



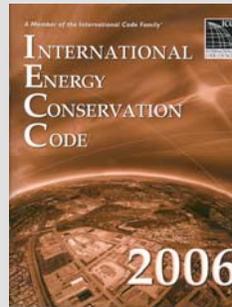
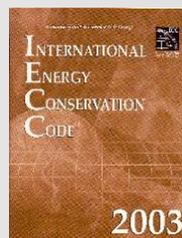
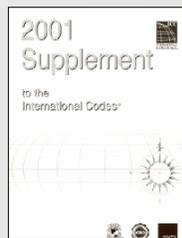
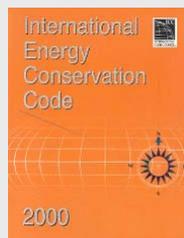
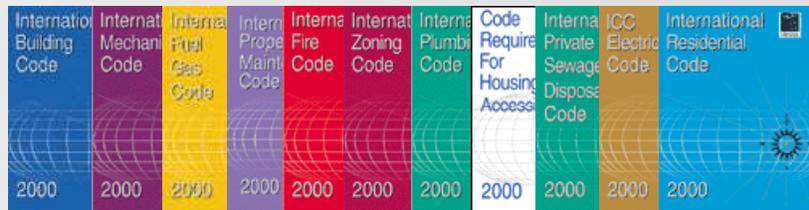
U.S. Department of Energy  
Energy Efficiency and Renewable Energy



# Residential Requirements of the 2006 International Energy Conservation Code

U.S. Department of Energy  
Building Energy Codes Program

## The Family of I-Codes

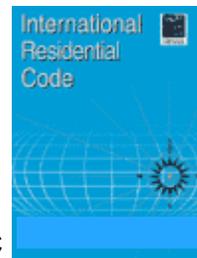


## Overview of Residential Code Requirements

- Focus is on building envelope
  - Ceilings, walls, windows, floors, foundations
  - Sets insulation levels, window U-factors 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 lighting or appliance requirements

## Relationship Between IRC and IECC

- IECC addresses only energy
  - IRC addresses all codes (structural, plumbing, etc.)
    - Allows builder to carry only one code book
    - Chapter 11 has energy
  - IECC addresses both residential and commercial; IRC only residential, excludes most apartments
  - IRC references IECC
  - Energy requirements in IRC and IECC almost identical
- Some minor differences:
- IRC has different “hard limits” for fenestration U-factor
  - IRC has no SHGC “hard limit”



## 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  
Chapter



## Scope

### Residential Buildings:

- IRC only for single-family, duplex, and townhouses
- IECC has all low-rise (1-3 stories) houses, condos, and apartments [R-2, R-3, R-4], but not hotels/motels [R-1]
- All buildings that are not “residential” by definition are “commercial”

Includes repairs, alterations, and additions

e.g., window replacements



## Exceptions

- Very low energy use buildings (<math>3.4 \text{ Btu/h-ft}^2</math> or  $1 \text{ watt/ft}^2</math>)$
- Buildings (or portions of) that are neither heated nor cooled
- Buildings designated as historic (Section 101.4.2)

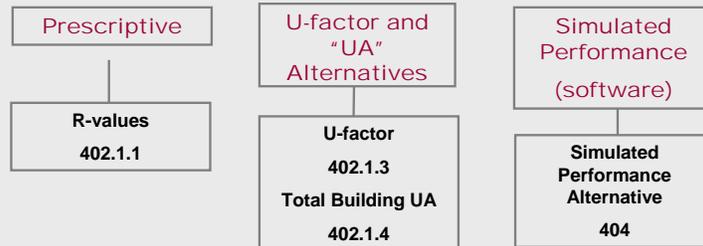


## Mixed Use Buildings

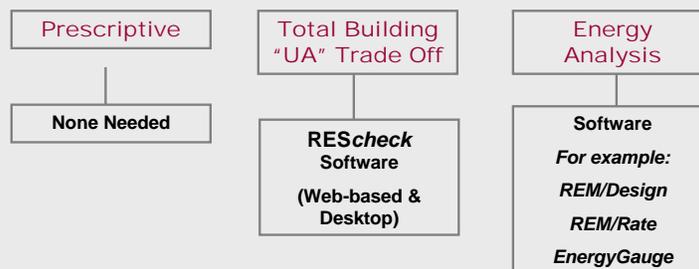
- Mixed occupancies
  - Treat the residential occupancy under the applicable residential code
  - Treat the commercial occupancy under the commercial code



