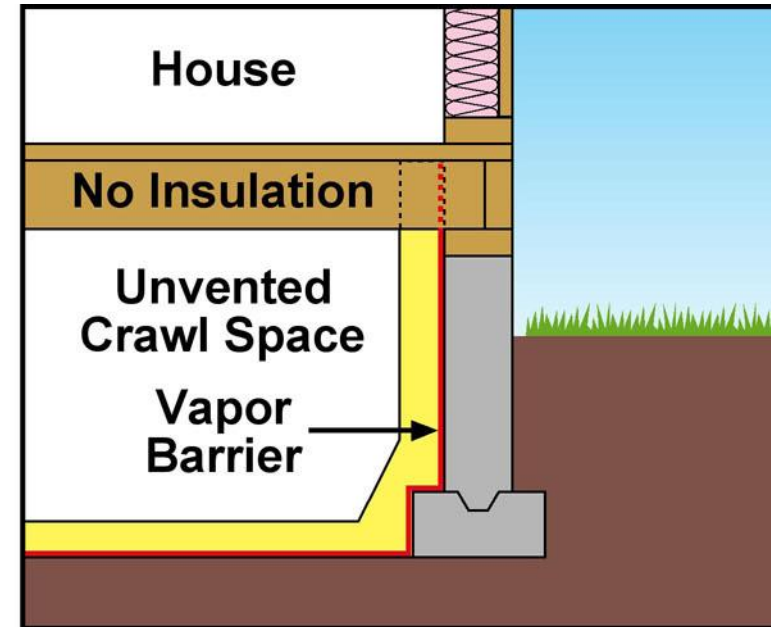
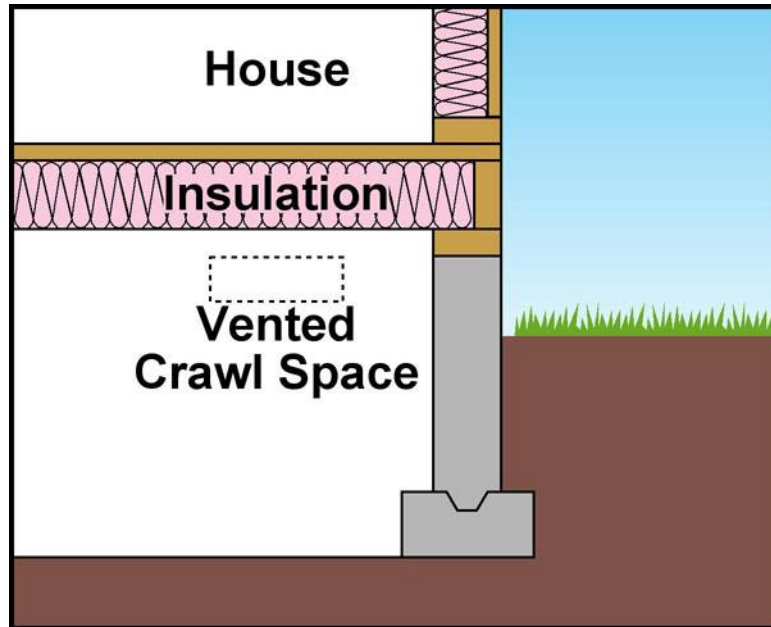


Crawl Space Wall Insulation

Section R402.2.10

Implies an unvented crawlspace (*aka, conditioned crawlspace*)

- ✓ Space must be mechanically vented or receive minimal supply air (*Refer to 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 R402.1.2*).
- ✓ 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.

Provisions

- ✓ Apply when wall heat capacity ≥ 6 Btu/ft²/°F
- ✓ When more than half the insulation is on the interior, the mass wall U-factors can't exceed values listed in Table R402.1.2, footnote b (Partial Table below)

Climate Zones	U-Factor Maximum
0-1	0.197 / 0.170
2	0.165 / 0.140
3	0.098 / 0.120
4 except Marine	0.098 / 0.087

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

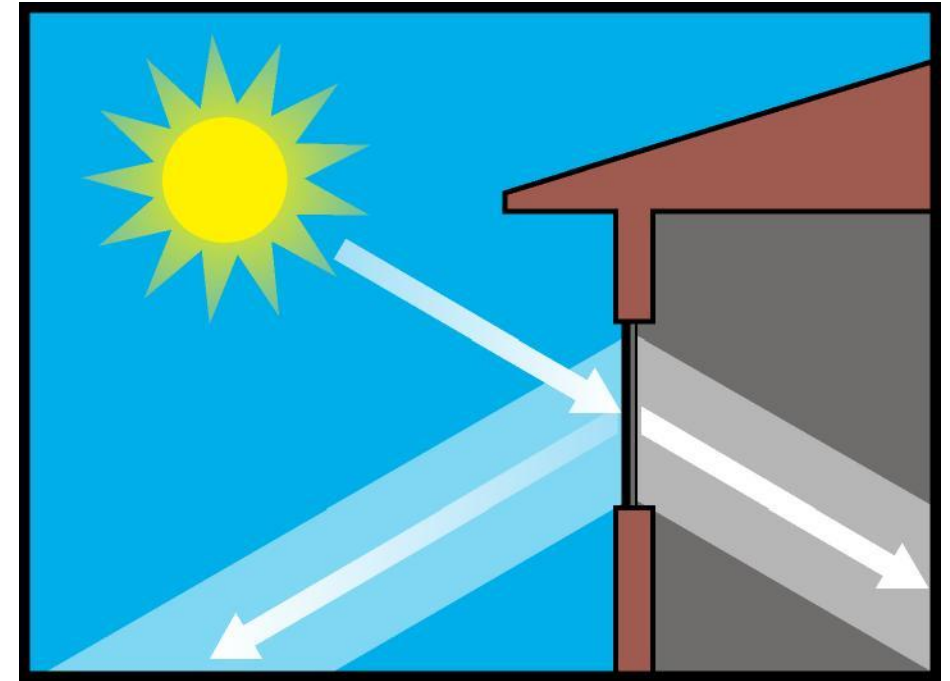
Climate Zones	U-Factor Maximum
4-5	0.48
6-8	0.40

