

IECC

Real World Application



energyLogic

Presented by Robby Schwarz

About energyLogic

Berthoud, Colorado-based EnergyLogic is a software and building consulting company that has provided expert resources, education and support to new home builders and energy raters involved in the construction of high-performance homes since 2006.



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Our Plan

- Intro
- What is a Rating?
- Diagnostic Testing
- Air Barrier and Insulation Installation Table
- Ventilation and HVAC



Change is Hard ... Change is Good... Change can be Made Easier

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Expectation



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2018 IECC Definition: R105.4 Approved Inspection Agencies

The *code official* is authorized to accept reports of third-party inspection agencies not affiliated with the *building* design or construction, provided that such agencies are *approved* as to qualifications and reliability relevant to the *building* components and systems that they are inspecting.



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What Are a Rater's Responsibilities?

- Different types of ratings, different responsibilities
- HERS minimum rated features vs. code mandatory
- HERS Index and HERC vs. ERI and ERI Report
 - Cost compliance report, UA compliance report
- Testing/inspection for code vs. for a HERS Ratings
 - Insulation / air barrier
 - Blower door
 - Duct leakage



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What Is a Rating?

- Methodology for evaluating a house
 - Provides
 - Alignment
 - Uniformity
 - Consistency
 - May also...
 - Assess performance
 - Demonstrate compliance
 - Offer certification
- Index score
- Energy code
- ENERGY STAR®
- LEED®
- Other program
- Warranty
- Audit



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Asset Rating

RESNET® HERS Rating

- Minimum rated features
- Not a pass / fail evaluation



Minimum rated features of a home include:

- Building envelope features
- Water heating
- Space heating and cooling systems
- Passive solar
- Solar domestic water heating
- Appliances
- One-site power production

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RESNET Insulation Grading

Modeling guidance for derating the R-value of insulation:

- When it is possible to inspect insulation as installed (i.e., new construction), inspectors shall rate the installation as "Grade I, II, or III" according to the following guidelines.

Grade 1



Grade 2



Grade 3



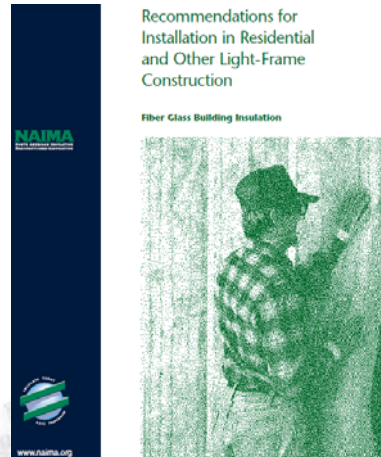
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Air Sealing and Insulation

N1101.13 (R303.2)

- Materials, systems and equipment **shall be installed in accordance with the manufacturer's instructions** and the *International Building Code* or the *International Residential Code*, as applicable.
- For insulation only Grade 1 installation meets the intent of the IECC.



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Program Rating

- Certification/labeling Rating
 - Minimum rated features
 - Pass / fail evaluation



ENERGY STAR v3

- HERS Index target
- Thermal enclosure checklist
- Rater HVAC checklist
- HVAC design report
- HVAC commissioning report
- Builder water management checklist
- Footnote requirements

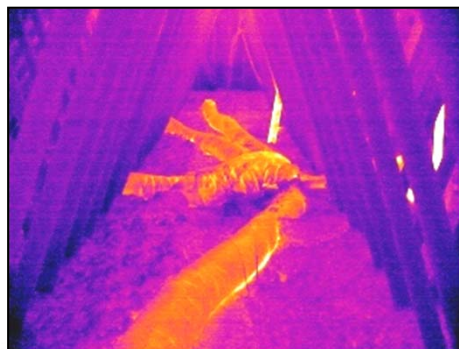
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R403.3.3 Duct Testing (Mandatory).

Leakage testing required when any portion of ductwork is in unconditioned space

- Attic
- Unconditioned crawl space
- Isolated mechanical room with natural draft appliance
- Floor over garage?
- Exterior wall?