## IECC Code Compliance – Three Options



## Code Compliance Tools



## Climate Specific Requirements

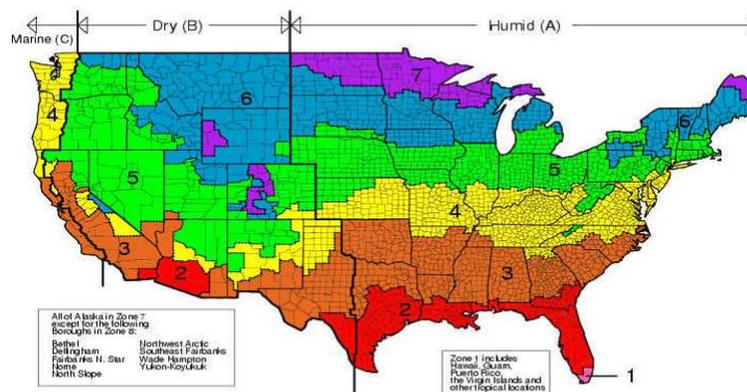
### Climate Specific Requirements:

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

### Universal Requirements (apply everywhere):

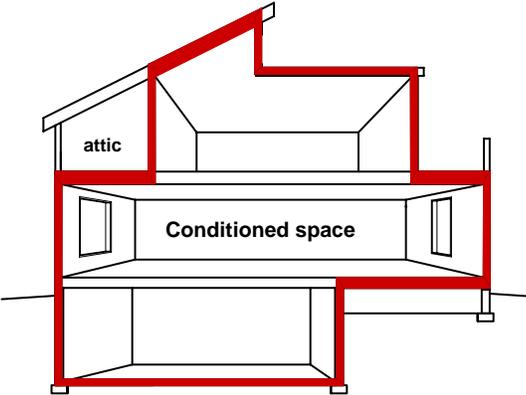
- Duct insulation and sealing
- Infiltration control
  - Including recessed cans

## Climate Zones



# Building Envelope

- Most IECC requirements for residential buildings are for the **Building Envelope**
  - The **Building Envelope** separates conditioned space from the outdoors and unconditioned spaces such as attics and garages
- Certificate!



# Insulation and Fenestration Requirements by Climate Zone

Table 402.1.1  
Insulation and Fenestration Requirements by Component

CLIMATE ZONE	FENESTRATION U-FACTOR	SKYLIGHT U-FACTOR	GLAZED FENESTRATION SHGC	CEILING R-VALUE	WOOD FRAME WALL R-VALUE	MASS WALL R-VALUE	FLOOR R-VALUE	BASEMENT WALL R-VALUE	SLAB R-VALUE & DEPTH	CRAWL SPACE WALL R-VALUE
1	1.20	0.75	0.40	30	13	3	13	0	0	0
2	0.75	0.75	0.40	30	13	4	13	0	0	0
3	0.65	0.65	0.40	30	13	5	19	0	0	5 / 13
4 except Marine	0.40	0.60	NR	38	13	5	19	10 / 13	10, 2ft	10 / 13
5 and Marine 4	0.35	0.60	NR	38	19 or 13+5	13	30	10 / 13	10, 2 ft	10 / 13
6	0.35	0.60	NR	49	19 or 13+5	15	30	10 / 13	10, 4 ft	10 / 13
7 and 8	0.35	0.60	NR	49	21	19	30	10 / 13	10, 4 ft	10 / 13

## U-Factor and Total UA (REScheck Approach)

### ➤ U-factor Alternative

Similar to Prescriptive but uses U-factors instead of R-values

- Allows for innovative or less common construction techniques such as structural insulated panels or log walls

### ➤ Total UA Alternative

Same as U-factor alternative but allows trade-offs across all envelope components