- ✓ U-0.75 for skylights in **Zones 4-8**
- ✓ U-factors of individual windows or skylights can be higher if area-weighted average is below these limits.

Hard limit on Solar Heat Gain Coefficient in southern U.S. (Zones 0-3)

- ✓ SHGC cannot exceed 0.40, even in performance trade-offs or ERI path
- ✓ SHGCs of individual windows or skylights can be higher if area-weighted average is below this limit.

Exception: Maximum U-factor and SHGC not required in storm shelters complying with ICC 500



Solar Heat Gain Coefficient

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

Sunroom definition:

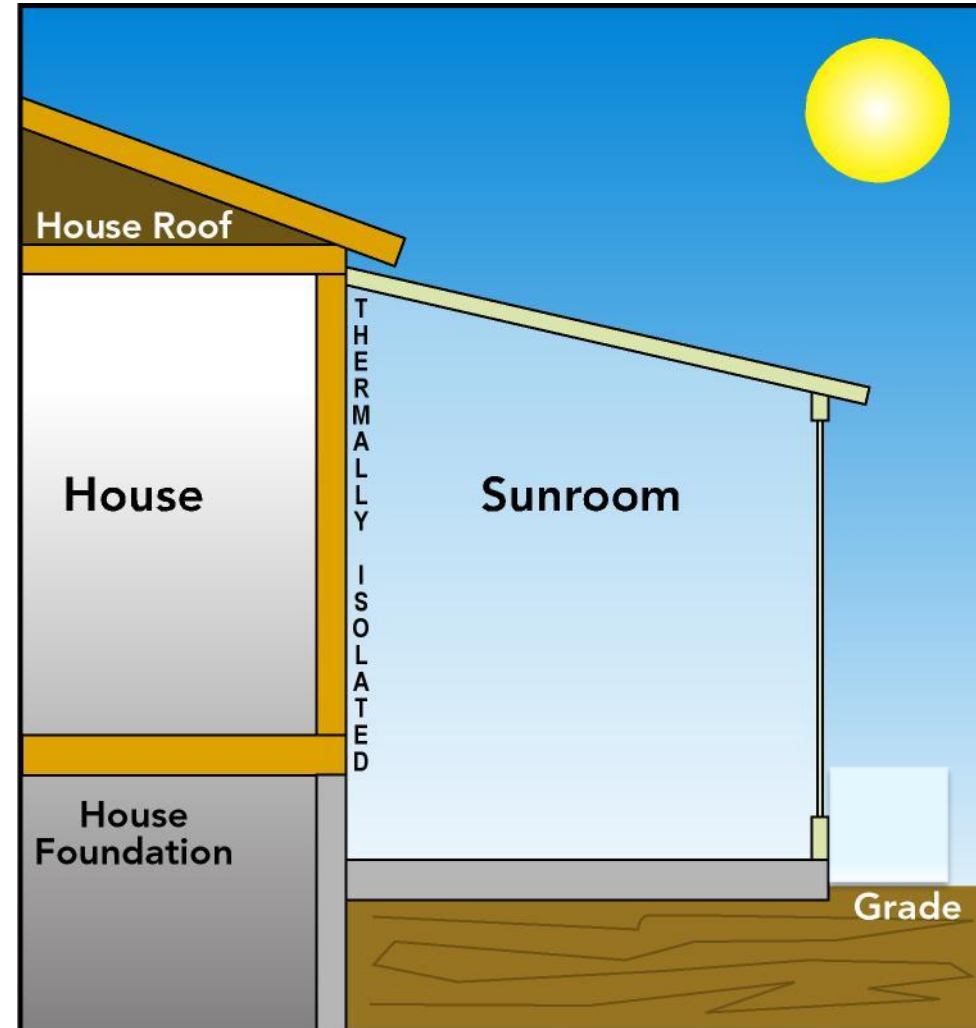
- ✓ One story structure
- ✓ Glazing area >40% glazing of gross exterior wall and roof area
- ✓ Separate heating or cooling system or zone
- ✓ Must be thermally isolated
(both HVAC and physical separation—closeable doors or windows between sunroom and rest of the house)
- ✓ Can always meet Table R402.1.2 requirements with unlimited glass



