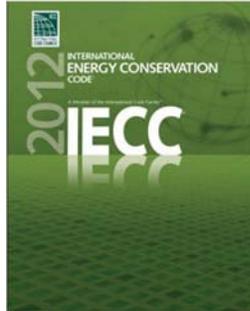


## 2012 IECC – Residential with State Adopted Changes



**Brent Ursenbach**

Salt Lake County Townships  
385-468-6694  
801-381-1449  
[bursenbach@slco.org](mailto:bursenbach@slco.org)  
[bursenbach@yahoo.com](mailto:bursenbach@yahoo.com)



UTAH OFFICE OF  
ENERGY DEVELOPMENT  
Advancing Utah's Energy Future



**BUILDING TALK**

1

2

### 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



## 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
- ✓ *In 2012, consolidated with IRC energy chapter (actually a change to the IRC, not the IECC)*
- ✓ *Previous versions IRC Chapter 11 and IECC Residential were not identical*
- ✓ IECC addresses both residential and commercial; IRC addresses subset of residential, detached one- and two-family dwellings and townhouses 3 stories or fewer



## State Amendments to the 2012 IECC

- Only amendments to the residential section
- Adoption delayed until DOE produced a new version of REScheck specifically modified for the Utah Amendments
- July 1, 2014, the 2012 IECC with amendments becomes effective

Enrolled Copy	H.B. 202
1	ENERGY CONSERVATION CODE AMENDMENTS
2	2013 GENERAL SESSION
3	STATE OF UTAH
4	Chief Sponsor: Brad R. Wilson
5	Senate Sponsor: Curtis S. Bramble
6	
7	<b>LONG TITLE</b>
8	<b>General Description:</b>
9	This bill amends the State Construction Code.
10	<b>Highlighted Provisions:</b>
11	This bill:
12	• adopts the 2012 edition of the International Energy Conservation Code;
13	• modifies certain provisions of the International Energy Conservation Code; and
14	• modifies certain energy provisions of the International Residential Code.
15	<b>Money Appropriated in this Bill:</b>
16	None
17	<b>Other Special Clauses:</b>
18	This bill provides a contingent effective date.
19	<b>Utah Code Sections Affected:</b>
20	AMENDS:
21	15A-2-103, as last amended by Laws of Utah 2012, Chapter 76
22	15A-3-203, as enacted by Laws of Utah 2011, Chapter 14
23	15A-3-701, as enacted by Laws of Utah 2011, Chapter 14
24	<b>Uncodified Material Affected:</b>
25	ENACTS UNCODIFIED MATERIAL.
26	
27	<i>Be it enacted by the Legislature of the state of Utah:</i>
28	Section 1. Section 15A-2-103 is amended to read:
29	15A-2-103. Specific editions adopted of construction code of a nationally

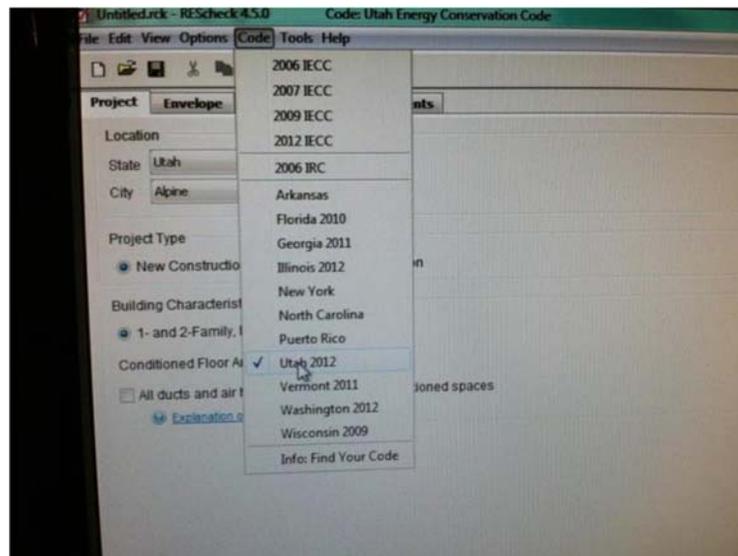
5

## Generally, the Entire State Must Follow Identical Codes

- Local Amendments are allowed
- Requires Legislative approval-
- Local Amendments Include:
  - Adjusted roof snow load requirements based on geography and weather historical data
  - Fire sprinkler requirements in hazardous wild land areas
- Executive Action- Governor's Signature Required for all Legislation

6

## Utah REScheck- Utah 2012 Code



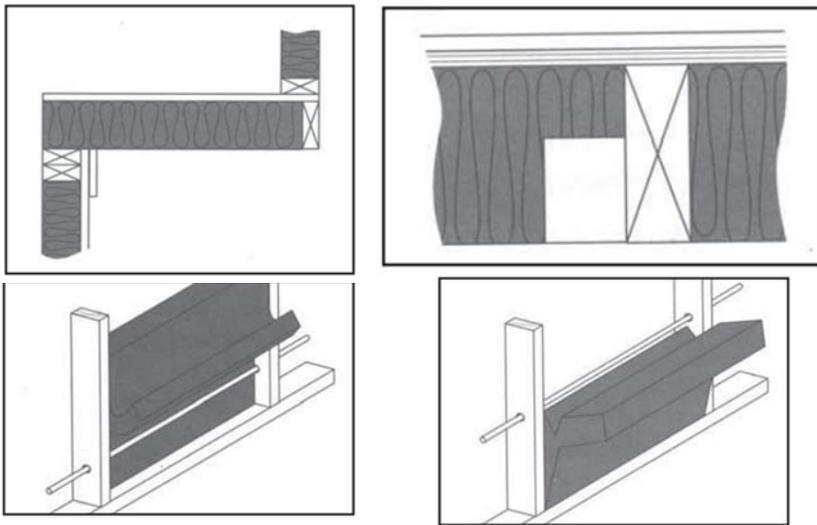
## Manufacturer's Instructions are Important / Mandatory

- IMC 304.1, (*IECC R303.2 other codes similar text*)- Equipment and appliances shall be installed as required by the terms of their approval, *in accordance with the conditions of the listing, the manufacturer's installation and this code.* Manufacturer's installation instructions shall be available on the job site at the time of inspection

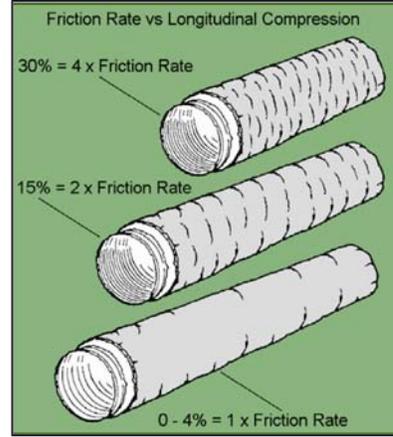
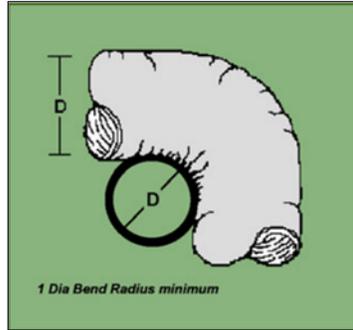
INSTRUCTIONS

8

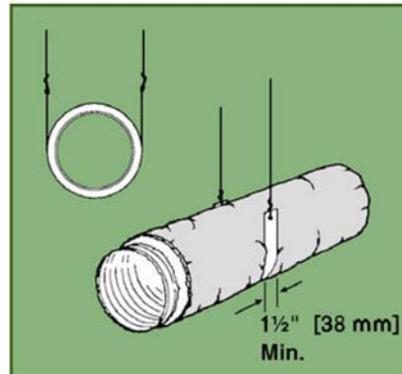
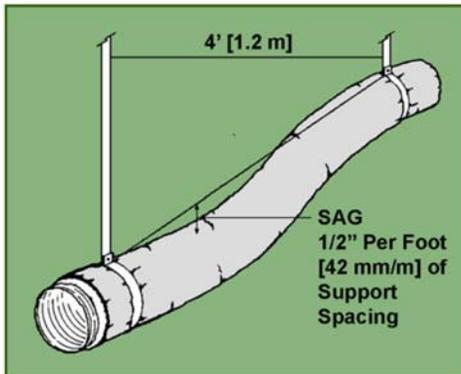
## Manufacturers' Installation Instructions



## Flex Duct Installation Instructions



## Flex Duct Installation Instructions-cont.



## -Flex Installations- Complete with kinks & squashed duct



### Structure of the 2012 IECC



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



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

## Scope

### Section R101



### Residential Buildings:

- ✓ One- and two-family dwellings, townhouses of any size and R-2, R-3, R-4 ≤ 3 stories
- ✓ All buildings that are not “residential” by definition are “commercial”
- ✓ Includes additions, alterations, renovations and repairs

13

## Scope

### Section R101.4, R101.5.2 - Exempted Buildings

- ✓ Existing buildings (*Section R101.4.1*)
- ✓ Buildings designated as historic (*Section R101.4.2*)
- ✓ Very low energy use buildings [ $<3.4 \text{ Btu/h-ft}^2$  or  $1 \text{ watt/ft}^2$ ] (*Section R101.5.2*)



14

15

## Scope

### Section R101.4.3 - Additions

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



16

## Scope

### Section R101.4.3/R402.3.6 - 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

(R402.3.6) 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 2-8**

17

**Scope****Section R101.4.3 - 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
- ✓ Lighting alterations if:
  - <50% of luminaries in a space are replaced
  - Only bulbs and ballasts within existing luminaries are replaced (provided installed interior lighting power isn't increased)

18

**Scope****Section R101.4.5 - Space Conditioning**

Any non-conditioned 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 an unfinished basement



## Scope

### Section R101.4.6 - Mixed Use Buildings

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



19

20

## IECC - Overview of Structure

### Climate-Specific Requirements:

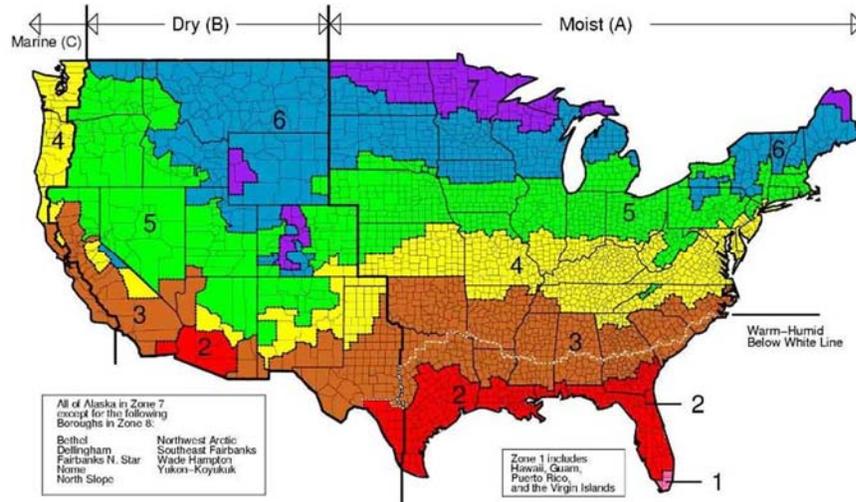
- ✓ Roofs
- ✓ Above grade walls
- ✓ Foundations
  - Basements
  - Slabs
  - Crawlspace
- ✓ Skylights, windows, and doors
- ✓ Solar Heat Gain Coefficient in warm climates

### Mandatory Requirements (*apply everywhere*):

- ✓ Infiltration control
- ✓ Duct insulation, sealing, and testing
- ✓ HVAC controls
- ✓ Piping Insulation
- ✓ Equipment sizing
- ✓ Dampers
- ✓ Lighting