- Approach used in REScheck software

## U-Factor Requirements by Climate Zone

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	FLOOR U-FACTOR	BASEMENT WALL U-FACTOR	CRAWL SPACE WALL U-FACTOR
1	1.20	0.75	0.035	0.082	0.197	0.064	0.360	0.477
2	0.75	0.75	0.035	0.082	0.165	0.064	0.360	0.477
3	0.65	0.65	0.035	0.082	0.141	0.047	0.360	0.136
4 except Marine	0.40	0.60	0.030	0.082	0.141	0.047	0.059	0.065
5 and Marine 4	0.35	0.60	0.030	0.060	0.082	0.033	0.059	0.065
6	0.35	0.60	0.026	0.060	0.06	0.033	0.059	0.065
7 and 8	0.35	0.60	0.026	0.057	0.057	0.033	0.059	0.065

## Windows & Glass Doors

### ➤ Key Elements

- U-factors
- SHGC values



- An area weighted average of fenestration can be used to satisfy the U-factor requirements
- Fenestration replacement must meet the 0.40 SHGC requirement in Climate Zones 1-3 and the U-factor requirements in all zones

## Windows – U-Factors

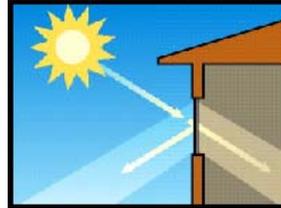
- NFRC rated and certified
  - Exceptions:
    - Unrated single-paned products comply in Zone 1
    - Unrated double-pane with thermal break comply in Zones 2 and 3
- Strict limits on U-factor in northern U.S. (cannot be traded off)
  - U-0.48 maximum in Zones 4 and 5, U-0.40 maximum in Zones 6-8
  - U-0.75 for skylights in Zones 4-8
  - These are based on building average, individual windows or skylights can be worse if average meets these requirements
- 15 sq. ft. of glazing (and one opaque door) exempt
  - For example, decorative glass on/near front door

## Windows - SHGC

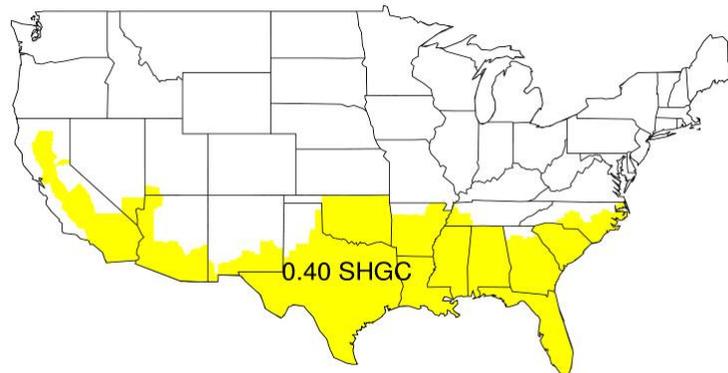
### ➤ Solar Heat Gain Coefficient

- SHGC of 0.40 or lower required in the southern U.S.
- SHGC cannot exceed 0.50 even if performance path trade-offs are used
- National Fenestration Rating Council (NFRC) tested

Solar Heat Gain Coefficient



## Locations with Window SHGC Requirements



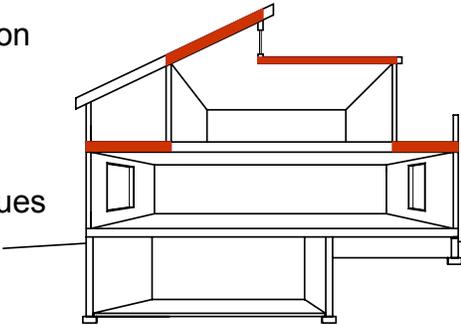
# NFRC Label

 National Fenestration Rating Council <b>CERTIFIED</b>	<b>World's Best Window Co.</b> Millennium 2000+ Vinyl-Clad Wood Frame Double Glazing - Argon Fill - Low E Product Type: Vertical Slider
<b>ENERGY PERFORMANCE RATINGS</b>	
U-Factor (U.S./I-P)	Solar Heat Gain Coefficient
<b>0.34</b>	<b>0.25</b>
<b>ADDITIONAL PERFORMANCE RATINGS</b>	
Visible Transmittance	Air Leakage (U.S./I-P)
<b>0.41</b>	<b>0.2</b>
<small>Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a basic set of environmental conditions and a specific product type. Consult manufacturer's literature for other product performance information. www.nfrc.org</small>	