Sunroom and Heated Garage Requirements

Section R402.2.12 / R402.3.5

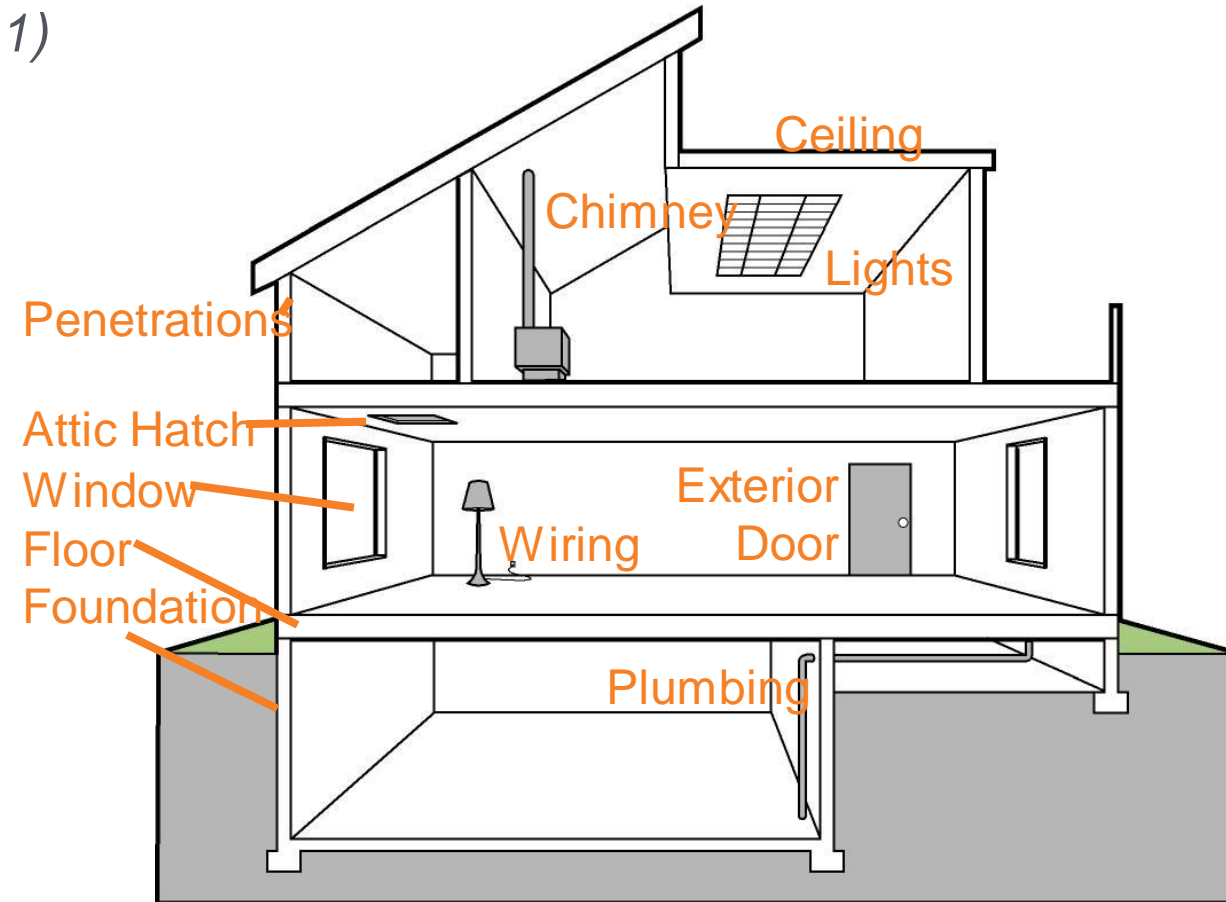
- ✓ Ceiling Insulation
 - Zones 0-4 R-19
 - Zones 5-8 R-24
- ✓ Wall Insulation
 - All zones R-13
- ✓ Fenestration U-Factor
 - Zones 2-8 0.45
- ✓ Skylight U-Factor
 - Zones 2-8 0.70



Air Leakage

Section R402.4

- ✓ Building thermal envelope (Section R402.4.1)
- ✓ Recessed lighting
- ✓ Fenestration
- ✓ Fireplaces
- ✓ Rooms with fuel-burning appliances
- ✓ **Electrical and communication outlet boxes**



Building thermal envelope



Requires BOTH:

- ✓ Whole-house pressure test – maximum air leakage under any compliance path to not exceed 5 ACH or 0.28 CFM/ft² of dwelling unit enclosure area
- ✓ When complying per prescriptive path:

Air Leakage Rate	Climate Zone	Test Pressure
≤ 5 ACH	0-2	50 Pascals
≤ 3 ACH	3-8	50 Pascals

- Testing may occur any time after creation of all building envelope penetrations
- ✓ Field verification of items listed in Table R402.4.1.1

Component	Air Barrier Criteria	Insulation Installation Criteria
General requirements	A continuous air barrier shall be installed in the building envelope. Breaks or joints in the air barrier shall be sealed.	Air-permeable insulation shall not be used as a sealing material.
Ceiling/attic	The air barrier in any dropped ceiling or soffit shall be aligned with the insulation and any gaps in the air barrier sealed. Access openings, drop down stair or knee wall doors to unconditioned attic spaces shall be sealed.	The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.
Walls	The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the top of exterior walls shall be sealed. Knee walls shall be sealed.	Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance R-value of not less than R-3 per inch. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.
Windows, skylights and doors	The space between framing and skylights and the jambs of windows and doors shall be sealed.	