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ENERGY STAR Requires Duct Testing Regardless of the Location of the Duct

Total Duct Leakage



Duct Leakage to Outside



Must be tested when using the performance path of code

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Code Rating

Compliance rating

- Minimum rated features
- Pass / fail evaluation



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Mandatory requirements:

- Compliance modeling
 - UA compliance
 - Cost compliance
 - EIR compliance
- Insulation installation
- Air barriers
- Air leakage 3/5ACH
- Duct leakage 4%
- High-efficacy lighting



Items Listed in This Table Are Mandatory and Sometimes Not Clear

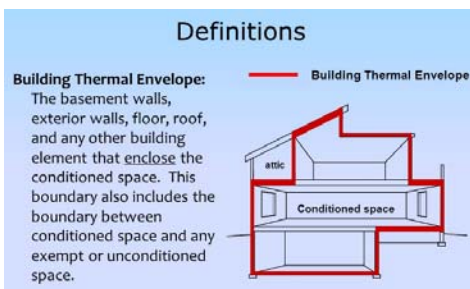


TABLE 602.4.1.1 AIR BARRIER AND INSULATION INSTALLATION		
COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
General requirements	A continuous air barrier shall be installed in the building envelope. The exterior thermal envelope contains a continuous air barrier. Breaks or joints in the air barrier shall be sealed. The air barrier in any dropped ceiling cavity shall be aligned with the insulation and any gaps in the air barrier shall be sealed. Access openings, drop-down stairs or knee walls shall be unconditioned and sealed.	Air-permeable insulation shall not be used as a sealing material. The insulation in any dropped ceiling cavity shall be aligned with the air barrier.
Ceiling attic	The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the top of exterior walls shall be sealed. Knee walls shall be sealed.	Condition within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance of R-9 per inch minimum. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.
Walls	The space between windows, doors, joints and framing and drywall and finishing shall be sealed.	Fin joints shall be insulated.
Windows, skylights and doors	The space between windows, doors, joints and framing and drywall and finishing shall be sealed.	Floor framing cavity insulation shall be installed so that the insulation is in contact with the underside of the floor joists, or door framing cavity insulation shall be installed so that the insulation is in contact with the top side of the sheathing, or continuous insulation installed on the exterior of floor framing shall extend from the bottom to the top of all perimeter floor framing members.
Fin joints	Fin joints shall include the air barrier.	When provided instead of floor insulation, insulation shall be permanently attached to the crawlspace walls.
Floors (including above garage and cantilevered floors)	The air barrier shall be installed at any exposed edge of insulation.	When provided instead of floor insulation, insulation shall be permanently attached to the crawlspace walls.
Crawl space walls	Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped.	When provided instead of floor insulation, insulation shall be permanently attached to the crawlspace walls.
Shafts, penetrations	Duct shafts, utility penetrations, and fire shafts opening to exterior or unconditioned space shall be sealed.	Batts in narrow cavities shall be cut to fit, or narrow cavities shall be filled by insulation that conforms to the available cavity space.
Narrow cavities		
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 sealed to the drywall.	Recessed light fixtures installed in the building thermal envelope shall be air tight and IC rated.
Plumbing and wiring		Best insulation shall be cut neatly to fit around wiring and plumbing in exterior walls, or insulation fast on insulation ready cutters to available space shall extend behind piping and wiring.
Shower/tub on exterior wall	The air barrier installed at exterior walls adjacent to showers and tubs shall separate them from the showers and tubs.	Exterior walls adjacent to showers and tubs shall be insulated.
Electrical phone boxes on exterior walls	The air barrier shall be installed behind electrical or communication boxes or air-sealed boxes shall be installed.	
HVAC register boots	HVAC register boots that penetrate building thermal envelope shall be sealed to the subfloor or drywall.	
Concealed utilities	When required to be sealed, concealed fire sprinklers shall only be sealed to a register that is recommended by the manufacturer. Chasing of other building features shall not be used to fit walls between fire sprinkler cover plates and walls or ceilings.	

a. In addition, tarping of top walls shall be in accordance with the provisions of ICC-605.

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Energy Code Inspection



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Fundamental Questions

Is It There?



Does It Work?