National Fenestration Rating Council (NFRC) product ratings are available on-line at [www.nfrc.org](http://www.nfrc.org)

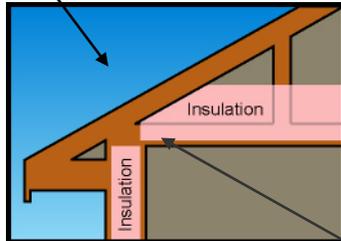
# Ceilings

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



## Standard Roof Truss

Possibility of ice dam formations



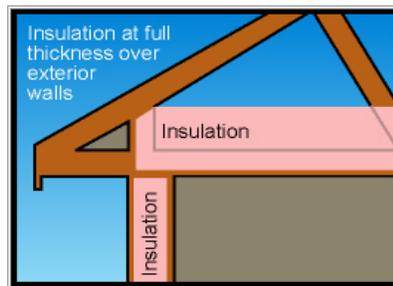
- Ceiling insulation code requirements assume standard truss systems

Cold corners contribute to condensation and mold growth

## Raised Heel Truss

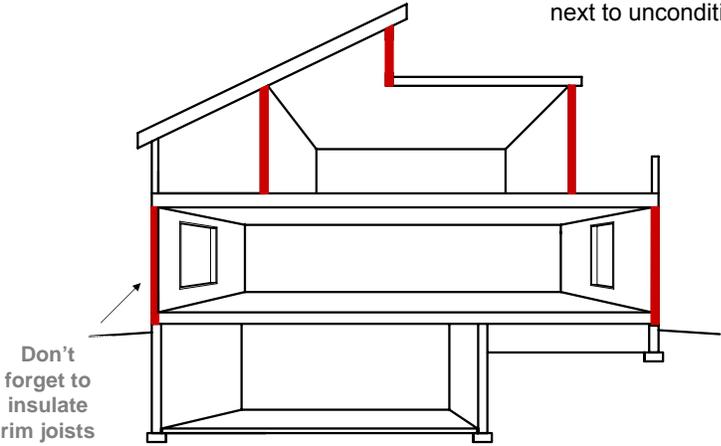


- Raised Heel/Energy Truss credit if insulation is full height over exterior wall
  - R-30 instead of R-38
  - R-38 instead of R-49