(partial table)

Building Thermal Envelope

Section R402.4.1.3 – Leakage Rate

✓ Prescriptive

Air Leakage Rate	Climate Zone	Test Pressure
≤ 5 ACH	0-2	50 Pascals
≤ 3 ACH	3-8	50 Pascals

✓ Total Building Performance and ERI – R402.4.1.2 sets a 5.0 ACH50 trade-off limit on tested air leakage for any climate zone

Air Leakage Rate	Climate Zone	Test Pressure
≤ 5 ACH	0-2	50 Pascals
≤ 5 ACH	3-8	50 Pascals



Fireplaces

Section R402.4.2

- New wood-burning fireplaces shall have tight fitting flue dampers or doors, and outdoor combustion air
- Tight fitting doors on fireplaces that are:
 - Factory built – listed and labeled per UL 127



TYPE	AIR INFILTRATION RATE
Windows, sliding glass doors, and skylights	≤ 0.3 cfm/ft ²
Swinging doors	≤ 0.5 cfm/ft ²

Exceptions

- ✓ Site-built windows, skylights, and doors

- Climate Zones 3-8
- Open combustion fuel burning appliances where open combustion air ducts provide combustion air
 - The appliances and combustion air opening shall be located outside the building thermal envelope OR
 - Enclosed in a room isolated from inside the thermal envelope
 - Sealed and insulated per Table R402.1.3
 - Door gasketed and sealed
 - Any ducts or water lines insulated per R403
 - Combustion air duct insulated to an R-value of not less than R-8 where it passes through conditioned space
 - Exceptions:
 - Direct vent appliances with both intake and exhaust pipes installed continuous to outside
 - Fireplaces and stoves complying with R402.4.2 and Section R1006-IRC

Recessed Lighting Fixtures

Section R402.4.5

- ✓ 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



- ✓ Sealed to limit air leakage between conditioned and unconditioned spaces
- ✓ Tested per NEMA OS 4, at 1.57 psf (75 Pa) pressure differential with no more than 2.0 cfm of air movement
- ✓ Boxes marked either NEMA OS 4 or OS 4
- ✓ Installed per manufacturer's instructions

Minimum equipment efficiency set by Federal law,
not the I-Codes

- ✓ Controls
- ✓ Heat pump supplementary heat
- ✓ Hot water boiler outdoor temperature setback
- ✓ Ducts
- ✓ HVAC piping insulation
- ✓ Hot water systems
- ✓ Ventilation
 - Dampers
- ✓ Equipment sizing
- ✓ Systems serving multiple dwelling units
- ✓ Snow melt controls
- ✓ Energy consumption of pools and spas

Programmable Thermostat

Section R403.1.1 - Controls

- ✓ At least one programmable thermostat controlling the primary heating/cooling per dwelling unit
- ✓ Capability to set back or temporarily operate the system to maintain zone temperatures
 - Not less than 55°F (13°C) or
 - Not greater than 85°F (29°C)
- ✓ Initially programmed by manufacturer with:
 - heating temperature set point not greater than 70°F (21°C) and
 - cooling temperature set point not less than 78°F (26°C)



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

Exception

- ✓ During defrost

- Manufacturer to equip each boiler (gas, oil and electric) with a means to automatically adjust water temperature supplied by boiler to ensure incremental change of the inferred head load will cause an incremental change in the temperature of the water supplied by the boiler
 - Outdoor reset OR
 - Indoor reset OR
 - Water temperature sensing
- Not required for boilers equipped with tankless domestic water heating coil

Ducts Located Outside Conditioned Space

Section R403.3.1

- ✓ Supply and return ducts in **attics**: R-8 where $\geq 3''$ diameter, R-6 if $< 3''$
- ✓ Ducts buried beneath a building – insulated as required per this section or have equivalent thermal distribution efficiency
 - ✓ Underground ducts using thermal distribution efficiency method to be listed and labeled with R-value equivalency

For simulated performance path, buried ducts may be considered inside conditioned space if:

1. The duct system is actually located completely within the continuous air barrier and within the building thermal envelope, OR
2. The ducts are buried within ceiling insulation in accordance with Section R403.3.6 and all of the following conditions exist:
 - 2.1. The air handler is located completely within the *continuous air barrier* and within the building thermal envelope.
 - 2.2. The duct leakage, as measured either by a rough-in test of the ducts or a post-construction total system leakage test to outside the building thermal envelope in accordance with Section R403.3.4, is less than or equal to 1.5 cubic feet per minute (42.5 L/min) per 100 square feet (9.29 m²) of conditioned floor area served by the duct system.
 - 2.3. The ceiling insulation *R*-value installed against and above the insulated duct is greater than or equal to the proposed ceiling insulation *R*-value, less the *R*-value of the insulation on the duct.