21

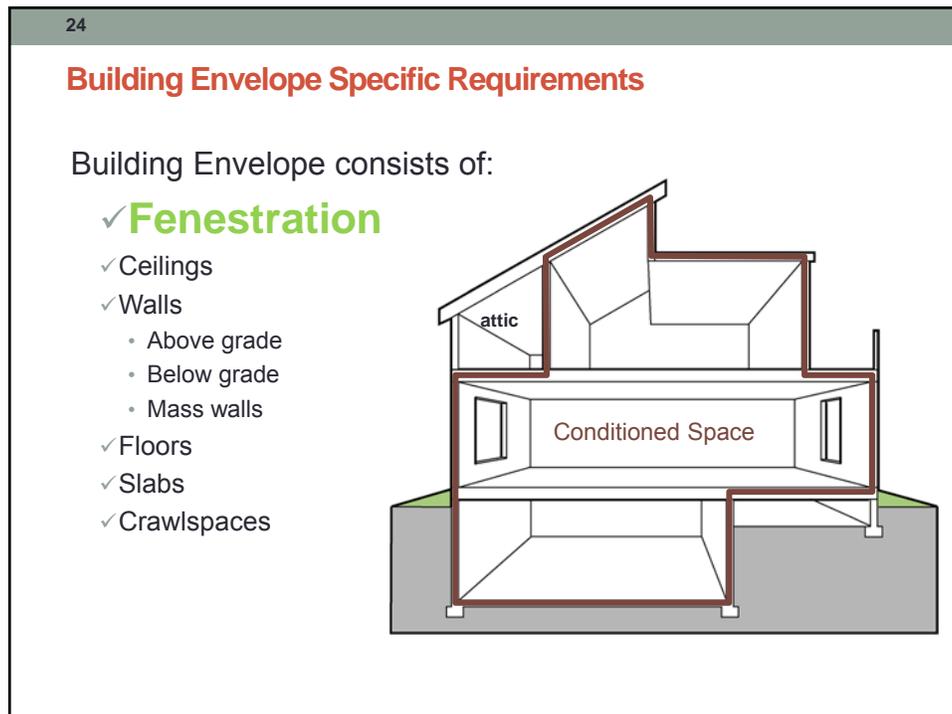
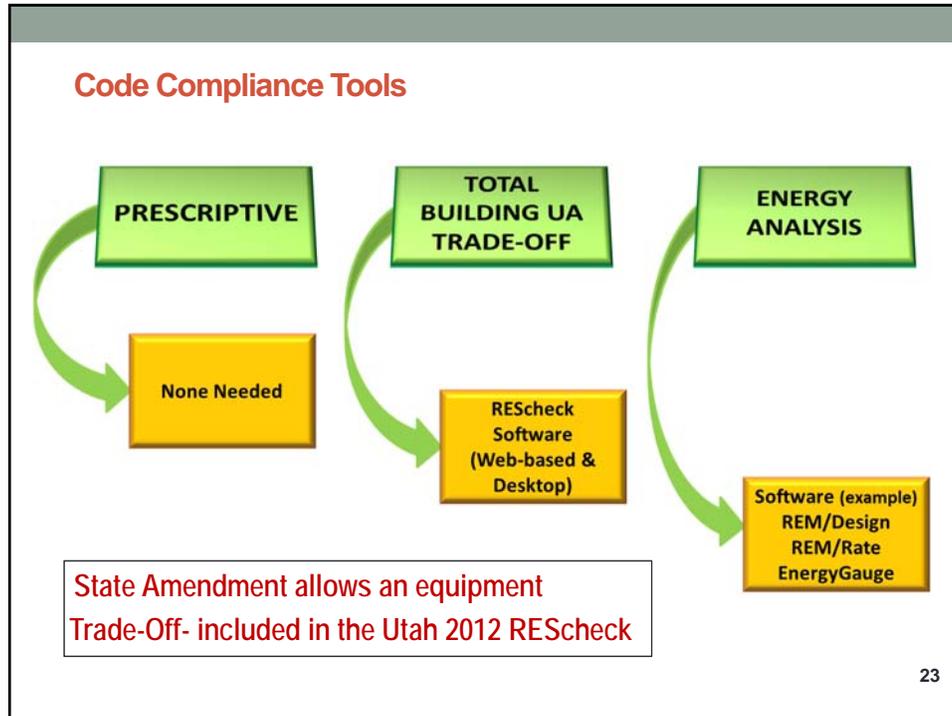
## Climate Zones for the 2012 IECC



22

## 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, and test
  - **Blower door testing is optional- State Amendment- similar to 2009 IECC- may use a comprehensive air barrier/insulation inspection**
- ✓ Ducts, air handlers, filter boxes – seal, insulate, and test
  - ✓ **Testing required only if air handler or 50% of duct is outside the thermal envelope- State Amendment**
- ✓ 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 – 75% of lamps to be high efficacy lamps or 75% of lighting fixtures to have only high efficacy lamps~~ **Deleted by State Amendment**



**Insulation and Fenestration Requirements by Climate Zone**

**SEE STATE AMENDMENTS- Very similar to 2006 Table**

**TABLE R402.1.1 INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT\***

CLIMATE ZONE	FENESTRATION U-FACTOR <sup>a</sup>	SKYLIGHT <sup>b</sup> U-FACTOR	GLAZED FENESTRATION SHGC <sup>c, d</sup>	CEILING R-VALUE	WOOD FRAME WALL R-VALUE	MASS WALL R-VALUE <sup>e</sup>	FLOOR R-VALUE	BASEMENT <sup>f</sup> WALL R-VALUE	SLAB <sup>g</sup> R-VALUE & DEPTH	CRAWL SPACE <sup>h</sup> WALL R-VALUE
1	NR	0.75	0.25	30	13	3/4	13	0	0	0
2	0.40	0.65	0.25	38	13	4/6	13	0	0	0
3	0.35	0.55	0.25	38	20 or 13+5 <sup>b</sup>	8/13	19	5/13 <sup>i</sup>	0	5/13
4 except Marine	0.35	0.55	0.40	49	20 or 13+5 <sup>b</sup>	8/13	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.32	0.55	NR	49	20 or 13+5 <sup>b</sup>	13/17	30 <sup>f</sup>	15/19	10, 2 ft	15/19
6	0.32	0.55	NR	49	20+5 or 13+10 <sup>b</sup>	15/20	30 <sup>f</sup>	15/19	10, 4 ft	15/19
7 and 8	0.32	0.55	NR	49	20+5 or 13+10 <sup>b</sup>	19/21	38 <sup>f</sup>	15/19	10, 4 ft	15/19

- For SI: 1 foot = 304.8 mm.
- a. R-values are minimums. U-factors and SHGC are maximums. When insulation is installed in a cavity which is less than the label or design thickness of the insulation, the installed R-value of the insulation shall not be less than the R-value specified in the table.
  - b. The fenestration U-factor column excludes skylights. The SHGC column applies to all glazed fenestration. Exception: Skylights may be excluded from glazed fenestration SHGC requirements in Climate Zones 1 through 3 where the SHGC for such skylights does not exceed 0.30.
  - c. "15/19" means R-15 continuous insulation 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 or exterior of the home or R-5 continuous insulation on the interior or exterior of the home. "10/13" means R-10 continuous insulation 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 Climate 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 R301.1 and Table R301.1.
  - g. Or insulation sufficient to fill the framing cavity, R-19 minimum.
  - h. First value is cavity insulation, second is continuous insulation or insulated siding, so "13+5" means R-13 cavity insulation plus R-5 continuous insulation or insulated siding. If structural sheathing covers 40 percent or less of the exterior, continuous insulation R-value shall be permitted to be reduced by no more than R-3 in the locations where structural sheathing is used -- to maintain a consistent total sheathing thickness.
  - i. The second R-value applies when more than half the insulation is on the interior of the mass wall.

**2012 AMENDED PRESCRIPTIVE TABLE- COMPARE TO 2006**

**TABLE R402.1.1 INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT\***

CLIMATE ZONE	FENESTRATION U-FACTOR <sup>a</sup>	SKYLIGHT <sup>b</sup> U-FACTOR	GLAZED FENESTRATION SHGC <sup>c, d</sup>	CEILING R-VALUE	WOOD FRAME WALL R-VALUE	MASS WALL R-VALUE <sup>e</sup>	FLOOR R-VALUE	BASEMENT <sup>f</sup> WALL R-VALUE	SLAB <sup>g</sup> R-VALUE & DEPTH	CRAWL SPACE <sup>h</sup> WALL R-VALUE
1	NR	0.75	0.25	30	13	3/4	13	0	0	0
2	0.40	0.65	0.25	38	13	4/6	13	0	0	0
3	0.35	0.55	0.25	38	20 or 13+5 <sup>b</sup>	8/13	19	5/13 <sup>i</sup>	0	5/13
4 except Marine	0.35	0.55	0.40	49	20 or 13+5 <sup>b</sup>	8/13	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.35	0.60	NR	38	19 or 13+5 <sup>b</sup>	13	30 <sup>f</sup>	10/13	10, 2 ft	10/13
6	0.35	0.60	NR	49	19 or 13+5 <sup>b</sup>	15	30 <sup>f</sup>	10/13	10, 4 ft	10/13
7 and 8	0.32	0.55	NR	49	20+5 or 13+10 <sup>b</sup>	19/21	38 <sup>f</sup>	15/19	10, 4 ft	15/19

- For SI: 1 foot = 304.8 mm.
- a. R-values are minimums. U-factors and SHGC are maximums. When insulation is installed in a cavity which is less than the label or design thickness of the insulation, the installed R-value of the insulation shall not be less than the R-value specified in the table.
  - b. The fenestration U-factor column excludes skylights. The SHGC column applies to all glazed fenestration. Exception: Skylights may be excluded from glazed fenestration SHGC requirements in Climate Zones 1 through 3 where the SHGC for such skylights does not exceed 0.30.
  - c. "15/19" means R-15 continuous insulation 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 or exterior of the home or R-5 continuous insulation on the interior or exterior of the home. "10/13" means R-10 continuous insulation 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 Climate 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 R301.1 and Table R301.1.
  - g. Or insulation sufficient to fill the framing cavity, R-19 minimum.
  - h. First value is cavity insulation, second is continuous insulation or insulated siding, so "13+5" means R-13 cavity insulation plus R-5 continuous insulation or insulated siding. If structural sheathing covers 40 percent or less of the exterior, continuous insulation R-value shall be permitted to be reduced by no more than R-3 in the locations where structural sheathing is used -- to maintain a consistent total sheathing thickness.
  - i. The second R-value applies when more than half the insulation is on the interior of the mass wall.

<sup>j</sup> Log walls complying with ICC400 and with a minimum average wall thickness of 5" or greater shall be permitted in Zones 5-8 when overall window glazing is .31 U-factor or lower, minimum heating equipment efficiency is 90 AFUE (gas) or 84 AFUE (oil), and all other component requirements are met."

27

## FENESTRATION

Skylights, roof windows, vertical windows (fixed or moveable), opaque doors, glazed doors, glazed block and combination opaque/glazed doors.



28

### Fenestration Sections R303.1.3/R402.3

#### Doors and windows

- ✓ NFRC rating or default table
  - If no labeled U-factor and SHGC, use default table
- ✓ No glass area limits with the prescriptive path
- ✓ Exemptions (~~prescriptive path only~~)
  - Up to 15 ft<sup>2</sup> of glazing per dwelling unit (Section R402.3.3)
  - One side-hinged opaque door assembly up to 24 ft<sup>2</sup> (Section R402.3.4)

*State Amendment allows exemption for any method /path used*



29

### Windows, Doors and Skylights- All consider fenestration

- ✓Meet U-factor
- ✓Meet SHGC



30

### Fenestration Sections R402.3.1/R402.3.3

- ✓Area-weighted Average
  - ✓Some may be better than code- others weaker
  - ✓Can be used to satisfy U-factor and SHGC requirements
  - ✓Subject to hard limits, even in trade-offs

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**
- ✓U-factors of individual windows or skylights can be higher if maximum area-weighted average is below these limits.

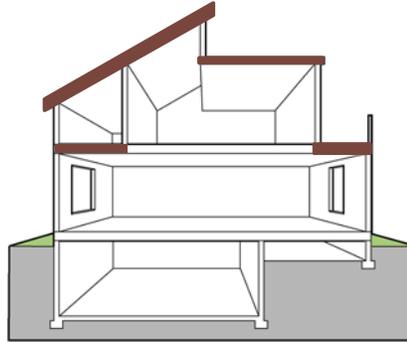
31

## Ceilings

Requirements based on

- ✓ Assembly type
- ✓ Continuous insulation
- ✓ Insulation between framing (cavity insulation)

Meet or exceed R-values



32

## Ceilings *Section R303.1*

R-values are to be printed on the batt insulation or rigid foam board.

Blown-in insulation must have an insulation certificate at or near the opening of the attic.

The certificate should include:

- ✓ R-value of installed thickness
- ✓ Initial installed thickness
- ✓ Installed density
- ✓ Settled thickness/settled R-value
- ✓ Coverage area
- ✓ Number of bags installed



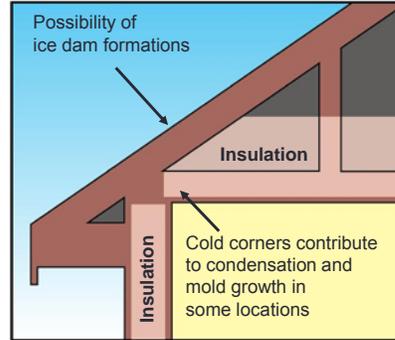
Insulation markers must be installed every 300 square feet and be marked with the minimum installed thickness and affixed to the trusses or joists.