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Code Compliance Paths



Prescriptive Path



UA Compliance Path



Simulated
Performance Path

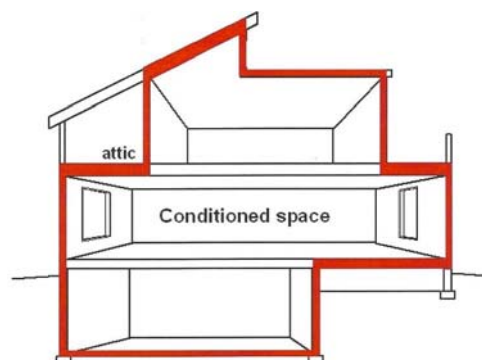
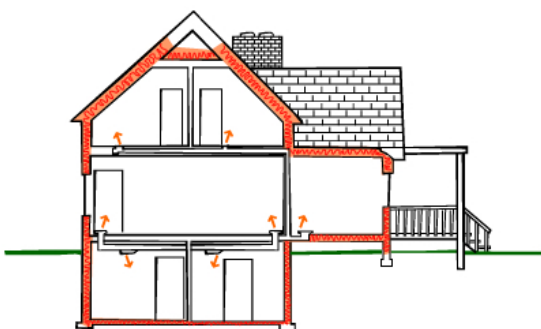


Energy Rating Index
Path

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Code Ensures a Solid Thermal Envelope



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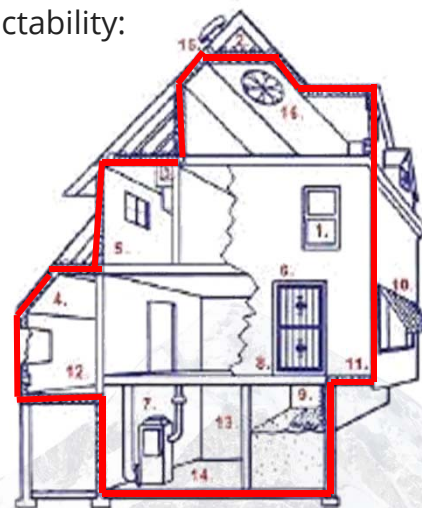


What / Where Is the Thermal Envelope?



- Control and predictability:

- Air Flow
- Moisture Flow
- Thermal Flow



HF12



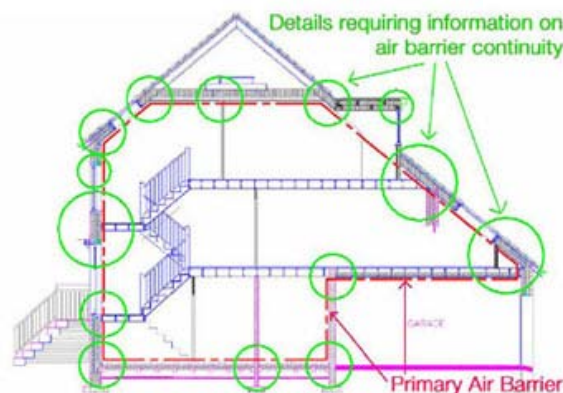
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Two Functions of an Air Barrier

- Interior vs. exterior air barrier
- At its simplest form:
 - Interior drywall
 - Exterior sheathing
 - House wrap?
 - Drainage plane
- Function
 - Enclosing insulation
 - 6 sided encapsulation
 - Thermal control
 - Air control
 - Moisture control



HF13



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Can a House Be Too Tight?

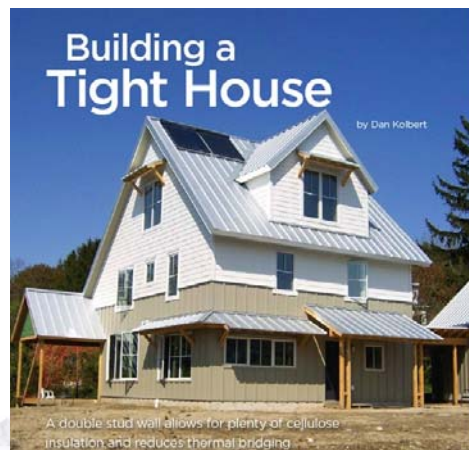
NO!