# Above Grade Walls

Insulate walls including those next to unconditioned spaces



# Wall Insulation



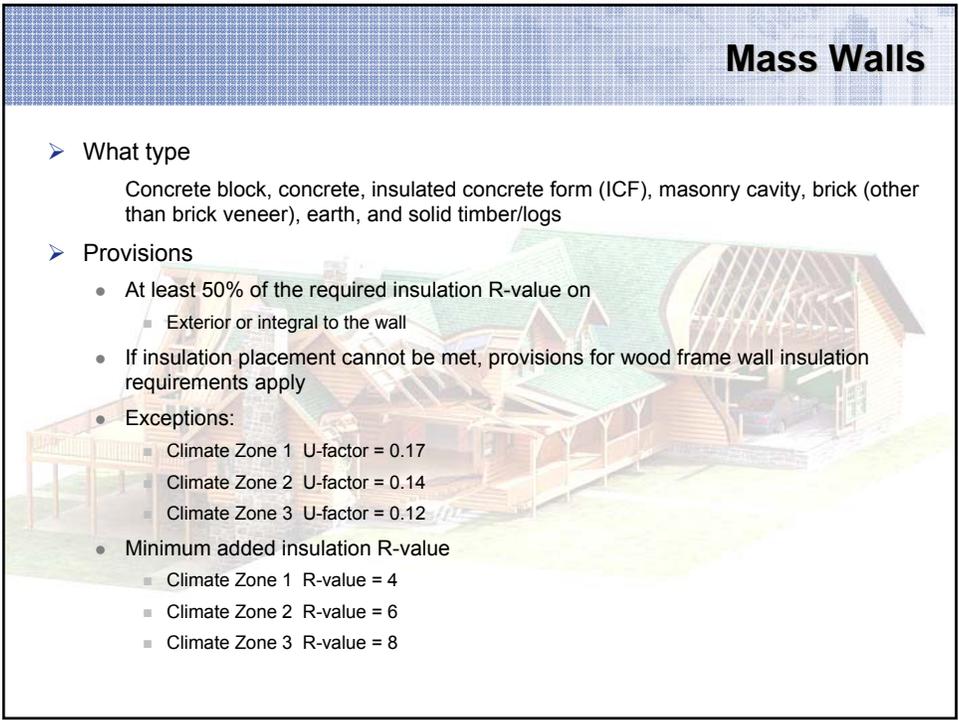
## Mass Walls

### ➤ 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 insulation R-value on
  - Exterior or integral to the wall
- If insulation placement cannot be met, provisions for wood frame wall insulation requirements apply
- Exceptions:
  - Climate Zone 1 U-factor = 0.17
  - Climate Zone 2 U-factor = 0.14
  - Climate Zone 3 U-factor = 0.12
- Minimum added insulation R-value
  - Climate Zone 1 R-value = 4
  - Climate Zone 2 R-value = 6
  - Climate Zone 3 R-value = 8



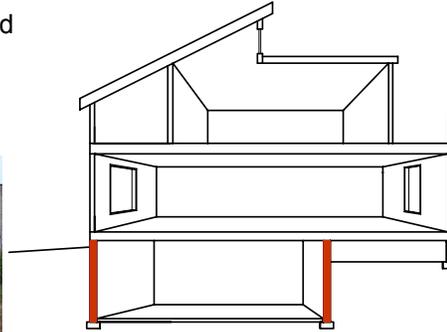
## Steel-frame

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, 2x6, or 2x8 R-49 any framing
R-38	R-49 2x4, 2x6, 2x8, or 2x10
Steel Framed Wall	
R-13	R-13 +5 or R-15 +4, or R-21 +3
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, 2x6 R-19 +12 in 2x8 or 2x10