33

**Ceilings with Attics - Section R402.2.1**

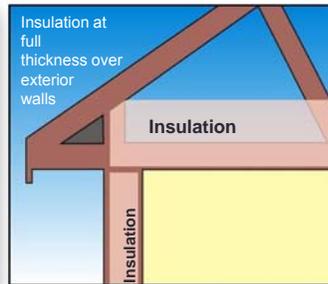
Ceiling insulation requirements in R-value table assume standard truss systems

Insulation is NOT considered continuous if blown or batt into a truss ceiling



34

**Ceilings with Attics, Cont'd. Section R402.2.1**



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

*State Amendment allows with any method/path  
 Note: This reduction ONLY applies to the R-value prescriptive path, not the U-factor or Total UA alternatives*

35

### Ceilings without Attic Spaces

*Section R402.2.2 - (e.g., vaulted)*

- ✓ R-30 allowed for 500 ft<sup>2</sup> or 20% total insulated ceiling area, whichever is less, where
  - ✓ Insulation levels are required > R-30
  - ✓ Not sufficient amount of space to meet higher levels
  - ✓ *Remember there is a air impermeable insulation requirement for ceilings without attics or ventilation-*
    - ✓ *Closed cell foam for condensation control*
    - ✓ *IRC R806.4*

*State Amendment allows use of this exception for any method/path*

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

36

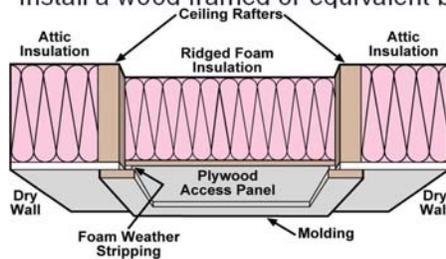
### Access Hatches and Doors - Section R402.2.3 - Prescriptive

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
- ✓ **This was a 2009 IECC requirement- remains in the 2012- New for Utah as 2009 Residential IECC was never adopted**

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

Install a wood framed or equivalent barrier



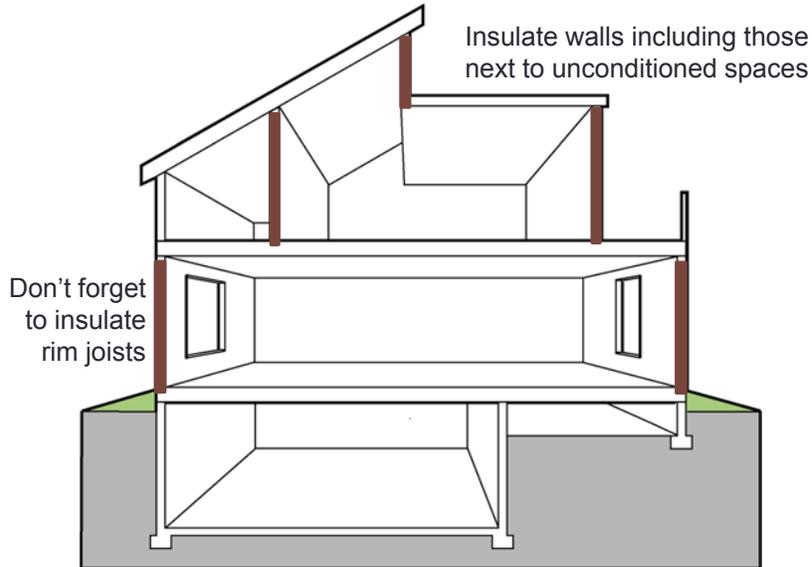
37

### Batt above Insulation Dam- No Gasket



38

### Above Grade Walls



**Wood-Frame Walls Section R402**

Table R402.1.1  
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT

CLIMATE ZONE	FENESTRATION U-FACTOR <sup>b</sup>	SKYLIGHT <sup>b</sup> U-FACTOR	GLAZED FENESTRATION SHGC <sup>b, e</sup>	CEILING R-VALUE	WOOD FRAME WALL R-VALUE
1	NR	0.75	0.25	30	13
2	0.40	0.65	0.25	38	13
3	0.35	0.55	0.25	38	20 or 13+5 <sup>h</sup>
4 except Marine	0.35	0.55	0.40	49	20 or 13+5 <sup>h</sup>
5 and Marine 4	0.32	0.55	NR	49	20 or 13+5 <sup>h</sup>
6	0.32	0.55	NR	49	20+5 or 13+10 <sup>h</sup>
7 and 8	0.32	0.55	NR	49	20+5 or 13+10 <sup>h</sup>

h. First value is cavity insulation, second is continuous insulation or insulated siding, so "13+5" means R-13 cavity insulation plus R-5 continuous insulation or insulated siding. If structural sheathing covers 40 percent or less of the exterior, continuous insulation R-value shall be permitted to be reduced by no more than R-3 in the locations where structural sheathing is used – to maintain a consistent total sheathing thickness.

**Steel-Frame Walls Section R402.2.6**

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

✓ "R-X + Y" means R-X cavity plus R-Y continuous

Wood Frame R-value Requirement	Cold-Formed Steel Equivalent R-value <sup>a</sup>
Steel Truss Ceilings <sup>b</sup>	
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 <sup>b</sup>	
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 + 4.2 or R-19 + 2.1, or R-21 + 2.8 or R-0+9.3 or R-15+R-3.8 or R-21 + 3.1
R-13+R-3	R-0 + 11.2 or R-13 + 6.1, or R-15 + 5.7 or R-19+5.0 or R-21+4.7

## Impact of Framing on Wall R-values

Framing member & spacing	Nominal cavity insulation	Combined cavity & framing R-value (w/o sheathing or air films)	
		Wood-framed	Steel-framed
2x4 16" o.c. <sup>1</sup>	R-11	R-9.0	R-5.5
	R-13	R-10.1	R-6.0
	R-15	R-11.2	R-6.4
2x4 24" o.c. <sup>2</sup>	R-11	R-9.4	R-6.6
	R-13	R-10.7	R-7.2
	R-15	R-11.9	R-7.8
2x6 16" o.c.	R-19	R-15.1	R-7.1
	R-21	R-16.2	R-7.4
2x6 24" o.c.	R-19	R-16.0	R-8.6
	R-21	R-17.2	R-9.0
2x8 16" o.c.	R-25	R-20.1	R-7.8
2x8 24" o.c.	R-25	R-21.2	R-9.6



### Mass Walls

#### Section R402.2.5

#### What type

- ✓ Concrete block, concrete, insulated concrete form (ICF), masonry cavity, brick (other than brick veneer), earth, and solid timber/logs

#### Provisions

- ✓ Are assumed to be above grade walls



43

## Mass Wall Requirements

### Section R402.2.5

Table R402.1.1

#### INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT

CLIMATE ZONE	FENESTRATION U-FACTOR <sup>b</sup>	SKYLIGHT <sup>b</sup> U-FACTOR	GLAZED FENESTRATION SHGC <sup>b, e</sup>	CEILING R-VALUE	WOOD FRAME WALL R-VALUE	MASS WALL R-VALUE <sup>f</sup>
1	NR	0.75	0.25	30	13	3/4
2	0.40	0.65	0.25	38	13	4/6
3	0.35	0.55	0.25	38	20 or 13+5 <sup>h</sup>	8/13
4 except Marine	0.35	0.55	0.40	49	20 or 13+5 <sup>h</sup>	8/13
5 and Marine 4					20 or 13+5 <sup>h</sup>	13/17
6					0+5 or 13+10 <sup>h</sup>	15/20
7 and 8					0+5 or 13+10 <sup>h</sup>	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)**

44

## Straw Bale –

Account for Thermal Bridging – Wood or Steel



## Straw Bale R-Value

**TABLE 1. Straw Bale R-values**

	Joe McCabe	Sandia Lab	ORNL	CEC	CEC	ORNL
Test Procedure	Hot plate Single bale	Thermal probe Single bale	Hot box Full wall	Approved Values	Hot box Full wall	Hot box Full wall
Test Date	1993	1994	Oct. 1996	Dec. 1996	May 1997	Feb. 1998
Type of Straw	Wheat	Not Listed	Wheat	Any	Rice	Wheat
Bale Type	3-string, 23"	2-string, 18"	2-string, 18"	3-string, 23"(assmd)	3-string, 23"	2-string, 19"
Moisture Content	8.4%	Not Listed	Not Listed	<20%	11%	13%
Density lbs/Ft <sup>3</sup>	8.3	5.2	Not Listed	7	6.7	8.0
R-value Per Inch	2.38	2.67	.94	.56 - .91	1.13	1.45

*1.46 - Commins and Stone*

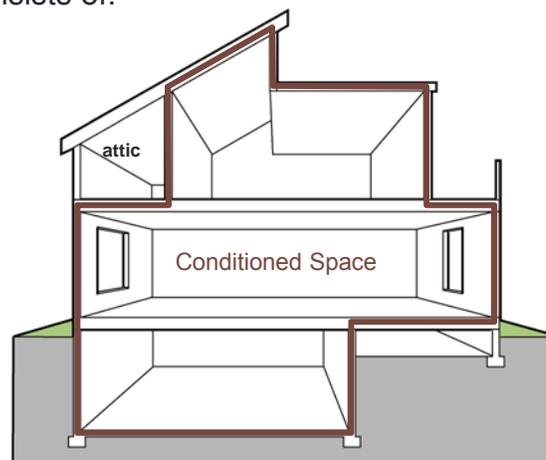
### Tested R-value for Straw Bale Walls and Performance Modeling for Straw Bale Homes

*Tav R. Commins, California Energy Commission, Sacramento, California  
Nehemiah I. Stone, California Energy Commission, Sacramento, California*

## Building Envelope Specific Requirements

Building Envelope consists of:

- ✓ Fenestration
- ✓ Ceilings
- ✓ Walls
  - Above grade
  - Below grade
  - Mass walls
- ✓ Floors
- ✓ Slabs
- ✓ Crawlspace



**Floors Over Unconditioned Space**  
*Section R402.2.7*

Table R402.1.1  
 INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT

**Footnote g**

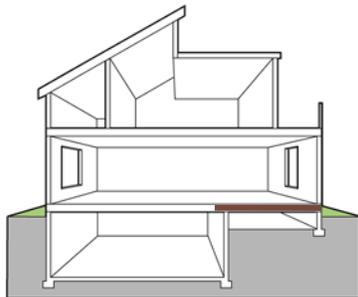
**Exception: If framing members are too small to accommodate R-30, insulation that fills the framing cavity, not less than R-19, complies**

CLIMATE ZONE	...	FLOOR R-VALUE
1		13
2		13
3		19
4 except Marine		19
5 and Marine 4		30 <sup>g</sup>
6		30 <sup>g</sup>
7 and 8		38 <sup>g</sup>

**Floors (Over Unconditioned Space)**  
*Section 402.2.7*

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

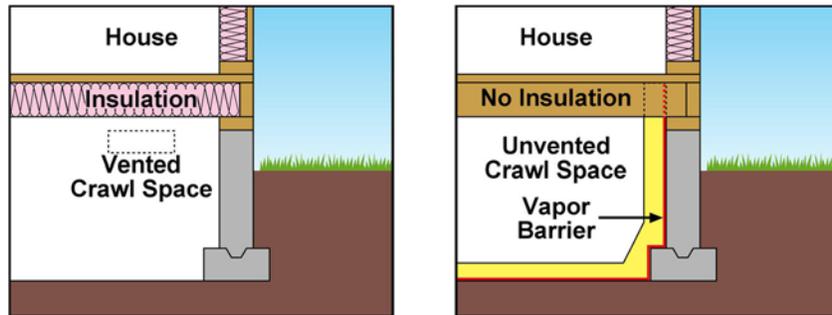
49

## Crawlspace 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



50

## Vented & Unvented Crawlspaces

### Section R402.2.10

#### 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 R402.1.1*).
- ✓ Crawlspace wall insulation must extend from the top of the wall to the inside finished grade and then 24" vertically or horizontally.
- ✓ Crawlspaces 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.