- Wrong question
- Control **air flow**
- In order to control the air

Real question...

- Can houses be under-ventilated?

YES!



Build tight and ventilate right!



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Code and Adopted Proven Building Science

Control and predictability

- Air flow
- Thermal flow
- Moisture flow



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R402.4.1.2 Testing

(Mandatory)

- The building or dwelling unit **shall be tested** and verified as having an air leakage rate not exceeding:
 - 5 ACH@50 in climate zones 1 and 2
 - 3 ACH@50 in climate zones 3 through 8
- Testing shall be conducted by an approved third-party
- Reporting



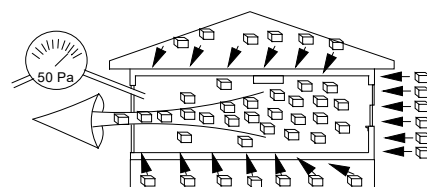
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Air Leakage Testing

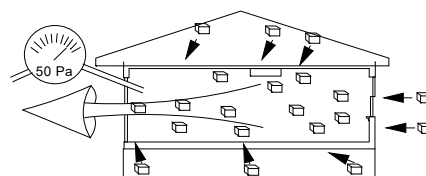
- Air out = air in
- The principle behind the blower door



Blower Door Depressurizing House To 50 Pascals



Leaky House



Tight House

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Air Leakage Report


Property
Ekotrope
123 Fake St
Anytown, CO 80840

Confirmed Rating
Confirmed Rating

Organization
Ekotrope Rating Co.
Test Rater

Builder
Ekotrope

HERS Rating Information
Rater ID (RTIN): 5459458
HERS Status: Confirmed



Air Leakage


Measurement Unit	CFM at 50 Pa
Measured Infiltration	1660
ACH50 (Calculated)	2.7
ELA [sq. in.] (Calculated)	91.3

Duct Leakage


Number of Duct Systems	3 System(s)
Leakage to Outdoors [CFM @ 25 Pa]	0.0
Leakage to Outdoors [CFM25 / 100 s.f.]	0.0
Total Leakage Test Type	Post-Construction
Total Leakage [CFM @ 25 Pa]	0.0
Total Leakage [CFM25 / 100 s.f.]	0.0

Mechanical Ventilation

Rate [CFM]	92.0
Hours per day	24.0
Fan Watts	15.0
Recovery Efficiency %	0.0
Runs at least once every 3 hrs?	True
Average Rate [CFM]	92.0
2010 ASHRAE 62.2 Req. Cont. Ventilation	82.5




Ekotrope HERS Rating Tool - Version 2.0.0.1590



Final Home Testing Results

Date: 10/10/2017




9191 E 52nd Dr
Denver, CO 80238
Lot/Block: 13/01

Supervisor:
Adrián Martí

Subdivision:
Stapleton





Climate Zone:
5 Dry

Plan Name:
1120

Prepared by:


Inspection performed by:
Greg Downing
720-232-2877
greg.downing@nrglogic.com

Inspected for the following programs/codes:








BUILDING SHELL/BLOWER DOOR TEST

	Target	Measured
✓ CFM@50	2015 IECC 2,044.80 CFM	1525 CFM
ACH@50	3.00 CFM	2.24 ACH
nACH	0.00 CFM	0.00 CFM
✓ House to Garage Connection	N/A	-45 Pa
HVAC (CAZ) to Garage	N/A	N/A
House to CAZ	N/A	N/A

BUILDING SHELL/INSULATION (Insulation installed to manufacturer's specs/Grade 1)

Exterior Walls	Insulation Type	R-Value
2x4 Walls		N/A
2x6 Walls	R3 - FIBERGLASS BATT	21