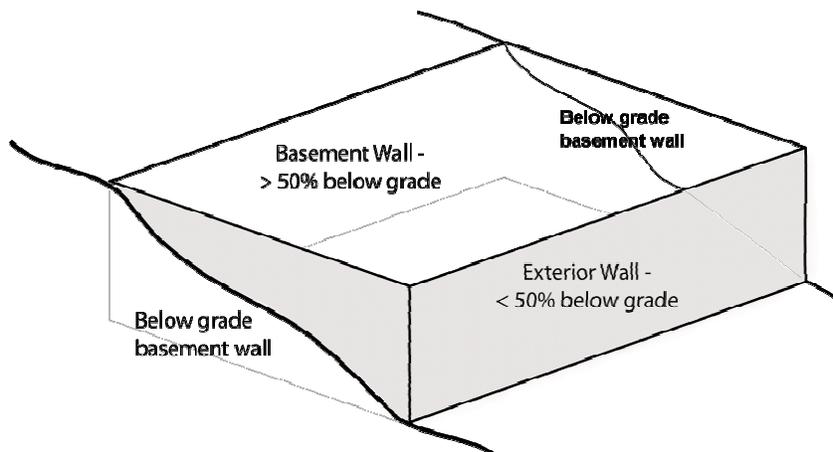
### ➤ Ceilings, walls, and floors

## Below-Grade Walls

- § 50% below grade
  - Meet or exceed required R-values



## Defining Below-Grade Walls



## Ways to Insulate Basement Walls



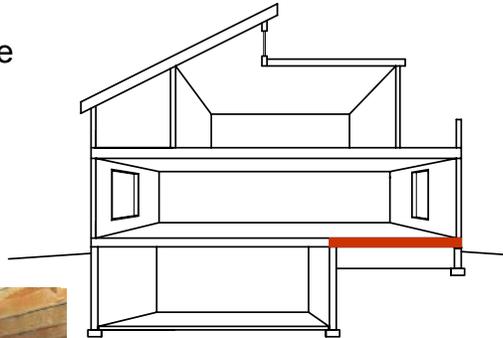
Interior Studs w/batts



Exterior Rigid Foam

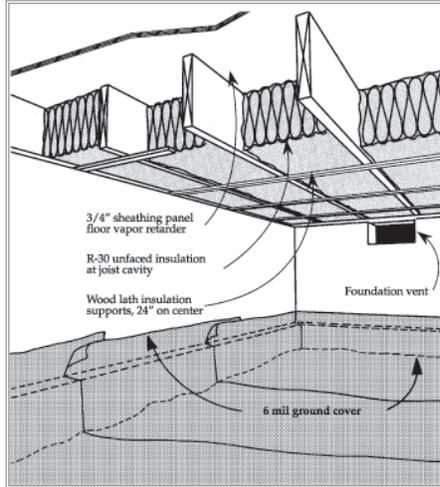
## Floors over Unconditioned Space

- Space can be unheated basement or a crawlspace



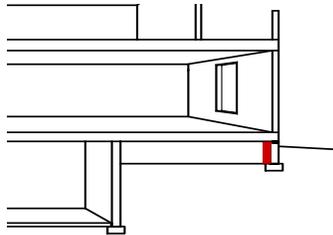
## Floor Insulation

- Permanent contact with underside of subfloor decking
- Support insulation in floor cavity



## Crawlspace Wall Insulation

When crawlspace walls are insulated, the space should be mechanically vented or conditioned. See Section R408 of the IRC.



## Vented & Unvented Crawspaces

### Vented Crawspace Requirements:

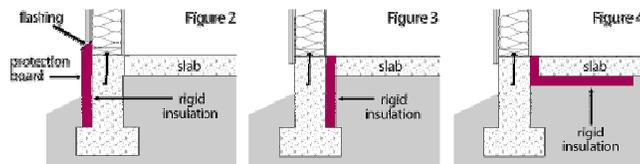
- The raised floor over the crawspace must be insulated.
- A vapor retarder may be required as part of the floor assembly.
- Ventilation openings must exist that are equal to at least 1 square foot for each 150 square feet of crawspace area and be placed to provide cross-flow (*IRC 408.1, may be less if ground vapor retarder is installed*).
- Ducts in crawspace must be sealed and have R-8 insulation.

### Unvented Crawspace Requirements:

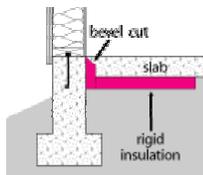
- The crawspace ground surface must be covered with an approved vapor retarder (*e.g., plastic sheeting*).
- Crawspace walls must be insulated to the R-value requirements specific for crawspace walls (*IECC Table 402.1*).
- Crawspace wall insulation must extend from the top of the wall to the inside finished grade and then 24" vertically or horizontally.
- Crawspaces must be mechanically vented (*1 cfm per 50 square feet*) or conditioned (*heated and cooled as part of the building envelope*).

## Slab Edge Insulation

- R-10 (typically 2 inches) insulation in Zones 4 and above
- 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 (must be under 10 inches of soil)

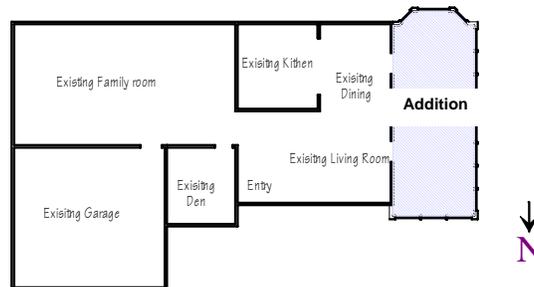


## Slab Edge Insulation



## Additions

- Treat as a stand-alone building
- Additions must meet the prescriptive requirements in Table 402.1.1



## Sunrooms

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

Sunroom definition:

- 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)