Prior to **2018**, the IECC did not prohibit buried ducts, but neither did it define the practice or make specific allowance for it. Provisions:

1. Define buried-duct practices that are explicitly allowed
2. Provide a means to characterize the performance of a buried duct system as an equivalent duct insulation R-value
3. Allow simplified credit for buried ducts in the performance path
 - Buried duct system may be considered inside conditioned space if certain requirements are met

- Where supply and return air ducts are partially or completely buried in ceiling insulation, such ducts shall comply with all of the following:
 - 1. The supply and return ducts shall have an insulation *R*-value not less than R-8.
 - 2. At all points along each duct, the sum of the ceiling insulation *R*-value against and above the top of the duct, and against and below the bottom of the duct, shall be not less than R-19, excluding the *R*-value of the duct insulation.
 - 3. In *Climate Zones* **0A**, 1A, 2A and 3A, the supply ducts shall be completely buried within ceiling insulation, insulated to an *R*-value of not less than R-13 and in compliance with the vapor retarder requirements of Section 604.11 of the *International Mechanical Code* or Section M1601.4.6 of the *International Residential Code*, as applicable.
- **Exception:** Sections of the supply duct that are less than 3 feet (914 mm) from the supply outlet shall not be required to comply with these requirements.

- Where using a simulated energy performance analysis, sections of ducts that are:
 - installed in accordance with Section R403.3.3
 - located directly on, or within 5.5 inches (140 mm) of the ceiling
 - surrounded with blown-in attic insulation having an *R*-value of R-30 or greater
 - located such that the top of the duct is not less than 3.5 inches below the top of the insulation
- shall be considered as having an effective duct insulation *R*-value of R-25

Duct Sealing

Section R403.3.4

- ✓ Sealing
 - Joints and seams to comply with IMC or IRC
 - All ducts, air handlers, and filter boxes to be sealed



Sealed Air Handler

Section R403.3.4.1

Air handlers to have a manufacturer's designation for an air leakage of $\leq 2\%$ of design air flow rate per ASHRAE 193



- Ducts shall be pressure tested **per ANSI/RESNET/ICC 380 or ASTM E1554** to determine air leakage by either of the following:
 - Rough-in test
 - Total leakage measured with a pressure differential of 0.1 inch w.g. (25 Pa) across the system including manufacturer's air handler enclosure
 - All registers taped or otherwise sealed
 - Postconstruction test
 - Total leakage measured with a pressure differential of 0.1 inch w.g. (25 Pa) across the entire system including manufacturer's air handler enclosure
 - All registers taped or otherwise sealed
 - Exception
 - Test not required for ducts serving heat or energy recovery ventilators not integrated with ducts serving heating or cooling systems
 - **(Note: exception for ducts in conditioned space was removed)**

Total leakage of ducts, where measured in accordance with Section 403.3.5 shall be as follows:

✓ Rough-in test

- Total leakage ≤ 4 cfm/per 100 ft² of conditioned floor area
 - if air handler not installed at time of test
 - » Total air leakage ≤ 3 cfm/per 100 ft²

✓ Postconstruction test

- Total leakage ≤ 4 cfm/per 100 ft² of conditioned floor area

✓ Test for ducts within thermal envelope

- Total leakage ≤ 8 cfm/per 100 ft² of conditioned floor area

Duct Tightness Tests



Building Cavities

Section R403.3.7

Framing cavities cannot be used
as ducts or plenums



- ✓ R-3 required on
 - HVAC systems
 - Exception: Piping that conveys fluids between 55 and 105°F
- If exposed to weather,
 - protect from damage, including
 - Sunlight
 - Moisture
 - Equipment maintenance
 - Wind
 - Provide shielding from solar radiation that can cause degradation of material
 - Adhesive tape is not allowed

- Heated water circulation systems
- Demand recirculation water systems
- Heat trace systems

- Heated water circulation systems
 - provided with circulation pump
 - return pipe must be a dedicated return pipe or a cold water supply pipe
 - gravity and thermosyphon circulation systems are prohibited
- Controls shall
 - start the pump based on identification of the demand for hot water within the occupancy
 - automatically turn off pump when water in the loop is at desired temperature and there is no demand for hot water
 - limit the temperature of water entering cold water pipe to not greater than 104°F
- Automatic controls, temperature sensors, and pumps shall be accessible
- Manual controls shall be readily accessible

- Demand recirculation water system to have controls that
 - start pump upon:
 - receiving a signal from action of user of a fixture or appliance
 - sensing the presence of a user of a fixture or
 - sensing the flow of hot or tempered water to a fixture fitting or appliance

- Electric heat trace systems shall comply with IEEE 515.1 or UL 515
- Controls shall automatically adjust the energy input to the heat tracing to maintain the desired water temperature in the piping in accordance with the times when heated water is used in the occupancy

- R-3 required on
 - Piping $\geq \frac{3}{4}$ in. nominal diameter **inside conditioned space**
 - Piping serving more than one dwelling unit
 - Piping located outside the conditioned space
 - Piping from the water heater to a distribution manifold
 - Piping under a floor slab
 - Buried piping
 - Supply and return piping in recirculating systems other than demand recirculation systems



Image courtesy of Ken Baker, K energy

- Comply with CSA B55.2 and tested in accordance with CSA B55.1
- Portable water-side pressure loss of drain water heat recovery units shall be < 3 psi for individual units connected to 1 or 2 showers
 - < 2 psi if connected to ≥ 3 showers

- ✓ Ventilation
 - Building **and dwelling units** to have ventilation complying with IRC or IMC or with other approved means
 - Outdoor air intakes and exhausts shall have automatic or gravity dampers that close when the ventilation system is not operating
- ✓ Heat or energy recovery ventilation
 - Dwelling units provide HRV or ERV in Climate Zones 7-8
 - System balanced with minimum sensible heat recovery efficiency of 65% at 32F at a flow \geq design airflow
- ✓ Whole-dwelling mechanical ventilation system fans to meet efficacy in Table R403.6.2
 - ✓ Fans tested per HVI 916 and listed
 - ✓ Airflow reported in product listing or on label
 - ✓ Fan efficacy
 - ✓ reported in product listing or derived from input power and airflow values reported in product listing or on label
 - ✓ For fully ducted HRV, ERC, balanced and in-line fans to be determined at static pressure not less than 0.2" w.c.
 - ✓ For ducted range hoods, bathroom and utility room fans to be determined at static pressure not less than 0.1" w.c.