## Steel-Frame Floors Section R402.2.6

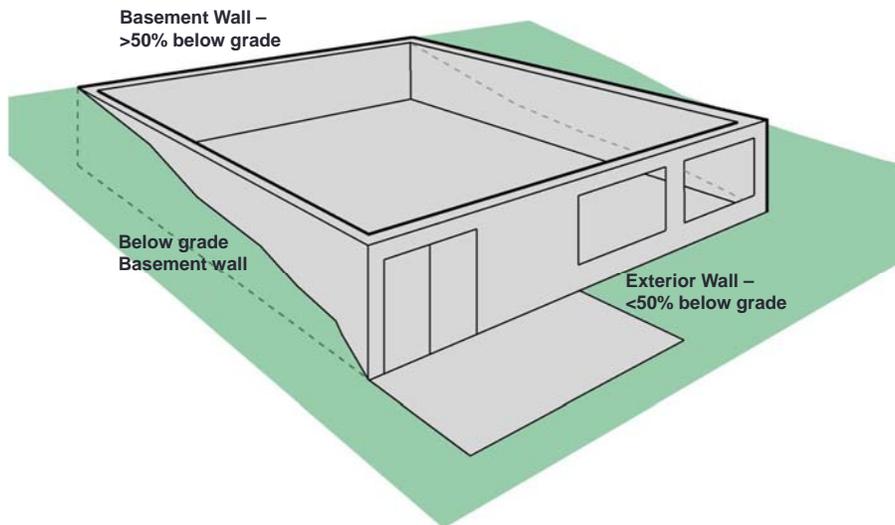
Table R402.2.6  
Steel-Frame Ceiling, Wall and Floor Insulation  
(R-Value)

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

Wood Frame R-value Requirement	Cold-Formed Steel Equivalent R-value <sup>a</sup>
	Steel Joist Floor <sup>b</sup>
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 + Y” means R-X cavity plus R-Y continuous

## Defining Below-Grade Walls



53

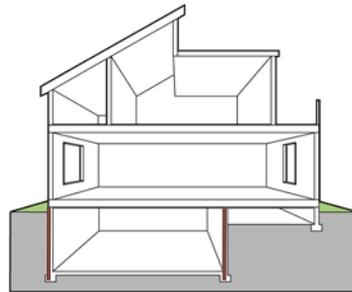
### Below-Grade Walls

- ✓ ≥ 50% below grade
- ✓ Otherwise treat as above-grade wall

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



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



54

### Below-Grade Walls

#### Section R402.1

Table R402.1.1  
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT

CLIMATE ZONE	...	FLOOR R-VALUE	BASEMENT <sup>a</sup> WALL R-VALUE
1		13	0
2		13	0
3		19	5/13 <sup>f</sup>
4, except			10/13
			15/19
			15/19
			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 (footnote f)

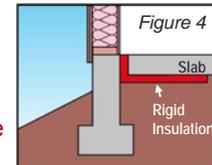
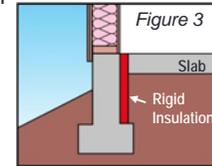
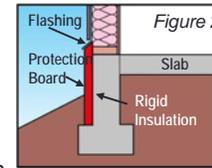
55

## Slab Edge Insulation

### Section R402.2.9

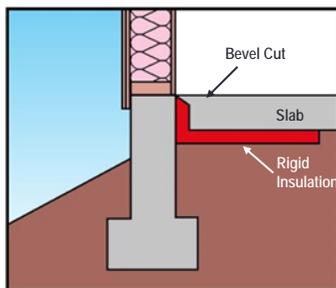
Applies to slabs with a floor surface < 12 inches below grade

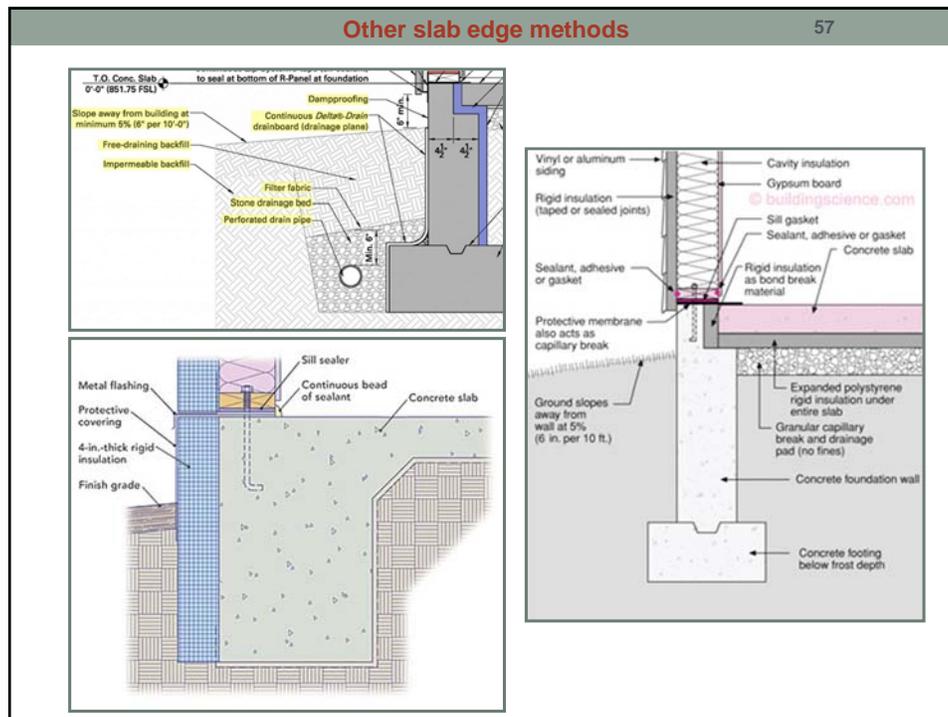
- ✓ R-10 (typically 2 inches) insulation in Zones 4 and above
- ✓ Must extend downward from top of slab a minimum of 24" (Zones 4 and 5) or 48" (Zones 6, 7, and 8)
- ✓ Insulation can be vertical or extend horizontally under the slab or out from the building
- ✓ Insulation extending outward must be under 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
- **This is not new or an amendment- it's simply one of the least enforced IECC requirements, and a source of substantial heat loss**



56

## Slab Edge Insulation





58

## U-Factor and Total UA Alternatives

### Section R402.1

#### 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
  - $UA = U \text{ factor} \times \text{area of assembly}$

59

## 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 R402.1.1 requirements with unlimited glass



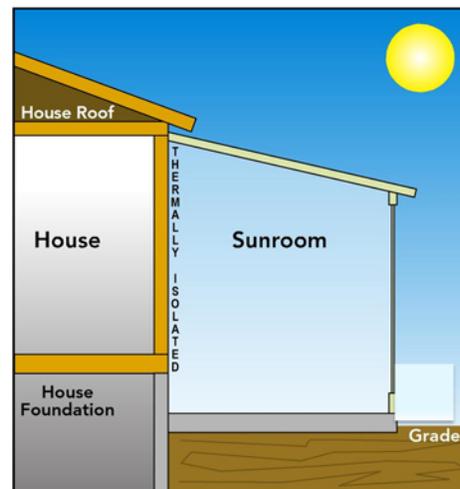
60

## Sunroom Requirements

*Section R402.2.12*

- ✓ Ceiling Insulation
  - Zones 1-4 R-19
  - Zones 5-8 R-24
- ✓ Wall Insulation
  - All zones R-13
- ✓ Fenestration U-Factor
  - Zones 4-8 0.45
- ✓ Skylight U-Factor
  - Zones 4-8 0.70

*Similar requirements for a heated garage?*



61

### Simulated Performance Alternative

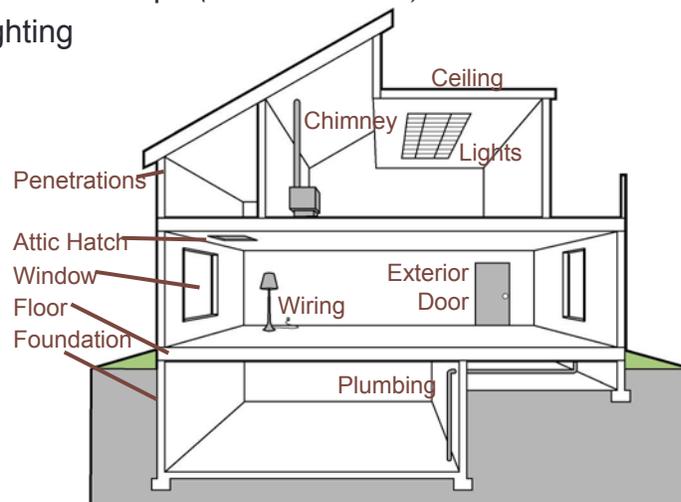
- ✓ Requires computer software with specified capabilities (local official may approve other tools)
- ✓ Includes both envelope and some systems
  - Are treated equally in standard and proposed design
- ✓ Allows greatest flexibility
  - Can trade-off tight duct systems
- ✓ Defines compliance based on equivalency of calculated energy or energy cost
- ✓ Section R405 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

62

### Mandatory Requirements

#### Section R402.4 - Air Leakage

- ✓ Building thermal envelope (*Section R402.4.1*)
- ✓ Recessed lighting
- ✓ Fenestration
- ✓ Fireplaces



63

## Air Leakage Control

### Section R402.4.1

Building thermal envelope must be sealed

Typical home built today leaks its entire volume of air....

**every 3 hours**

8 times a day!



64

## Building Thermal Envelope

### Section R402.4.1 – Air Leakage

Two options to demonstrate compliance

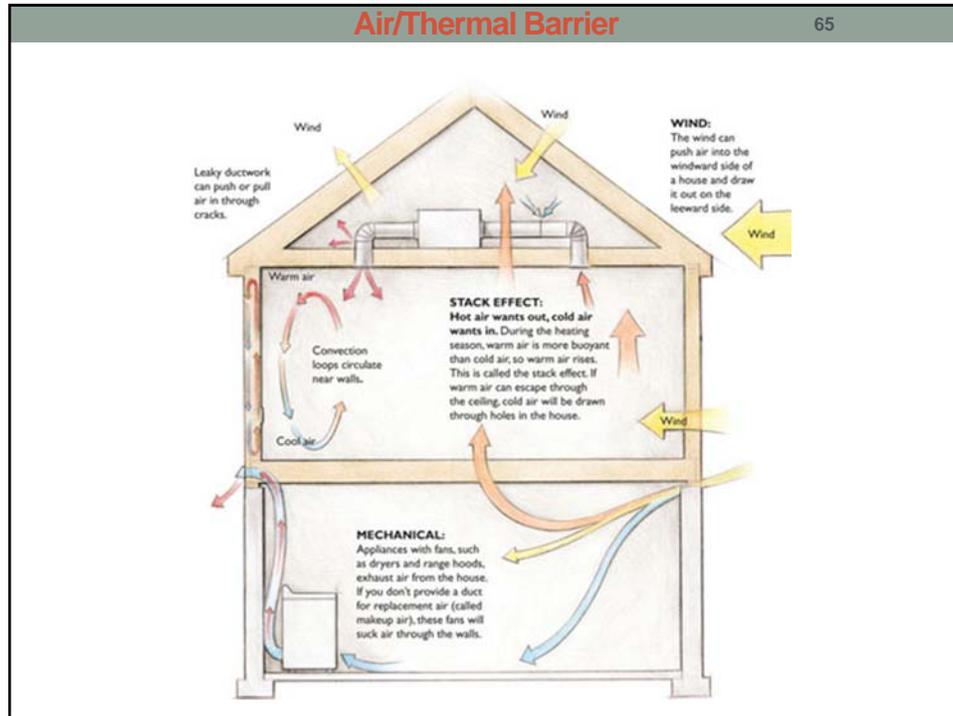
✓ Whole-house pressure test

Air Leakage Rate	Climate Zone	Test Pressure
≤ 5 ACH	1-2	50 Pascals
≤ 3 ACH	3-8	50 Pascals

- By State Amendment, all climate zones test to 5 ACH
- Testing may be by any certified testing- including contractors and sub contractors
- Testing may occur any time after creation of all building envelope penetrations

OR

✓ Field verification of items listed in Table R402.4.1.1



**Air Leakage Control - Section R402.4.1** 66

Building thermal envelope must be sealed

Typical home built today leaks its entire volume of air....

**every 3 hours**

**8 times a day!**

## Building Thermal Envelope Section R402.4.1 – Air Leakage

### Two options to demonstrate compliance

✓ Whole-house pressure test

Air Leakage Rate	Climate Zone	Test Pressure
≤ 5 ACH	1-2	50 Pascals
≤ 3 ACH	3-8	50 Pascals

- By State Amendment, all climate zones test to 5 ACH
- Testing may be by any certified testing- including contractors and sub contractors
- Testing may occur any time after creation of all building envelope penetrations

OR

✓ Field verification of items listed in Table R402.4.1.1

TABLE R402.4.1.1

AIR BARRIER AND INSULATION INSTALLATION

COMPONENT	CRITERIA*
<b>Air barrier and thermal barrier</b>	A continuous air barrier shall be installed in the building envelope. Exterior thermal envelope contains a continuous air barrier. Breaks or joints in the air barrier shall be sealed. Air-permeable insulation shall not be used as a sealing material.
<b>Ceiling/attic</b>	The air barrier in any dropped ceiling/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.
<b>Walls</b>	Comers and headers shall be insulated and the junction of the foundation and sill plate shall be sealed. The junction of the top plate and top of exterior walls shall be sealed. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier. Knee walls shall be sealed.
<b>Windows, skylights and doors</b>	The space between window/door jambs and framing and skylights and framing shall be sealed.
<b>Rim joists</b>	Rim joists shall be insulated and include the air barrier.
<b>Floors (including above-garage and cantilevered floors)</b>	Insulation shall be installed to maintain permanent contact with underside of subfloor decking. The air barrier shall be installed at any exposed edge of insulation.
<b>Crawl space walls</b>	Where provided, in lieu of floor insulation, insulation shall be permanently attached to the crawlspace walls. Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped.
<b>Shafts, penetrations</b>	Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed.
<b>Narrow cavities</b>	Batts in narrow cavities shall be cut to fit, or narrow cavities shall be filled by insulation that on installation readily conforms to the available cavity space.
<b>Garage separation</b>	Air sealing shall be provided between the garage and conditioned spaces.
<b>Recessed lighting</b>	Recessed light fixtures installed in the building thermal envelope shall be air tight, IC rated and sealed to dry wall.
<b>Plumbing and wiring</b>	Batt insulation shall be cut neatly to fit around wiring and plumbing in exterior walls, or insulation that on installation readily conforms to available space shall extend behind piping and wiring.
<b>Shower/tub on exterior wall</b>	Exterior wall adjacent to showers and tubs shall be insulated and the air barrier installed separating them from the showers and tubs.
<b>Electrical/phone box on exterior wall</b>	The air barrier shall be installed behind electrical or communication boxes or air sealed boxes shall be installed.
<b>HVAC register boxes</b>	HVAC register boots that penetrate building thermal envelopes shall be sealed to subfloor or drywall.
<b>Fireplace</b>	An air barrier shall be installed on fireplace walls. Fireplaces shall have gasketed doors.