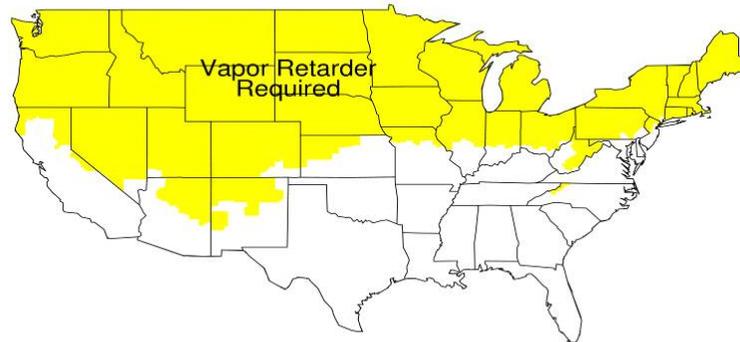


## Sunroom Requirements

- 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

## Vapor Retarder

### Mandatory Requirements



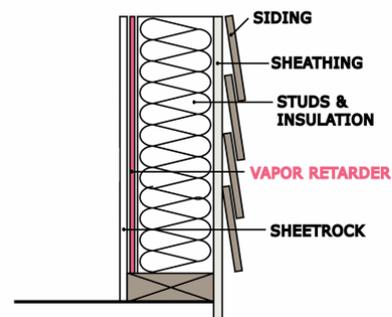
### Vapor Retarders – Code Requirements

#### ➤ Requirements

- Install on “warm-in-winter side” of insulation
- Use in unvented framed walls, floors, and ceilings
- Must have perm rating of  $\leq 1.0$

#### ➤ Exceptions

- In construction where moisture or its freezing won't damage materials
- If other approved means to avoid condensation are provided



## Vapor Retarders - Examples



Poly Vapor Retarder

Kraft-faced Vapor Retarder



## Air Leakage Control

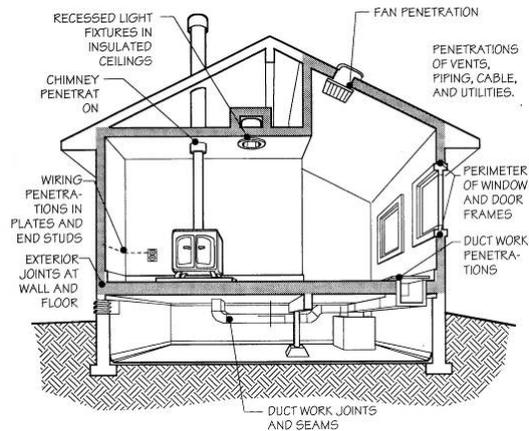
- Building envelope
  - Sealed with caulking materials or
  - Closed with gasketing systems
  - Joints and seams sealed or taped or covered with a moisture vapor-permeable wrapping material



Mandatory Requirements

## 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



## Recessed Lighting Fixtures

### Mandatory Requirements

- Type IC rated and labeled in a sealed or gasketed enclosure
- Type IC rated and labeled as meeting ASTM E 283 with no more than 2.0 cfm of air movement
- Located inside an airtight box with clearances of at least 0.5 inch from combustible material and 3 inches from insulation



## Mechanical Systems & Equipment



## Efficiency Terms

- Equipment efficiency set by Federal law, not the I-Codes
- Efficiency metrics (similar in concept to MPG for cars)
  - Annual Fuel Utilization Efficiency (AFUE) – gas and oil heating equipment
    - 78% for furnaces, 80% for boilers
  - Seasonal Energy Efficiency Ratio (SEER) – residential air conditioners
  - Heating Seasonal Performance Factor (HSPF) – residential heat pumps
    - SEER requirement increased from 10 to 13 and HSPF from 6.8 to 7.7 in January 2006 for most systems

## Load Calculations

- 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



## Piping Insulation

- R-2 required on
  - HVAC systems
    - Exception: Piping that conveys fluids between 55 and 105 °F
  - All circulating domestic hot water systems



## Duct Insulation

- Ducts outside the building envelope shall be insulated to R-8
  - R-6 allowed for ducts in floor trusses



## Duct Construction

IECC references Section M1601.3.1 of the IRC

- Joints shall be made substantially airtight by tapes, mastics (adhesives), gasketing, or other approved systems.
- Rigid fibrous glass ducts shall comply with UL 181A
- Flex ducts and connectors shall comply with UL 181B
- Duct connections to flanges or sheet metal fittings shall be mechanically fastened
- Crimp joints for round ducts shall have a contact lap of at least 1.5" and shall be fastened by at least 3 sheet metal screws or rivets equally spaced

## Duct Sealing



## 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



## Simulated Performance

- Requires computer software
- Includes both envelope and equipment
- Allows greatest flexibility. Credits features such as:
  - High efficiency furnaces, air-conditioners, etc.
  - Tight ducts (must be leak tested) or hydronic systems
  - Exterior shading, favorable orientation, thermal mass, SHGC, etc.
- Section 404 specifies “ground rules”
  - These will generally be “hidden” in compliance software calculation algorithms
  - Very similar ground rules are used in new home federal tax credits and Energy Star Home guidelines