- ✓ Tested and verified to provide minimum ventilation flow rates per R403.6
- ✓ Testing performed
 - ✓ per manufacturer's instructions OR
 - ✓ Using flow hood or box, flow grid, or other airflow measuring device at the fan's inlet terminals or grilles, outlet terminals or grilles, or in connected ventilation ducts
- ✓ Where required by code official, testing to be conducted by an approved third party, with a signed, written report with results provided to code official

✓ Equipment Sizing

- Load calculations determine the proper capacity (size) of equipment
 - Goal is big enough to ensure comfort but no bigger
- Sizing shall be performed in accordance with ACCA Manual S based on loads calculated in accordance with ACCA Manual J (other approved methods)

✓ Efficiency Rating

- New or replacement heating/cooling equipment shall have an efficacy rating equal to or greater than minimum required by federal law for geographic location of installation

Systems serving multiple dwelling units shall comply with Sections C403 and C404 **instead** of Section R403



Snow- and ice-melting system controls

- ✓ Automatic shutoff when pavement temperature is $> 50^{\circ}\text{F}$ and precipitation is not falling
- ✓ Automatic or manual shutoff when outdoor temperature is $> 40^{\circ}\text{F}$

- ✓ Heaters
 - with a readily accessible on-off switch that is integral part of heater mounted on the exterior of heater or external to within 3 feet of heater
 - Switch shall not change the setting of heater thermostat
 - Switches shall be in addition to the circuit breaker for the power to the heater
 - fired by natural gas not allowed to have continuously burning pilot lights
- ✓ Time switches (or other control method) to automatically turn heaters and pumps off and on according to a preset schedule installed on all heaters and pump motors
- ✓ Note: heaters, pumps, and motors with built-in timers meet the requirement
 - Exceptions
 - Public health standards requiring 24-hour pump operation
 - Pumps operating pools with solar and waste-heat recovery heating systems



On outdoor heated pools and outdoor permanently installed spas

- ✓ Vapor-retardant cover OR
- ✓ Other approved vapor retarder means

Exception:

- ✓ If >75% of energy from **heat pump or** on-site renewable energy system **(computed over an operation season not fewer than 3 calendar months)**



- Energy consumption of electric-powered portable spas shall be controlled by the requirements of APSP14



All permanently installed lighting fixtures shall contain only high efficacy **lighting sources**

Exception: kitchen appliance lighting fixtures



Connected exterior lighting to comply with Section C405.4

Exceptions:

- Detached one- and two-family dwellings
- Townhouses
- Solar-powered lamps not connected to any electric service
- Luminaires controlled by a motion sensor
- Lamps and luminaires that comply with Section R404.1

Fuel gas lighting systems may not have continuously burning pilot lights

Permanently installed fixtures to be controlled with a dimmer, an occupant sensor control or other control installed or built into the fixture

Exceptions:

- Bathrooms
- Hallways
- Exterior lighting fixtures
- Lighting designed for safety or security

Where total permanently installed exterior lighting power is > 30 watts

- Lighting to be controlled by manual on and off switch which permits automatic shut-off actions (not required for dwelling units)
- Lighting to be automatically shut off when daylight is present and satisfies the lighting needs
- Controls that override automatic shut-off actions not allowed unless override automatically returns control to normal operation within 24 hrs

- Proposed design to be shown to have an annual energy cost that is less than or equal to the annual energy cost of the standard reference design
- Specifications for standard reference and proposed design are in Table **R405.4.2(1)**
 - New in 2018: Allowance for batch sampling of stacked multifamily units

- ✓ Requires computer software with specified capabilities (local official may approve other tools)
- ✓ Includes both envelope and some systems
 - Equipment treated equally in standard and proposed design
- ✓ Allows greatest flexibility
 - Can trade off tight duct systems
- ✓ Defines compliance based on equivalency of calculated energy cost or source energy
- ✓ Section R405 specifies “ground rules”
 - These will generally be “hidden” in compliance software calculation algorithms
 - Similar ground rules are used in home federal tax credits and ENERGY STAR Home guidelines

Service Hot Water Changes

Section R405.4 – Calculation Procedure - Hot Water Distribution Compactness Factor

1. Locate the water heater and the hot water fixtures and appliances
2. Draw a rectangle through the center line of the water heater and the plumbing walls next to the hot water fixtures and appliances
3. Calculate the area of this rectangle
4. Divide this area by the conditioned floor area of the home to get the Compactness Ratio
5. Determine if a credit can be taken and how large it can be



- First included in the 2015 IECC, ERI path differs from the traditional prescriptive and performance paths
 - Unlike the performance path, is not based on the prescriptive requirements
 - Fundamental requirement is a single rating (ERI) based on **RESNET/ICC 301**
- **Requirements table R406.2 lists requirements to be met**