\*In addition, inspection of log walls shall be in accordance with the provisions of ICC-400.

TABLE R402.4.1.1

69

AIR BARRIER AND INSULATION INSTALLATION

COMPONENT	CRITERIA*
Air barrier and thermal barrier	A continuous air barrier shall be installed in the building envelope. Exterior thermal envelope contains a continuous air barrier. Breaks or joints in the air barrier shall be sealed.
Ceiling/attic	Air-permeable insulation shall not be used as a sealing material. The air barrier in any dropped ceiling/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.
Walls	Corners and headers shall be insulated and the junction of the foundation and sill plate shall be sealed. The junction of the top plate and top of exterior walls shall be sealed. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier. Knee walls shall be sealed.
Windows, skylights and doors	The space between window/door jambs and framing and skylights and framing shall be sealed.
Rim joists	Rim joists shall be insulated and include the air barrier.
Floors (including above-garage and cantilevered floors)	Insulation shall be installed to maintain permanent contact with underside of subfloor decking. The air barrier shall be installed at any exposed edges of insulation.
Crawl space walls	Where provided, in lieu of floor insulation, insulation permanently attached to the crawlspace walls. Exposed earth in unvented crawl spaces shall be Class I vapor retarder with overlapping joints to exterior or unconditioned space shall be sealed.
Shafts, penetrations	Batts in narrow cavities shall be cut to fit, or not be filled by insulation that on installation readily available cavity space.
Narrow cavities	Ar sealing shall be provided between the garage conditioned spaces.
Garage separation	Recessed light fixtures installed in the building shall be air tight, IC rated and sealed to dry rot.
Recessed lighting	Batt insulation shall be cut neatly to fit around plumbing in exterior walls, or insulation that conforms to available space shall extend behind wiring.
Plumbing and wiring	Exterior wall adjacent to showers and tubs shall have the air barrier installed separating them from the tubs.
Shower/tub on exterior wall	The air barrier shall be installed behind electrical communication boxes or air sealed boxes shall be sealed.
Electrical/phone box on exterior wall	HVAC register boots that penetrate building shall be sealed to subfloor or drywall.
HVAC register boxes	An air barrier shall be installed on fireplace walls have gasketed doors.
Fireplace	

\*In addition, inspection of log walls shall be in accordance with the provisions of ICC-400.

Stuffing batts in rim joist cavities will NOT pass.



Fail.



Pass

There are many ways to air Seal (air barrier) the rim joists, rigid foam, Caulking, mastic, spray foams, spray latex etc... None are easy or cheap.

This point alone might make 3<sup>rd</sup> party Blower door test (performance method) the More cost effective option.

TABLE R402.4.1.1

70

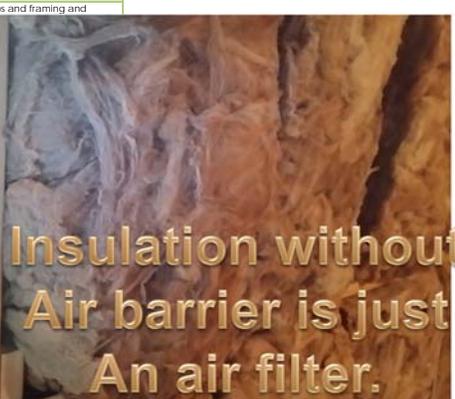
AIR BARRIER AND INSULATION INSTALLATION

COMPONENT	CRITERIA*
Air barrier and thermal barrier	A continuous air barrier shall be installed in the building envelope. Exterior thermal envelope contains a continuous air barrier. Breaks or joints in the air barrier shall be sealed.
Ceiling/attic	Air-permeable insulation shall not be used as a sealing material. The air barrier in any dropped ceiling/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.
Walls	Corners and headers shall be insulated and the junction of the foundation and sill plate shall be sealed. The junction of the top plate and top of exterior walls shall be sealed. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier. Knee walls shall be sealed.
Windows, skylights and doors	The space between window/door jambs and framing and
Rim joists	
Floors (including above-garage and cantilevered floors)	
Crawl space walls	
Shafts, penetrations	
Narrow cavities	
Garage separation	
Recessed lighting	
Plumbing and wiring	
Shower/tub on exterior wall	
Electrical/phone box on ext	
HVAC register boxes	
Fireplace	

\*In addition, inspection of log walls shall be in accordance with the provisions of ICC-400.

Attic knee walls must have full Air Barrier on attic side and sealed On all 6 sides.

Knee wall must be full depth. No more trying to 'squeeze' a R-19 batt into a 2x4 attic truss.



Insulation without Air barrier is just An air filter.

TABLE R402.4.1.1 71

AIR BARRIER AND INSULATION INSTALLATION

COMPONENT	CRITERIA*
Air barrier and thermal barrier	A continuous air barrier shall be installed in the building envelope. Exterior thermal envelope contains a continuous air barrier. 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/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. Corners and headers shall be insulated and the junction of the foundation and sill plate shall be sealed. The junction of the top plate and top of exterior walls shall be sealed.
Walls	Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier. Knee walls shall be sealed.

Attic knee walls must have full Air Barrier on attic side and sealed On all 6 sides.

Knee wall must be full depth. No more trying to 'squeeze' a R-19 batt into a 2x4 attic truss.



72

## Improper Insulation Installation



73

# Air Barrier – 6 sides

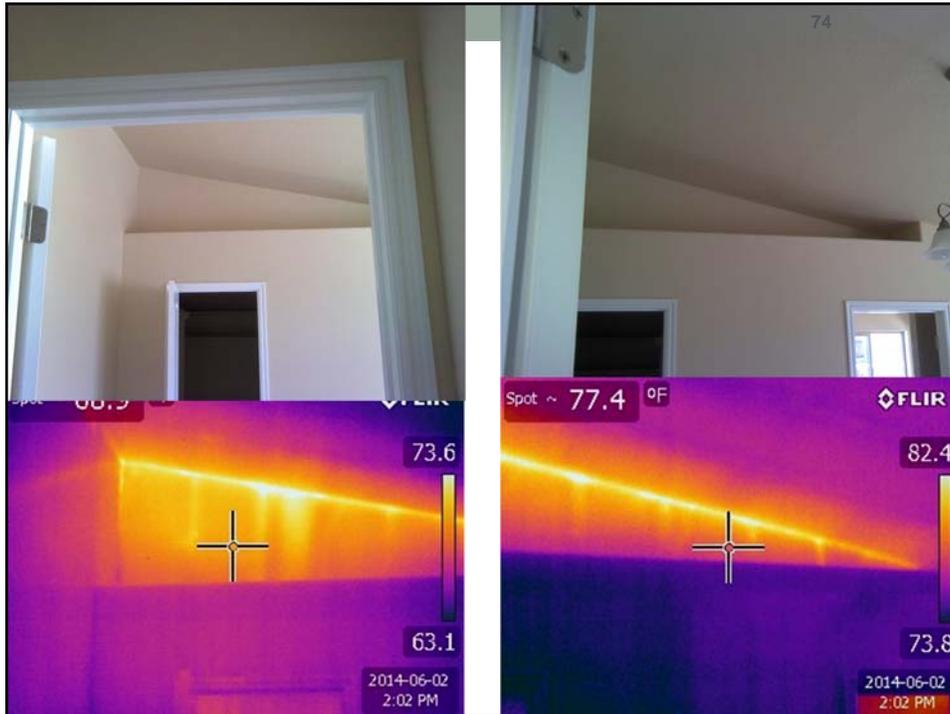


TABLE R402.4.1.1

75

AIR BARRIER AND INSULATION INSTALLATION

COMPONENT	CRITERIA*
<b>Air barrier and thermal barrier</b>	A continuous air barrier shall be installed in the building envelope. Exterior thermal envelope contains a continuous air barrier. Breaks or joints in the air barrier shall be sealed. Air-permeable insulation shall not be used as a sealing material.
<b>Ceiling/attic</b>	The air barrier in any dropped ceiling/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.
<b>Walls</b>	Corners and headers shall be insulated and the junction of the foundation and sill plate shall be sealed. The junction of the top plate and top of exterior walls shall be sealed. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier. Knee walls shall be sealed.
<b>Windows, skylights and doors</b>	The space between window/door jambs and framing and skylights and framing shall be sealed.
<b>Rim joists</b>	Rim joists shall be insulated and include the air barrier.
<b>Floors (including above-garage and cantilevered floors)</b>	Insulation shall be installed to maintain permanent contact with underside of subfloor decking. The air barrier shall be installed at any exposed edge of insulation.
<b>Crawl space walls</b>	Where provided, in lieu of floor insulation, insulation shall be permanently attached to the crawlspace walls. Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped.
<b>Shafts, penetrations</b>	Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed.
<b>Narrow cavities</b>	Batts in narrow cavities shall be cut to fit, or narrow cavities shall be filled by insulation that on installation readily conforms to the available cavity space.
<b>Garage separation</b>	Air sealing shall be provided between the garage and conditioned spaces.
<b>Recessed lighting</b>	Recessed light fixtures installed in the building thermal envelope shall be air tight, IC rated and sealed to dry wall.
<b>Plumbing and wiring</b>	Batt insulation shall be cut neatly to fit around wiring and plumbing in exterior walls, or insulation that on installation readily conforms to available space shall extend behind piping and wiring.
<b>Shower/tub on exterior wall</b>	Exterior wall adjacent to showers and tubs shall be insulated and the air barrier installed separating them from the showers and tubs.
<b>Electrical/phone box on exterior wall</b>	The air barrier shall be installed behind electrical or communication boxes or air sealed boxes shall be installed.
<b>HVAC register boxes</b>	HVAC register boots that penetrate building thermal envelopes shall be sealed to subfloor or drywall.
<b>Fireplace</b>	An air barrier shall be installed on fireplace walls. Fireplaces shall have gasketed doors.

\*In addition, inspection of log walls shall be in accordance with the provisions of ICC-400.

Attic access hatches  
Must have insulation attached  
To the backside. (attached!)

Hatch must have gasket.

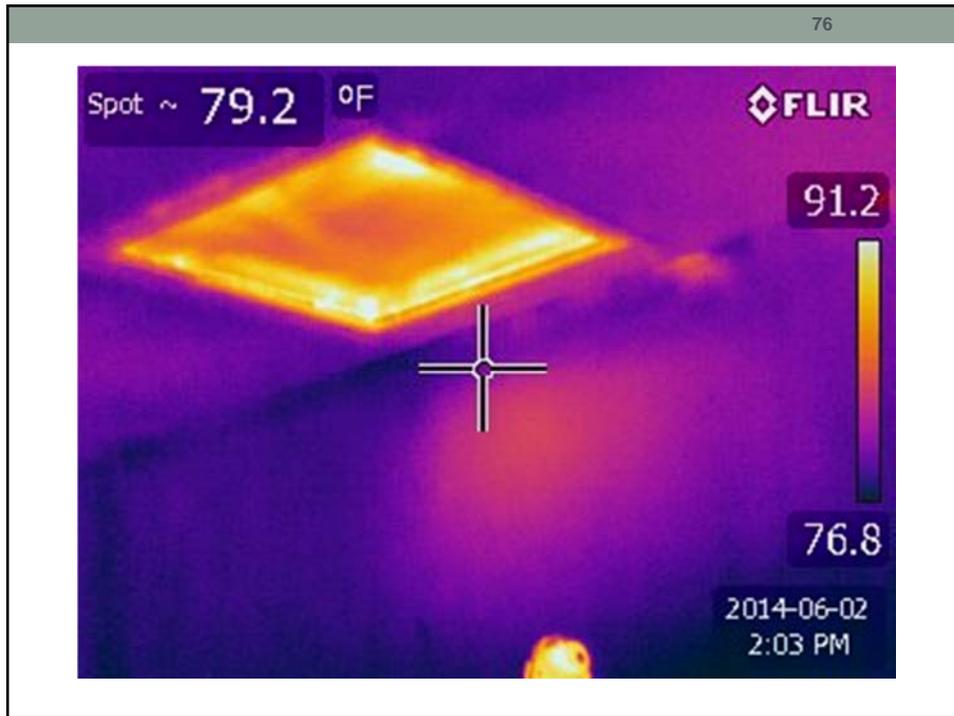



TABLE R402.4.1.1  
AIR BARRIER AND INSULATION INSTALLATION

COMPONENT	CRITERIA*
Air barrier and thermal barrier	A continuous air barrier shall be installed in the building envelope. Exterior thermal envelope contains a continuous air barrier. 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/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.
Walls	Corners and headers shall be insulated and the junction of the foundation and sill plate shall be sealed. The junction of the top plate and top of exterior walls shall be sealed. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier. Knee walls shall be sealed.
Windows, skylights and doors	The space between window/door jambs and framing and skylights and framing shall be sealed.
Rim joists	Rim joists shall be insulated and include the air barrier.
Floors (including above-garage and cantilevered floors)	Insulation shall be installed to maintain permanent contact with underside of subfloor decking. The air barrier shall be installed at any exposed edge of insulation.
Crawl space walls	Where provided, in lieu of floor insulation, insulation shall be permanently attached to the crawlspace walls. Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped.
Shafts, penetrations	Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed.
Narrow cavities	Batts in narrow cavities shall be cut to fit, or narrow cavities shall be filled by insulation that on installation readily conforms to the available cavity space.
Garage separation	Air sealing shall be provided between the garage and conditioned spaces.
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be air tight, IC rated and sealed to dry wall.
Plumbing and wiring	Batt insulation shall be cut neatly to fit around wiring and plumbing in exterior walls, or insulation that on installation readily conforms to available space shall extend behind piping and wiring.
Shower/tub on exterior wall	Exterior wall adjacent to showers and tubs shall be insulated and the air barrier installed separating them from the showers and tubs.
Electrical/phone box on exterior wall	The air barrier shall be installed behind electrical or communication boxes or air sealed boxes shall be installed.
HVAC register boxes	HVAC register boots that penetrate building thermal envelopes shall be sealed to subfloor or drywall.
Fireplace	An air barrier shall be installed on fireplace walls. Fireplaces shall have gasketed doors.