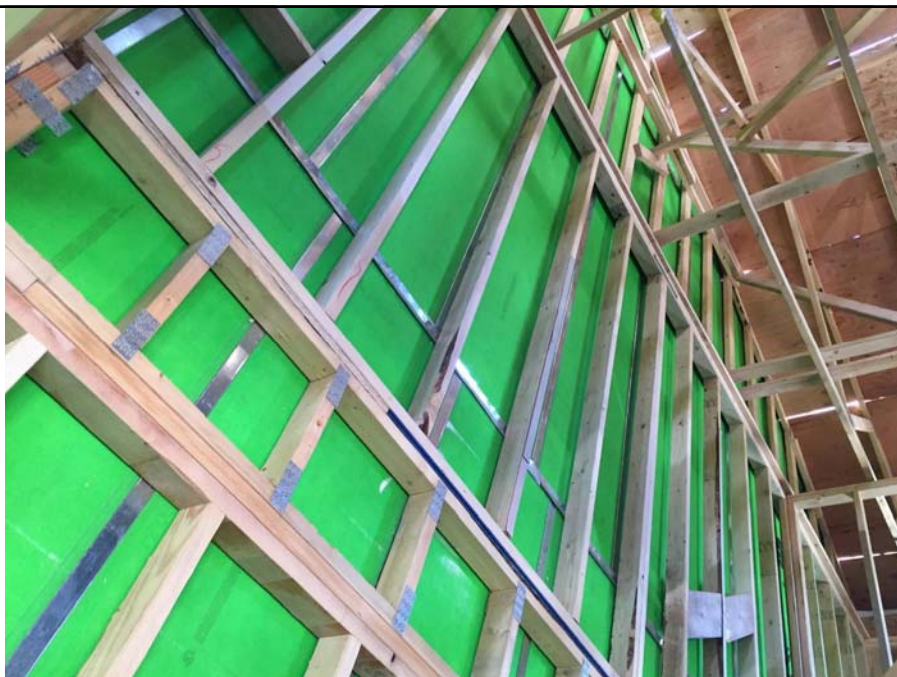




Single Family vs. Attached Housing



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Potential Alternative Language

- **R402.4.1.2 Testing.** The *building* or dwelling unit shall be tested and verified as having an air leakage rate not exceeding five air changes per hour or 0.30 cubic feet per minute (CFM) per square foot (ft²) of dwelling unit enclosure area in *Climate Zones* 1 and 2, and three air changes per hour or 0.24 CFM per (ft²) of dwelling unit enclosure area in *Climate Zones* 3 through 8. Testing shall be conducted in accordance with RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pascals). Where required by the *code official*, testing shall be conducted by an *approved* third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the *code official*. Testing shall be performed at any time after creation of all penetrations of the *building thermal envelope*.

Exception:

- An air leakage rate not exceeding 0.30 cfm per ft² of the dwelling unit enclosure area shall be an accepted alternative in all climate zones for:
- All attached/multifamily building dwelling units.
- Buildings or dwelling units that are 1500 sqft or smaller.

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402.4 Air Leakage and Air Barriers (Mandatory)



- **R402.4.1.1 Installation.** The components of the building thermal envelope as indicated in Table R402.4.1.1 shall be installed in accordance with the manufacturer's instructions and the criteria indicated in Table R402.4.1.1, as applicable to the method of construction.
- **Building Thermal Envelope.** The basement walls, exterior walls, floors, ceiling, roofs and any other building element assemblies that enclose conditioned space or provide a boundary between conditioned space and exempt or unconditioned space.

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2015/18 IECC Table



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TABLE R402.1.1 AIR BARRIER AND INSULATION INSTALLATION*		
COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
General requirements	A continuous air barrier shall be installed in the building envelope. The 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 or soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed. Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.	The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.
Walls	The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the top of exterior walls shall be sealed. Knee walls shall be sealed.	Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance, R-value, of not less than R-3 per inch. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.
Windows, skylights and doors	The space between framing and skylights, and the joints of windows and doors, shall be sealed.	—
Rim joints	Rim joints shall include the air barrier.	Rim joints shall be insulated.
Floors, including cantilevered floors and floors above garages	The air barrier shall be installed at any exposed edge of insulation.	Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of subfloor decking. Alternatively, floor framing cavity insulation shall be in contact with the top side of sheathing, or continuous insulation installed on the underside of floor framing, and shall extend from the bottom to the top of all perimeter floor framing members.
Crawl space walls	Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped.	Crawl space insulation, where provided instead of floor insulation, shall be permanently attached to the walls.
Shafts, penetrations	Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed.	—
Narrow cavities	—	Batts to be installed in narrow cavities shall be cut to fit or narrow cavities shall be filled with 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 sealed to the finished surface.	Recessed light fixtures installed in the building thermal envelope shall be air tight and IC rated.
Plumbing and wiring	—	In exterior walls, batt insulation shall be cut neatly to fit around wiring and plumbing, or insulation, that on installation readily conforms to available space, shall extend behind piping and wiring.
Shower/tub on exterior wall	The air barrier installed at exterior walls adjacent to showers and tubs shall separate the wall from the shower or tub.	Exterior walls adjacent to showers and tubs shall be insulated.
Electrical/phone box on exterior walls	The air barrier shall be installed behind electrical and communication boxes. Alternatively, air-sealed boxes shall be installed.	—
HVAC register boots	HVAC supply and return register boots that penetrate building thermal envelope shall be sealed to the subfloor, wall covering or ceiling penetrated by the boot.	—
Concealed sprinklers	Where required to be sealed, concealed fire sprinklers shall only be sealed in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.	—