- Compliance with this method must be completed by an approved third party and documentation including compliance reports must be reviewed by the code official
- Compliance is demonstrated if the calculated ERI is \leq a defined threshold for the climate zone in which the building is located
- **Summary of 2021 IECC Changes**
 - Required values in Table R406.5 were reduced
 - R406.3 limits renewable energy production to reduce no more than 5% of total energy use
 - Additional Efficiency Package Options – requires a target score reduction of 5%

Table R406.5
Maximum Energy Rating Index

Climate Zone	ERI ^a
0-1	52
2	52
3	51
4	54
5	55
6	54
7	53
8	53

➤ **ERI envelope backstop at 115% of 2021 IECC Reference UA**

On-site renewables are NOT included:

- Proposed total building thermal envelope UA (sum of U-factor x assembly area) to be less than or equal to building thermal envelope UA using prescriptive U-factors from Table R402.1.2 x 1.15 (Equation 4-1).
- Area-weighted maximum fenestration SHGC permitted in Climate Zones 0-3 to be 0.30.

➤ **ERI envelope backstop to 2018 IECC with on-site renewable energy**

- Building thermal envelope to be greater than or equal to levels of efficiency and SHGC in Table R402.1.2 or Table R402.1.4 of the 2018 IECC

- ERI is determined in accordance with ANSI/RESNET/ICC 301
- Except for buildings covered by IRC, the ERI Reference Design Ventilation rate to be in accordance with Equation 4-2:

Equation 4-2

Ventilation rate, CFM = $(0.01 \times \text{total square foot area of house}) + [7.5 \times (\text{number of bedrooms} + 1)]$

Energy used to recharge or refuel a vehicle used for transportation on roads not on the building site not included in ERI reference design or rated design

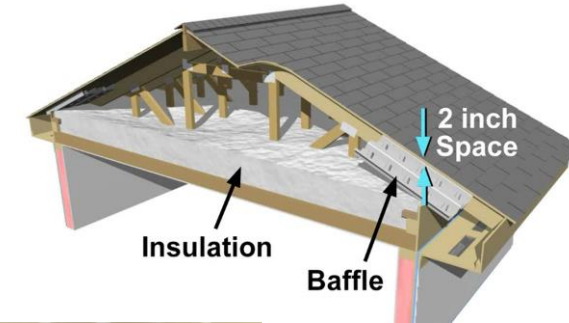
- Buildings deemed to comply at elevation < 2,400 feet above sea level where the following conditions are met:
 - < ½ space is air conditioned
 - Occupied space is not heated
 - $\geq 80\%$ solar, wind, or other renewable energy source supplies service water heating
 - SHGC on fenestration ≤ 0.40 or overhang projection factor ≥ 0.30
 - Lighting in accordance with R404
 - Exterior roof complies with Table C402.2.11 (commercial cool roof) or insulation of $\geq R-15$, if present, attics above insulation are vented and attics below insulation unvented
 - Roof surface slope of not less than $\frac{1}{4}$ unit vertical in 12 units horizontal (i.e., 1/48 or 2.1% [*note: code says 2 1%*])

- Operable fenestration provides ventilation of not less than 14% of floor area for each room or equivalent ventilation is provided by a ventilation fan
- Bedrooms with 2 exterior walls facing different directions have operable fenestration
- Interior doors to bedrooms capable of being secured open
- Ceiling fan or rough-in provided for bedrooms and the largest space that is not used as a bedroom

Additional Efficiency Package Options

Section R408

- R408.2.1 – Enhanced envelope performance option
 - Design UA \leq Standard UA * 0.95
- R408.2.2 – More efficient HVAC equipment performance option
 - Furnace \geq 95 AFUE and AC \geq 16 SEER
 - Air Source Heat Pump \geq 10 HSPF/16 SEER
 - Ground Source Heat Pump \geq 3.5 COP
- R408.2.3 – Reduced energy use in service water heating option
 - Fossil fuel water heater \geq 0.82 EF
 - Electric water heater \geq 2.0 EF
 - Solar water heater \geq 0.4 Solar Fraction
- R408.2.4 – More efficient duct thermal distribution system option
 - 100% of ducts and air handler inside building thermal envelope
 - 100% of ductless or hydronic system inside building thermal envelope
 - 100% of duct thermal distribution system located in conditioned space
- R408.2.5 – Improved air sealing and efficient ventilation system option
 - Air Leakage \leq 3.0 ACH50
 - HRV (75% Sensible Recovery Efficiency) or ERV (50% Latent Recovery/Moisture Transfer)