\*In addition, inspection of log walls shall be in accordance with the provisions of ICC-400.

Either fill entire subfloor cavity (a R-30 batt. Will often do this) OR must use Props at manufacturer designated intervals. Typically 1 foot to 18 in.

Wire rods are non compliant as They twist and sag and do not Maintain permanent contact with Sub floor.



TABLE R402.4.1.1  
AIR BARRIER AND INSULATION INSTALLATION

COMPONENT	CRITERIA*
Air barrier and thermal barrier	A continuous air barrier shall be installed in the building envelope. Exterior thermal envelope contains a continuous air barrier. 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/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.
Walls	Corners and headers shall be insulated and the junction of the foundation and sill plate shall be sealed. The junction of the top plate and top of exterior walls shall be sealed. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier. Knee walls shall be sealed.
Windows, skylights and doors	The space between window/door jambs and framing and skylights and framing shall be sealed.
Rim joists	Rim joists shall be insulated and include the air barrier.
Floors (including above-garage and cantilevered floors)	Insulation shall be installed to maintain permanent contact with underside of subfloor decking. The air barrier shall be installed at any exposed edge of insulation.
Crawl space walls	Where provided, in lieu of floor insulation, insulation shall be permanently attached to the crawlspace walls. Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped.
Shafts, penetrations	Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed.
Narrow cavities	Batts in narrow cavities shall be cut to fit, or be filled by insulation that on installation readily conforms to the available cavity space.
Garage separation	Air sealing shall be provided between the garage and conditioned spaces.
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be air tight, IC rated and sealed to dry wall.
Plumbing and wiring	Batt insulation shall be cut neatly to fit around plumbing in exterior walls, or insulation that on installation readily conforms to available space shall extend behind piping and wiring.
Shower/tub on exterior wall	Exterior wall adjacent to showers and tubs shall be insulated and the air barrier installed separating them from the showers and tubs.
Electrical/phone box on exterior wall	The air barrier shall be installed behind electrical or communication boxes or air sealed boxes shall be installed.
HVAC register boxes	HVAC register boots that penetrate building thermal envelopes shall be sealed to subfloor or drywall.
Fireplace	An air barrier shall be installed on fireplace walls. Fireplaces shall have gasketed doors.

\*In addition, inspection of log walls shall be in accordance with the provisions of ICC-400.

The sub floor joist area that is shared by interior space and the garage must have a rigid air barrier and be air sealed.

This can be costly if not designed for and discussed with framing crews ahead of time.



TABLE R402.4.1.1

79

AIR BARRIER AND INSULATION INSTALLATION

COMPONENT	CRITERIA*
<b>Air barrier and thermal barrier</b>	A continuous air barrier shall be installed in the building envelope. Exterior thermal envelope contains a continuous air barrier. Breaks or joints in the air barrier shall be sealed. Air-permeable insulation shall not be used as a sealing material.
<b>Ceiling/attic</b>	The air barrier in any dropped ceiling/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.
<b>Walls</b>	Corners and headers shall be insulated and the junction of the foundation and sill plate shall be sealed. The junction of the top plate and top of exterior walls shall be sealed. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier. Knee walls shall be sealed.
<b>Windows, skylights and doors</b>	The space between window/door jambs and framing and skylights and framing shall be sealed.
<b>Rim joists</b>	Rim joists shall be insulated and include the air barrier.
<b>Floors (including above-garage and cantilevered floors)</b>	Insulation shall be installed to maintain permanent contact with underside of subfloor decking. The air barrier shall be installed at any exposed edge of insulation.
<b>Crawl space walls</b>	Where provided, in lieu of floor insulation, insulation shall be permanently attached to the crawlspace walls. Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped.
<b>Shafts, penetrations</b>	Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed.
<b>Narrow cavities</b>	Batts in narrow cavities shall be cut to fit, or narrow cavities shall be filled by insulation that on installation readily conforms to the available cavity space.
<b>Garage separation</b>	Air sealing shall be provided between the garage and conditioned spaces.
<b>Recessed lighting</b>	Recessed light fixtures installed in the building thermal envelope shall be air tight, IC rated and sealed to dry wall.
<b>Plumbing and wiring</b>	Batt insulation shall be cut neatly to fit around wiring and plumbing in exterior walls, or insulation that on installation readily conforms to available space shall extend behind piping and wiring.
<b>Shower/tub on exterior wall</b>	Exterior wall adjacent to showers and tubs shall be insulated and the air barrier installed separating them from the showers and tubs.
<b>Electrical/phone box on exterior wall</b>	The air barrier shall be installed behind electrical or communication boxes or air sealed boxes shall be installed.
<b>HVAC register boxes</b>	HVAC register boots that penetrate building thermal envelopes shall be sealed to subfloor or drywall.
<b>Fireplace</b>	An air barrier shall be installed on fireplace walls. Fireplaces shall have gasketed doors.

\*In addition, inspection of log walls shall be in accordance with the provisions of ICC-400.

IC rated cans must be installed (correctly!) or sealed air boxes must be installed over them.

Sparky must install the cans WITH the gasket on the finish trim piece.

That gasket almost always



TABLE R402.4.1.1

80

AIR BARRIER AND INSULATION INSTALLATION

COMPONENT	CRITERIA*
<b>Air barrier and thermal barrier</b>	A continuous air barrier shall be installed in the building envelope. Exterior thermal envelope contains a continuous air barrier. Breaks or joints in the air barrier shall be sealed. Air-permeable insulation shall not be used as a sealing material.
<b>Ceiling/attic</b>	The air barrier in any dropped ceiling/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.
<b>Walls</b>	Corners and headers shall be insulated and the junction of the foundation and sill plate shall be sealed. The junction of the top plate and top of exterior walls shall be sealed. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier. Knee walls shall be sealed.
<b>Windows, skylights and doors</b>	The space between window/door jambs and framing and skylights and framing shall be sealed.
<b>Rim joists</b>	Rim joists shall be insulated and include the air barrier.
<b>Floors (including above-garage and cantilevered floors)</b>	Insulation shall be installed to maintain permanent contact with underside of subfloor decking. The air barrier shall be installed at any exposed edge of insulation.
<b>Crawl space walls</b>	Where provided, in lieu of floor insulation, insulation shall be permanently attached to the crawlspace walls. Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped.
<b>Shafts, penetrations</b>	Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed.
<b>Narrow cavities</b>	Batts in narrow cavities shall be cut to fit, or narrow cavities shall be filled by insulation that on installation readily conforms to the available cavity space.
<b>Garage separation</b>	Air sealing shall be provided between the garage and conditioned spaces.
<b>Recessed lighting</b>	Recessed light fixtures installed in the building thermal envelope shall be air tight, IC rated and sealed to dry wall.
<b>Plumbing and wiring</b>	Batt insulation shall be cut neatly to fit around wiring and plumbing in exterior walls, or insulation that on installation readily conforms to available space shall extend behind piping and wiring.
<b>Shower/tub on exterior wall</b>	Exterior wall adjacent to showers and tubs shall be insulated and the air barrier installed separating them from the showers and tubs.
<b>Electrical/phone box on exterior wall</b>	The air barrier shall be installed behind electrical or communication boxes or air sealed boxes shall be installed.
<b>HVAC register boxes</b>	HVAC register boots that penetrate building thermal envelopes shall be sealed to subfloor or drywall.
<b>Fireplace</b>	An air barrier shall be installed on fireplace walls. Fireplaces shall have gasketed doors.

\*In addition, inspection of log walls shall be in accordance with the provisions of ICC-400.

Batt insulation must have NO gaps, voids or compressions. NO inset stapling. It must fit in just



81

TABLE R402.4.1.1  
AIR BARRIER AND INSULATION INSTALLATION

COMPONENT	CRITERIA*
Air barrier and thermal barrier	A continuous air barrier shall be installed in the building envelope. Exterior thermal envelope contains a continuous air barrier. 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/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.
Walls	Corners and headers shall be insulated and the junction of the foundation and sill plate shall be sealed. The junction of the top plate and top of exterior walls shall be sealed. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier. Knee walls shall be sealed.
Windows, skylights and doors	The space between window/door jambs and framing and skylights and framing shall be sealed.
Rim joists	Rim joists shall be insulated and include the air barrier.
Floors (including above-garage and cantilevered floors)	Insulation shall be installed to maintain permanent contact with underside of subfloor decking. The air barrier shall be installed at any exposed edge of insulation.
Crawl space walls	Where provided, in lieu of floor insulation, insulation shall be permanently attached to the crawlspace walls. Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped.
Shafts, penetrations	Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed.
Narrow cavities	Batts in narrow cavities shall be cut to fit, or narrow cavities shall be filled by insulation that on installation readily conforms to the available cavity space.
Garage separation	Air sealing shall be provided between the garage and conditioned spaces.
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be air tight, IC rated and sealed to dry wall.
Plumbing and wiring	Batt insulation shall be cut neatly to fit around wiring and plumbing in exterior walls, or insulation that on installation readily conforms to available space shall extend behind piping and wiring.
Shower/tub on exterior wall	Exterior wall adjacent to showers and tubs shall be insulated and the air barrier installed separating them from the showers and tubs.
Electrical/phone box on exterior wall	The air barrier shall be installed behind electrical or communication boxes or air sealed boxes shall be installed.
HVAC register boxes	HVAC register boots that penetrate building thermal envelopes shall be sealed to subfloor or drywall.
Fireplace	An air barrier shall be installed on fireplace walls. Fireplaces shall have gasketed doors.

Batt insulation must have NO gaps, voids or compressions. NO inset stapling. It must fit in just like it was blown in.



82

TABLE R402.4.1.1  
AIR BARRIER AND INSULATION INSTALLATION

COMPONENT	CRITERIA*
Air barrier and thermal barrier	A continuous air barrier shall be installed in the building envelope. Exterior thermal envelope contains a continuous air barrier. 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/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.
Walls	Corners and headers shall be insulated and the junction of the foundation and sill plate shall be sealed. The junction of the top plate and top of exterior walls shall be sealed. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier. Knee walls shall be sealed.
Windows, skylights and doors	The space between window/door jambs and framing and skylights and framing shall be sealed.
Rim joists	Rim joists shall be insulated and include the air barrier.
Floors (including above-garage and cantilevered floors)	Insulation shall be installed to maintain permanent contact with underside of subfloor decking. The air barrier shall be installed at any exposed edge of insulation.
Crawl space walls	Where provided, in lieu of floor insulation, insulation shall be permanently attached to the crawlspace walls. Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped.
Shafts, penetrations	Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed.
Narrow cavities	Batts in narrow cavities shall be cut to fit, or narrow cavities shall be filled by insulation that on installation readily conforms to the available cavity space.
Garage separation	Air sealing shall be provided between the garage and conditioned spaces.
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be air tight, IC rated and sealed to dry wall.
Plumbing and wiring	Batt insulation shall be cut neatly to fit around wiring and plumbing in exterior walls, or insulation that on installation readily conforms to available space shall extend behind piping and wiring.
Shower/tub on exterior wall	Exterior wall adjacent to showers and tubs shall be insulated and the air barrier installed separating them from the showers and tubs.
Electrical/phone box on exterior wall	The air barrier shall be installed behind electrical or communication boxes or air sealed boxes shall be installed.
HVAC register boxes	HVAC register boots that penetrate building thermal envelopes shall be sealed to subfloor or drywall.
Fireplace	An air barrier shall be installed on fireplace walls. Fireplaces shall have gasketed doors.

\*In addition, inspection of log walls shall be in accordance with the provisions of ICC-400.

Batt insulation must have NO gaps, voids or compressions. NO inset stapling. It must fit in just like it was blown in.