**www.energycodes.gov**  
**techsupport@becp.pnl.gov**

U.S. Department of Energy  
**Energy Efficiency and Renewable Energy** *Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable*

**Building Energy Codes Program**

Search energycodes.gov

Search Help > More Search Options >

Site Map  
**Need Help?** - Ask an Energy Codes Expert (Software Tools and Energy Codes Assistance)

EERE Information Center  
Printer Friendly Format

NEWS

**Notice Requesting Public Input on Further Analysis Related to Wall Insulation Requirements for Residential Buildings in the IECC and Other Potential Code Change Proposals**

Statement of the Department of Energy - State Energy Code Criteria for Residential AC and HP  
2005 ICC Final Action Hearings

**MARCH LIVE WEBCAST**  
Residential Requirements of the 2006 International Energy Conservation Code (IECC) March 23, 2006

**About the Program**

**Compliance Tools**  
Residential (REScheck)  
Commercial (COMcheck)  
On-line Compliance Tools  
Federal Building Codes - Commercial

**Training/Education**  
Residential Training  
Commercial Training  
Events Calendar  
Energy Codes Glossary  
Annual Workshop

**Implementation Tools**  
Resource Center  
DOE 2004 Proposals  
DOE Determinations  
DOE Assistance  
Resource Materials  
Status of State Energy Codes  
Setting the Standard

**Technical Support**  
Code Notes

DOE's Building Energy Codes Program is an information resource on national model energy codes. We work with other government agencies, state and local jurisdictions, national code organizations, and industry to promote stronger building energy codes and help states adopt, implement, and enforce those codes.

The Program recognizes that energy codes maximize energy efficiency only when they are fully embraced by users and supported through education, implementation, and enforcement.

**Free Software**

**REScheck**  
REScheck, REScheck-Web, REScheck Package Generator

**COMcheck**  
COMcheck, COMcheck-Web, COMcheck Package Generator

**Technical Support**

**Resource Center**  
Resource Center

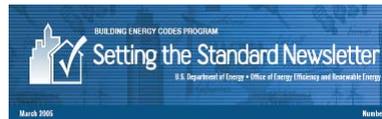
**Ask an Energy Codes Expert**  
Ask an Expert

## Setting the Standard Newsletter

- Register on-line to receive the latest up-to-date information on energy code related issues

### [Newsletter](#)

- <http://www.energycodes.gov/news/>



### Basements: Advantages and Disadvantages of Finishing Basements During Initial Construction of the Home

The 2005 and 2003 Editions of the International Energy Conservation Code (IECC) require basement walls to be insulated. Insulation is required in the basement ceiling. The 2003 IECC requires floor over unheated space in basement walls that define the conditioned space (Section 502.2.1.1) or 502.2.1.2) to meet the applicable energy thermal transmittance factor (U-factor) or the minimum R-value based on the prescriptive specifications on an individual component basis. In basic terms, this means, if the basement is conditioned, the floor above the basement (basement ceiling) must be insulated and some of the requirements of the IECC for floors over an unconditioned space. If the basement is considered part of the conditioned building envelope, the basement walls must be insulated and meet all the requirements of the IECC for basement walls. The requirements do vary depending on section and climate conditions. Requirements in the IECC include some of the following: insulation installation (Section 502.4), Moisture Control (Section 502.1), and Crawling and Swallow (Section 502.1.4.3).

Many houses are being constructed with unfinished basements to reduce initial costs. In most cases, the basements eventually finish the basement for additional living space by installing basement wall insulation. Because such basements are essentially unoccupied, the advantages and disadvantages of establishing the basements should be thoroughly reviewed prior to permitting and construction. Table 1 provides a list of advantages and disadvantages of basement wall insulation compared to basement ceiling insulation.

## Questions/Comments

- Help Desk – on-line electronic form  
<http://www.energycodes.gov/support/helpdesk.php>

### Email

[Techsupport@becp.pnl.gov](mailto:Techsupport@becp.pnl.gov)

*U.S. Department of Energy's  
Building Energy Codes Program*

## AIA Test and Certificate

[http://www.energycodes.gov/training/onlinetraining/2006iecc\\_thankyou.stm](http://www.energycodes.gov/training/onlinetraining/2006iecc_thankyou.stm)