* Section of fire walls shall be in accordance with the provisions of ICC 400.

2015/18 IECC Table



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TABLE R402.1.1 AIR BARRIER AND INSULATION INSTALLATION*		
COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
General requirements	A continuous air barrier shall be installed in the building envelope. The 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 or soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed. Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.	The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.
Walls	The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the top of exterior walls shall be sealed. Knee walls shall be sealed.	Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance, R-value, of not less than R-3 per inch. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.
Windows, skylights and doors	The space between framing and skylights, and the joints of windows and doors, shall be sealed.	—
Rim joints	Rim joints shall include the air barrier.	Rim joints shall be insulated.
Floors, including cantilevered floors and floors above garages	The air barrier shall be installed at any exposed edge of insulation.	Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of subfloor decking. Alternatively, floor framing cavity insulation shall be in contact with the top side of sheathing, or continuous insulation installed on the underside of floor framing, and shall extend from the bottom to the top of all perimeter floor framing members.
Crawl space walls	Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped.	Crawl space insulation, where provided instead of floor insulation, shall be permanently attached to the walls.
Shafts, penetrations	Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed.	—
Narrow cavities	—	Batts to be installed in narrow cavities shall be cut to fit or narrow cavities shall be filled with 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 sealed to the finished surface.	Recessed light fixtures installed in the building thermal envelope shall be air tight and IC rated.
Plumbing and wiring	—	In exterior walls, batt insulation shall be cut neatly to fit around wiring and plumbing, or insulation, that on installation readily conforms to available space, shall extend behind piping and wiring.
Shower/tub on exterior wall	The air barrier installed at exterior walls adjacent to showers and tubs shall separate the wall from the shower or tub.	Exterior walls adjacent to showers and tubs shall be insulated.
Electrical/phone box on exterior walls	The air barrier shall be installed behind electrical and communication boxes. Alternatively, air-sealed boxes shall be installed.	—
HVAC register boots	HVAC supply and return register boots that penetrate building thermal envelope shall be sealed to the subfloor, wall covering or ceiling penetrated by the boot.	—
Concealed sprinklers	Where required to be sealed, concealed fire sprinklers shall only be sealed in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.	—

* Section of fire walls shall be in accordance with the provisions of ICC 400.

R402.4 Air Leakage and Air Barriers

(Mandatory)



TABLE R402.4.1.1 AIR BARRIER AND INSULATION INSTALLATION		
COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
General requirements	A continuous air barrier shall be installed in the building envelope. The 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 or soffit shall be aligned with the insulation and any gaps in the air barrier sealed. Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.	The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.
Walls	The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the top of exterior walls shall be sealed. Gable walls shall be sealed.	Cavity within corners and breakers of frame walls shall be sealed by completely filling the cavity with a material having a thermal resistance, R-value, of not less than 5.1 per inch. Exterior thermal envelope insulation for framed walls shall be installed to substantial contact and continuous alignment with the air barrier.
Windows, skylights and doors	The space between framing and skylights, and the joints of windows and doors, shall be sealed.	---
Roof joints	Roof joints shall include the air barrier.	Roof joints shall be sealed.
Floors, including conditioned basements and floors above garages	The air barrier shall be installed at any exposed edge of insulation.	Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of outdoor decking. Alternatively, floor framing cavity insulation shall be in contact with the top side of sheathing, or continuous insulation installed as a separate layer of floor framing, and shall extend from the bottom to the top of all perimeter base framing members.
Crawl space walls	Exposed earth in unventilated crawl spaces shall be covered with a Class 1 vapor retarder with overlapping joints taped.	Crawl space insulation, where provided instead of floor insulation, shall be permanently attached to the walls.
Stacks, penetrations	Deck stacks, utility penetrations, and pipe stacks opening to exterior or unconditioned space shall be sealed.	---