TABLE R402.4.1.1

83

AIR BARRIER AND INSULATION INSTALLATION

COMPONENT	CRITERIA*
<b>Air barrier and thermal barrier</b>	A continuous air barrier shall be installed in the building envelope. Exterior thermal envelope contains a continuous air barrier. Breaks or joints in the air barrier shall be sealed.
<b>Ceiling/attic</b>	Air-permeable insulation shall not be used as a sealing material. The air barrier in any dropped ceiling/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.
<b>Walls</b>	Corners and headers shall be insulated and the junction of the foundation and sill plate shall be sealed. The junction of the top plate and top of exterior walls shall be sealed. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier. Knee walls shall be sealed.
<b>Windows, skylights and doors</b>	The space between window/door jambs and framing and skylights and framing shall be sealed.
<b>Rim joists</b>	Rim joists shall be insulated and include the air barrier.
<b>Floors (including above-garage and cantilevered floors)</b>	Insulation shall be installed to maintain permanent contact with underside of subfloor decking. The air barrier shall be installed at any exposed edge of insulation.
<b>Crawl space walls</b>	Where provided, in lieu of floor insulation, insulation shall be permanently attached to the crawlspace walls. Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped.
<b>Shafts, penetrations</b>	Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed.
<b>Narrow cavities</b>	Batts in narrow cavities shall be cut to fit, or narrow cavities shall be filled by insulation that on installation readily conforms to the available cavity space.
<b>Garage separation</b>	Air sealing shall be provided between the garage and conditioned spaces.
<b>Recessed lighting</b>	Recessed light fixtures installed in the building thermal envelope shall be air tight, IC rated and sealed to dry wall.
<b>Plumbing and wiring</b>	Batt insulation shall be cut neatly to fit around wiring and plumbing in exterior walls, or insulation that on installation readily conforms to available space shall extend behind piping and wiring.
<b>Shower/tub on exterior wall</b>	Exterior wall adjacent to showers and tubs shall be insulated and the air barrier installed separating them from the showers and tubs.
<b>Electrical/phone box on exterior wall</b>	The air barrier shall be installed behind electrical or communication boxes or air sealed boxes shall be installed.
<b>HVAC register boxes</b>	HVAC register boots that penetrate building thermal envelopes shall be sealed to subfloor or drywall.
<b>Fireplace</b>	An air barrier shall be installed on fireplace walls. Fireplaces shall have gasketed doors.

\*In addition, inspection of log walls shall be in accordance with the provisions of ICC-400.



TABLE R402.4.1.1

84

AIR BARRIER AND INSULATION INSTALLATION

COMPONENT	CRITERIA*
<b>Air barrier and thermal barrier</b>	A continuous air barrier shall be installed in the building envelope. Exterior thermal envelope contains a continuous air barrier. Breaks or joints in the air barrier shall be sealed.
<b>Ceiling/attic</b>	Air-permeable insulation shall not be used as a sealing material. The air barrier in any dropped ceiling/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.
<b>Walls</b>	Corners and headers shall be insulated and the junction of the foundation and sill plate shall be sealed. The junction of the top plate and top of exterior walls shall be sealed. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier. Knee walls shall be sealed.
<b>Windows, skylights and doors</b>	The space between window/door jambs and framing and skylights and framing shall be sealed.
<b>Rim joists</b>	Rim joists shall be insulated and include the air barrier.
<b>Floors (including above-garage and cantilevered floors)</b>	Insulation shall be installed to maintain permanent contact with underside of subfloor decking. The air barrier shall be installed at any exposed edge of insulation.
<b>Crawl space walls</b>	Where provided, in lieu of floor insulation, insulation shall be permanently attached to the crawlspace walls. Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped.
<b>Shafts, penetrations</b>	Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed.
<b>Narrow cavities</b>	Batts in narrow cavities shall be cut to fit, or narrow cavities shall be filled by insulation that on installation readily conforms to the available cavity space.
<b>Garage separation</b>	Air sealing shall be provided between the garage and conditioned spaces.
<b>Recessed lighting</b>	Recessed light fixtures installed in the building thermal envelope shall be air tight, IC rated and sealed to dry wall.
<b>Plumbing and wiring</b>	Batt insulation shall be cut neatly to fit around wiring and plumbing in exterior walls, or insulation that on installation readily conforms to available space shall extend behind piping and wiring.
<b>Shower/tub on exterior wall</b>	Exterior wall adjacent to showers and tubs shall be insulated and the air barrier installed separating them from the showers and tubs.
<b>Electrical/phone box on exterior wall</b>	The air barrier shall be installed behind electrical or communication boxes or air sealed boxes shall be installed.
<b>HVAC register boxes</b>	HVAC register boots that penetrate building thermal envelopes shall be sealed to subfloor or drywall.
<b>Fireplace</b>	An air barrier shall be installed on fireplace walls. Fireplaces shall have gasketed doors.

\*In addition, inspection of log walls shall be in accordance with the provisions of ICC-400.

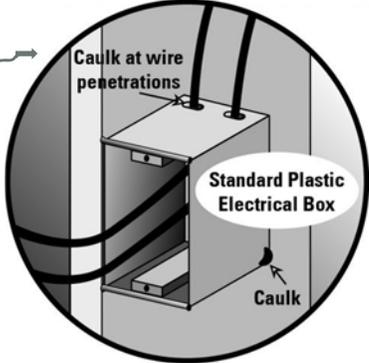


TABLE R402.4.1.1 AIR BARRIER AND INSULATION INSTALLATION	
COMPONENT	CRITERIA*
<b>Air barrier and thermal barrier</b>	A continuous air barrier shall be installed in the building envelope. Exterior thermal envelope contains a continuous air barrier. Breaks or joints in the air barrier shall be sealed. Air-permeable insulation shall not be used as a sealing material.
<b>Ceiling/attic</b>	The air barrier in any dropped ceiling/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.
<b>Walls</b>	Corners and headers shall be insulated and the junction of the foundation and sill plate shall be sealed. The junction of the top plate and top of exterior walls shall be sealed. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier. Knee walls shall be sealed.
<b>Windows, skylights and doors</b>	The space between window/door jambs and framing and skylights and framing shall be sealed.
<b>Rim joists</b>	Rim joists shall be insulated and include the air barrier.
<b>Floors (including above-garage and cantilevered floors)</b>	Insulation shall be installed to maintain permanent contact with underside of subfloor decking. The air barrier shall be installed at any exposed edge of insulation.
<b>Crawl space walls</b>	Where provided, in lieu of floor insulation, insulation shall be permanently attached to the crawlspace walls. Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped.
<b>Shafts, penetrations</b>	Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed.
<b>Narrow cavities</b>	Batts in narrow cavities shall be cut to fit, or narrow cavities shall be filled by insulation that on installation readily conforms to the available cavity space.
<b>Garage separation</b>	Air sealing shall be provided between the garage and conditioned spaces.
<b>Recessed lighting</b>	Recessed light fixtures installed in the building thermal envelope shall be air tight, IC rated and sealed to dry wall.
<b>Plumbing and wiring</b>	Batt insulation shall be cut neatly to fit around wiring and plumbing in exterior walls, or insulation that on installation readily conforms to available space shall extend behind piping and wiring.
<b>Shower/tub on exterior wall</b>	Exterior wall adjacent to showers and tubs shall be insulated and the air barrier installed separating them from the showers and tubs.
<b>Electrical/phone box on exterior wall</b>	The air barrier shall be installed behind electrical or communication boxes or air sealed boxes shall be installed.
<b>HVAC register boxes</b>	HVAC register boots that penetrate building thermal envelopes shall be sealed to subfloor or drywall.
<b>Fireplace</b>	An air barrier shall be installed on fireplace walls. Fireplaces shall have gasketed doors.

\*In addition, inspection of log walls shall be in accordance with the provisions of ICC-400.

TABLE R402.4.1.1 AIR BARRIER AND INSULATION INSTALLATION	
COMPONENT	CRITERIA*
<b>Air barrier and thermal barrier</b>	A continuous air barrier shall be installed in the building envelope. Exterior thermal envelope contains a continuous air barrier. Breaks or joints in the air barrier shall be sealed. Air-permeable insulation shall not be used as a sealing material.
<b>Ceiling/attic</b>	The air barrier in any dropped ceiling/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.
<b>Walls</b>	Corners and headers shall be insulated and the junction of the foundation and sill plate shall be sealed. The junction of the top plate and top of exterior walls shall be sealed. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier. Knee walls shall be sealed.
<b>Windows, skylights and doors</b>	The space between window/door jambs and framing and skylights and framing shall be sealed.
<b>Rim joists</b>	Rim joists shall be insulated and include the air barrier.
<b>Floors (including above-garage and cantilevered floors)</b>	Insulation shall be installed to maintain permanent contact with underside of subfloor decking. The air barrier shall be installed at any exposed edge of insulation.
<b>Crawl space walls</b>	Where provided, in lieu of floor insulation, insulation shall be permanently attached to the crawlspace walls. Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped.
<b>Shafts, penetrations</b>	Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed.
<b>Narrow cavities</b>	Batts in narrow cavities shall be cut to fit, or narrow cavities shall be filled by insulation that on installation readily conforms to the available cavity space.
<b>Garage separation</b>	Air sealing shall be provided between the garage and conditioned spaces.
<b>Recessed lighting</b>	Recessed light fixtures installed in the building thermal envelope shall be air tight, IC rated and sealed to dry wall.
<b>Plumbing and wiring</b>	Batt insulation shall be cut neatly to fit around wiring and plumbing in exterior walls, or insulation that on installation readily conforms to available space shall extend behind piping and wiring.
<b>Shower/tub on exterior wall</b>	Exterior wall adjacent to showers and tubs shall be insulated and the air barrier installed separating them from the showers and tubs.
<b>Electrical/phone box on exterior wall</b>	The air barrier shall be installed behind electrical or communication boxes or air sealed boxes shall be installed.
<b>HVAC register boxes</b>	HVAC register boots that penetrate building thermal envelopes shall be sealed to subfloor or drywall.
<b>Fireplace</b>	An air barrier shall be installed on fireplace walls. Fireplaces shall have gasketed doors.

\*In addition, inspection of log walls shall be in accordance with the provisions of ICC-400.

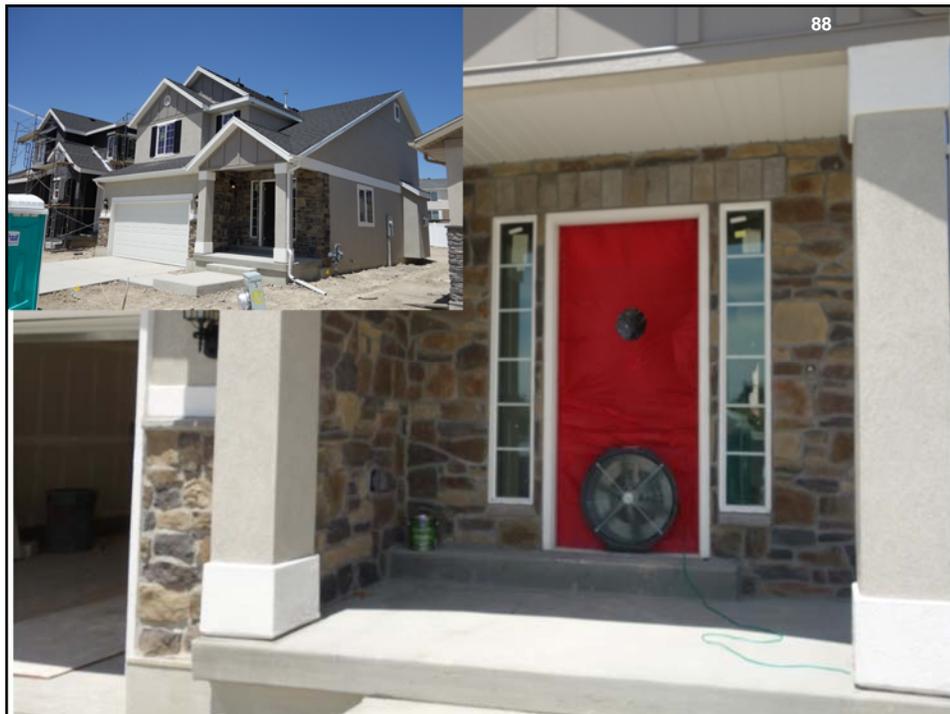
87

## Homes must be more air tight.

- Complete stringent air sealing checklist along with photo documentation

# OR

Pass a blower door test.  
(if not passing, energy tester can tell you a couple of improvements that will get you there instead of the entire monster list.)



## Blower Door?

- Depressurize house by 50 pascal (.2 inch of water column)
- Equivalent of 20mph wind- all sides
- Note CFM (cubic feet per minute) of air required to do so.
- CFM is the leakage rate.

## ACH calculation for Blower Door.

- Finished square feet x Ceiling Height = Volume
- $(\text{Volume} \times 5) \div 60 = \text{Max CFM allowed}$
  
- 5 air changes per hour (ACH) is the most you can allow a home to leak.
- In other words... ACH is how many times ALL the air in a home will leak out in one hour.

91

## Testing Requirements – Blower Door

- 5 Air Changes/Hour (ACH) @ 50 PA



92

## Who can provide air leakage tests?

- **Section 402.4.1.2 Testing:** “The following parties shall be approved to conduct testing: Parties certified by BPI or RESNET, or licensed contractors who have completed training provided by Blower Door Test equipment manufacturers or other comparable training.”