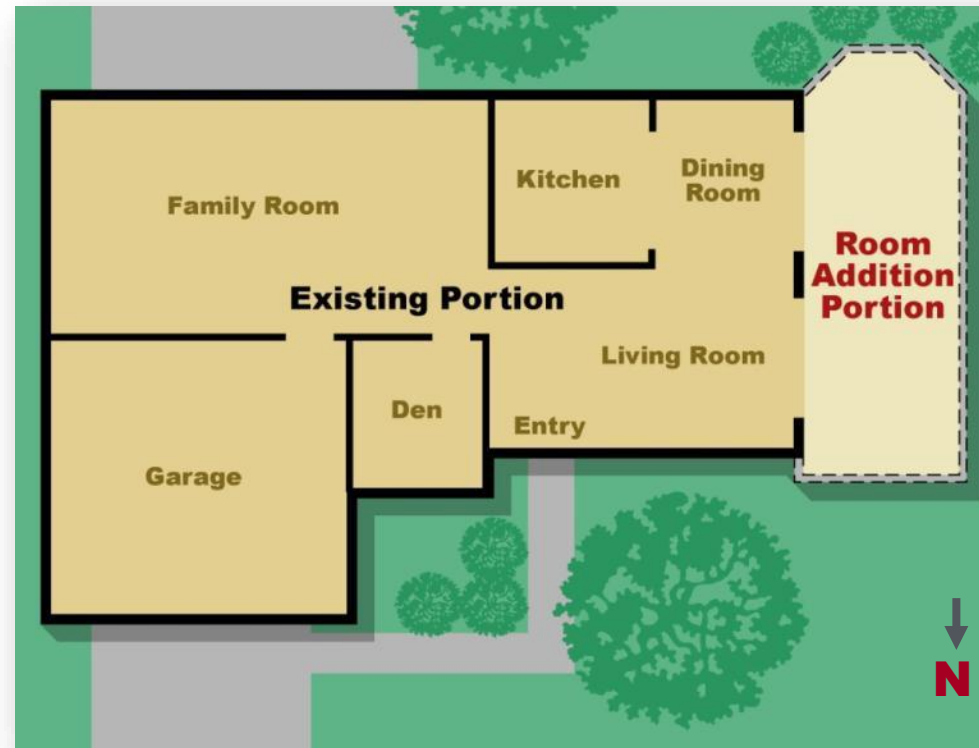


- ✓ Additions, alterations, or repairs
- ✓ Existing buildings
- ✓ Maintenance
- ✓ Compliance
- ✓ New and replacement materials
- ✓ Buildings designated as historic



- ✓ Additions, alterations, repairs or changes of occupancy to, or relocation of, existing building to comply with R502, R503, R504 or R505
- ✓ If changing unconditioned space to conditioned space, comply with R502

- ✓ Additions must meet the prescriptive requirements in Table R402.1.2 or R402.1.4 (*R-value computation or U-factor or total UA alternatives*)



- ✓ Additions comply if any of the following is demonstrated
 - ✓ The addition alone complies with the provisions of this code
 - ✓ The existing building and addition together comply as a single building
 - ✓ The existing building and addition together use no more energy than the existing building

- ✓ Any unconditioned or low-energy space altered to become conditioned space must fully comply with the code
- ✓ Exceptions:
 - ✓ If using simulated performance, annual energy cost of proposed design is allowed to be 110 percent of annual energy cost otherwise allowed by R405.2
 - ✓ If Total UA of existing building AND addition AND any alterations is \leq Total UA generated for existing building
 - ✓ If complying per R405 and annual energy cost or energy use of the addition AND existing building AND any alterations is \leq annual energy cost of the existing building
 - ✓ Addition and alterations to comply with R405 in its entirety



Code applies to any new construction

Unaltered portion(s) do not need to comply

(R503.1.1.1) Replacement fenestration that includes both glazing and sash must meet

- ✓ 0.25 SHGC in **Climate Zones 1-3**
- ✓ 0.40 SHGC in **Climate Zone 4 except Marine**
- ✓ U-factors in all **Climate Zones 1-8**

Where more than 1 replacement fenestration unit is to be installed, an area-weighted average U-factor, SHGC or both of all replacement fenestration units can be an alternative compliance approach.

Building Envelope

Exceptions:

- ✓ Storm windows over existing fenestration
- ✓ Surface-applied window film installed on existing single pane
- ✓ Exposed, existing ceiling, wall or floor cavities if already filled with insulation
- ✓ Where existing roof, wall or floor cavity isn't exposed
- ✓ Roof recover
- ✓ Roofs without cavity insulation and neither sheathing nor insulation is exposed during the reroofing
 - Insulate either above or below the sheathing

Lighting

Exceptions:

- ✓ <10% of luminaires in a space are replaced
- ✓ Only bulbs and ballasts within existing luminaires are replaced (provided installed interior lighting power isn't increased)

- Heating and Cooling
 - HVAC ducts newly installed as part of the alteration to comply with Section 403
 - Exception: Where ducts from on existing HVAC system are extended to an addition
- Service hot water (SHW) systems
 - New SHW systems that are part of the alteration to comply with R403.5

- Work on nondamaged components necessary for the required repair or damaged components shall be considered part of the repair and are not subject to the alteration requirements
- Repairs considered part of the code
 - Glass-only replacements in an existing sash and frame
 - Roof repairs
 - Repairs where only the bulb, ballast or both within the existing luminaires in a space are replaced provided the replacement does not increase the installed interior lighting power

Appendix RB – Solar-ready Provisions – Detached One- and Two-family Dwellings and Townhouses

- Allows jurisdictions to adopt a model for zero energy home designation
- Meant to support potential future improvements of solar electric and solar thermal systems
- Applies to new construction (not additions or alterations)



- New residential buildings
- Would result in a residential building with zero net energy consumption over the course of a year
- Designed to work with residential occupancies where ERI can be applied
- Requires a maximum ERI first be met for building energy use only and then achieve a score of 0 when on-site power production is considered
- Allows for renewable energy to be generated onsite or offsite