# Step-by-step: Air leakage/ blower door test







## Documentation

- Air leakage/blower door test

SPECIAL INSPECTION: IECC 2009: BUILDING AIR TIGHTNESS	
Date Tested: 3/1/2013	Tested By: <i>Mitch Richardson</i>
Project: Parc at Day Dairy	Street Address:
Unit (Lot): 103	Unit Finished SqFt: 1182 x ceiling height 9 = Volume 10638
Observed Leakage in CFM: 1094	
For IECC 2009 Compliance this unit must be less than 7 air changes per hour at -50 pascal of blower door pressure.	
Calculate the leak limit of this 'home' as follows...	
Step 1... (Volume 10638 x 7) ÷ 60 = 1241	Max CFM
Step 2... If the leakage test CFM number is less than the above Max CFM then the 'home' passes	Pass Fail
For Further Verification Contact: Mitch Richardson (801) 739-9933,, SurveyTestingServices@Gmail.com	
Survey & Testing Services Inc. 1042 Ft. Union #549, Midvale, UT 84047	
Building Science Consulting, Energy Efficiency Testing, Code Compliance Testing, Rebate Inspections & Processing	

## Duct Sealing

### Section R403.2.2 - Mandatory

#### ✓ Sealing (Mandatory)

- Joints and seams to comply with IMC or IRC
- All ducts, air handlers, and filter boxes to be sealed (Section R403.2.2)



#### • Exceptions

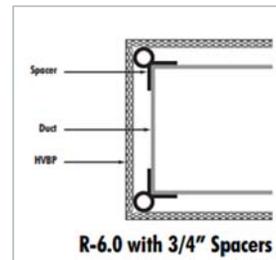
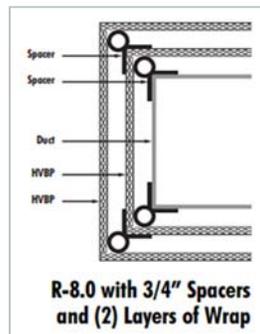
- No additional joint seals required for air-impermeable spray foam product
- Where duct connection is partially inaccessible, 3 screws or rivets to be equally spaced on exposed portion of joint to prevent a hinge effect
- Continuously welded and locking-type longitudinal joints and seams in ducts operating at static pressures < 2 in. w.c. pressure classification don't require additional closure systems

## R403.2.1 Insulation

- Supply duct in attic/outside- R-8
- All other ducts- R-6
- Exception: Completely inside the thermal envelope



## Reflective Bubble “Duct” Insulation



## Duct Tightness Tests

### Section R403.2.2

Duct tightness shall be verified by either of the following:

- ✓ Post construction test
  - Total leakage:  $\leq 4-10$  cfm/per 100 ft<sup>2</sup> 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
- ✓ Rough-in test
  - Total leakage  $\leq 4-10$  cfm/per 100 ft<sup>2</sup> 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  $\leq 3-7.5$  cfm/per 100 ft<sup>2</sup>

**Exceptions:** Duct tightness test is not required if the air handler and **at least 50% of ducts (measured by length)** are located within building thermal envelope

## Duct Tightness Tests

### Section R403.2.2



105

## Building Cavities

### Section R403.2.3 - Mandatory

Framing cavities cannot be used as ducts or plenums

The state amendment eliminates plenums in framing cavities--- is a floor joist space considered a plenum or a duct? Intent was to allow panning



## Sealed Air Handler - Section R403.2.2.1

106

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

Most equipment is manufactured in compliance with this requirement



107

## Sealed Air Handler

### Section R403.2.2.1

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



108

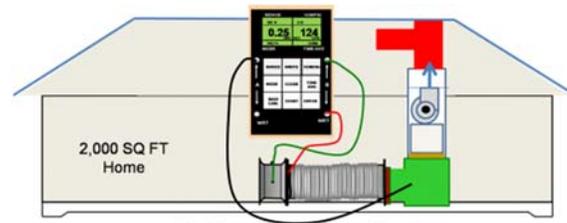
## Why Duct Testing?

- Visual inspection does not work.
- HVAC crew KNEW we were going to test this home. Yet was 38% leaky. 38% of the air going to places it wasn't designed to go.
- Leaks = some rooms too cold, some too hot and lots of wasted energy, fights over thermostats. Comfort problems etc...

109

## Testing Requirements – Duct Blaster

- > 50% (10% max) outside conditioned



### Total Duct Leakage Test at Final

The duct system has a leakage rate of 124 CFM25. The quantified (Qn, see RESNET Standards) total rough-in leakage rate is  $124 \div 2,000 = .062$  Qn.  
Meets Energy Star requirements at  $(.062 \times 100)$  6.2 CFM per 100 SQ FT

110

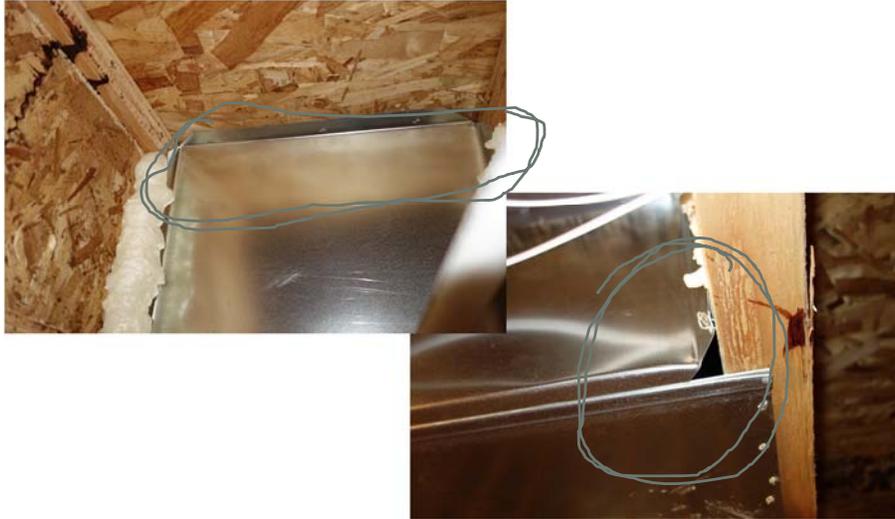
## Why Duct Testing?

- If a home doesn't pass, we pump disco fog into the duct system to find the leaks.
- After 3 minutes pumping fog into a supposedly sealed system, this is what the basement looked like...



111

## Return air pans are not sealed



112

## This return will pull outside air through the rim joist



113

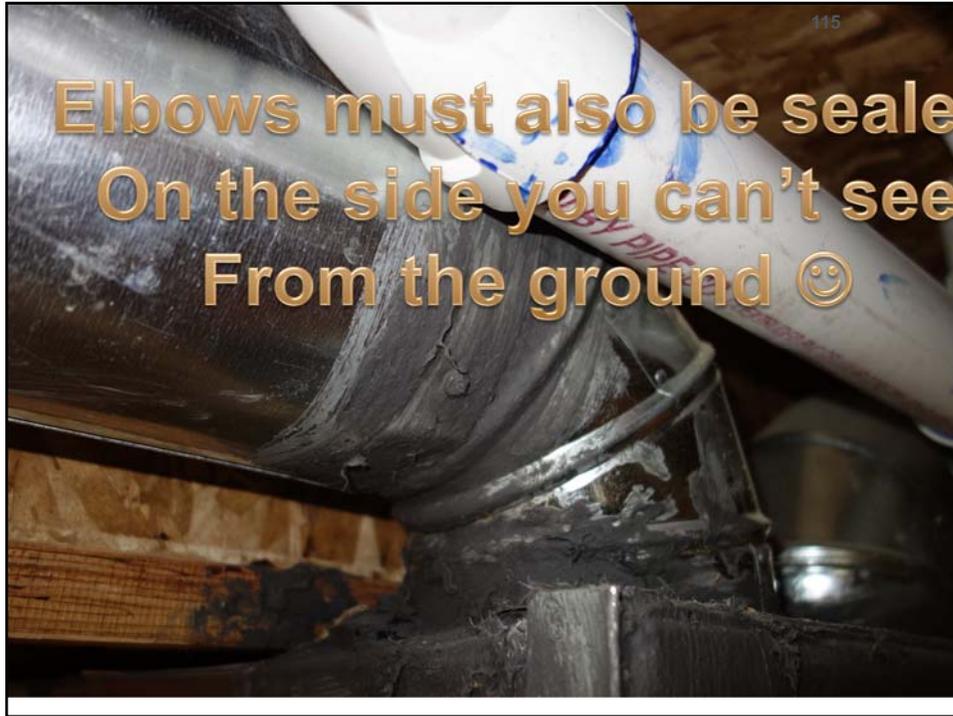


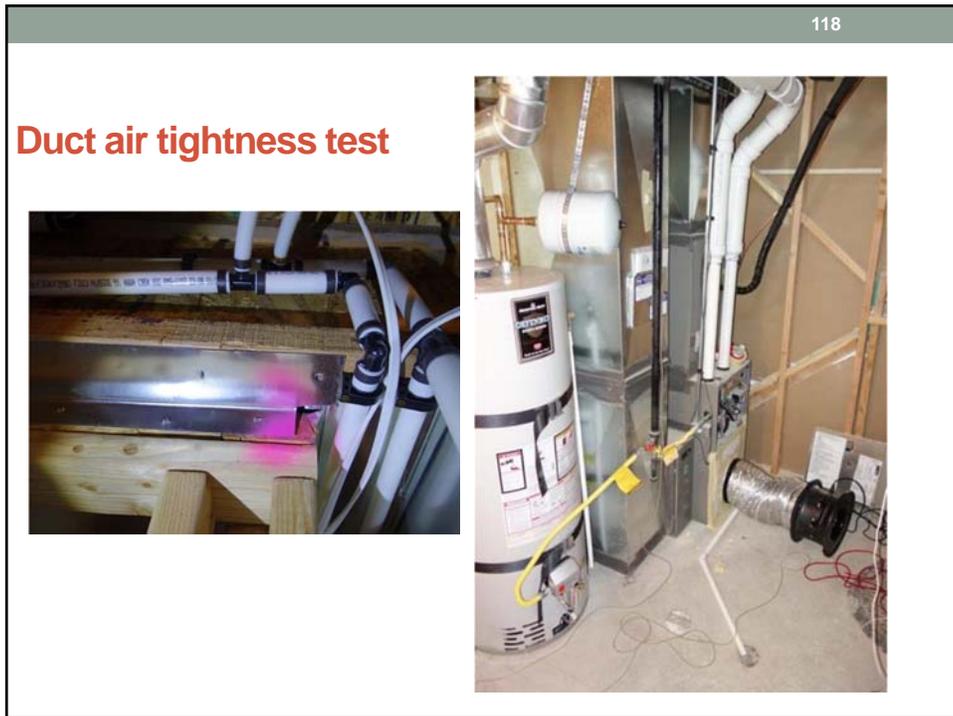
Sparky loves to make holes  
In the return ducts.

114



Fog leaking out of 'factory' seam







121

## Fireplaces

### Section R402.4.2

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



## Piping Insulation

### Section R403.3 - Mandatory

- ✓ 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

122

123

## Snow Melt System Controls

### - Section R403.8

Snow- and ice-melting system controls

- ✓ Automatic shutoff when pavement temperature is > 50°F and no precipitation is falling
- ✓ Automatic or manual shutoff when outdoor temperature is > 40°F
- ✓ This was in the 2009 Res. IECC- requires sensor in concrete- no manual switches or timers



## Pools and In-ground Permanently Installed Spas - Section R403.9



- ✓ Heaters
  - with a readily accessible on-off switch mounted outside heater so heater can be shut off without adjusting thermostat setting
  - fired by natural gas not allowed to have continuously burning pilot lights
- ✓ Time switches (or other control method) to automatically turn off and on heaters and pumps according to a preset schedule installed on all heaters and pumps
- ✓ 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-waste-heat recovery heating systems

124

## Lighting Equipment

### Section R404.1 - Prescriptive

~~A minimum of 75 percent of the lamps in permanently installed lighting fixtures shall be high efficacy lamps or 75% of permanently installed lighting fixtures to contain only high efficacy lamps~~

### Exception:

- ✓ ~~Low voltage lighting~~ Deleted by amendment



## Additional Utah Comments

- Effective date is July 1, 2014
- Current Versions of REScheck include Utah 2012 Code
  - Specifically modified for the Utah Amendments
- A log wall prescriptive footnote is located in Tables- requires minimum 5" log, 0-31 windows and 90% AFUE furnace
- The definition for CONDITIONED SPACE has been amended to include indirectly conditioned spaces

## Thank you for your participation!

- Questions/comments may be addressed to me at:
- Brent Ursenbach
- Salt Lake County
- [bursenbach@slco.org](mailto:bursenbach@slco.org)
- [bursenbach@yahoo.com](mailto:bursenbach@yahoo.com)
- 385-468-6694
- 801-381-1449

*If you would like a copy of this presentation so you can print additional or larger copies, please email your request to one of the above email addresses*