TABLE R402.4.1.1 (IN 1102.4.1.1) AIR BARRIER AND INSULATION INSTALLATION		
COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
General Requirements	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.	The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.

- The building thermal envelope shall be constructed to limit air leakage in accordance with the requirements of Sections R402.4.1 through R402.4.4.
- The components of the building thermal envelope as listed in **Table R402.4.1.1** shall be installed in accordance with the manufacturer's instructions and the criteria listed in Table R402.4.1.1

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Insulation 101



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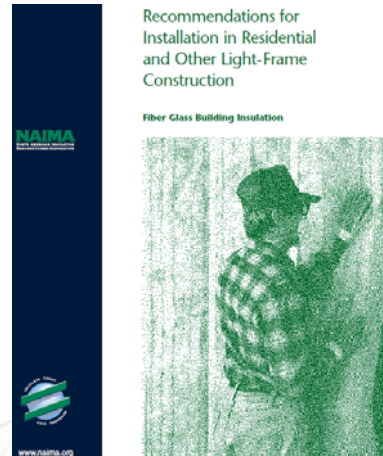


Air Sealing and Insulation



2015 IECC R402.4

- The components of the thermal envelope as listed in Table R402.4.1.1 **shall** be installed in accordance with the **manufacturer's instructions** and the criteria listed in table R402.4.1.1 as applicable to the method of construction



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Examples of Manufacturer's Instructions

- When insulating walls, place the insulation in the cavity and check to be sure **it completely fills the cavity**, top to bottom.
- Gently press the insulation at the sides into the framing cavity, usually about 3/4 inch, until the outside edge of **the flange is flush with the face of the framing**.
- Avoid gaps and "fish-mouths"** between flanges and framing (Refer to Figure 3A).
- Remember, **compressing insulation ... will result in some loss of R-value**.
- Wherever insulation is installed in a building, it is very important that it **fit snugly on all sides**.
- When the wiring is in the center of the cavity, either a shallow cut in the insulation may be used to **allow the wiring to pass through the insulation** or it may be split lengthwise and the **wiring sandwiched within**
- It is recommended that the **insulation be pushed up to the subfloor**.
- It is important also for the insulation to **cover the top plate**.
- Use baffles** if necessary to keep the insulation from blocking the passage of air.

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Insulation Installation Instructions

Insulation Institute™
KNOWLEDGE. LEADERSHIP. CONFIDENCE.

About NAIMA | New

About Insulation

Why Insulate

Installation

I'm a Homeowner > Installation > Doing it Yourself > Walls and Knee Walls

Instructions for Installing Wall and Knee Wall Insulation

This section provides info on "How to Install Insulation." It contains specific information on installation details for walls and knee walls that will assist with proper installation to meet RESNET Grade 1 criteria for fiber glass and mineral wool batt insulation. Includes information on special situations as well as tips for insulating near pipes, along rim or band joists and around doors and windows.

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RESNET Standards Grade 1 Insulation Installation

- Installed according to manufacturer's instructions
- Fills each cavity side-to-side and top-to-bottom
- No substantial gaps, voids, compressions, or obstructions
- Split or fitted tightly around wiring or obstructions in wall
- Occasional very small gaps are acceptable for "Grade I"
- Wall insulation shall be enclosed on all six sides
- Must be in substantial contact with the sheathing material.
- Inset stapling is neat (no buckling), and the batt is only compressed at the edges of each cavity, to the depth of the tab itself.
- Compression or incomplete fill amounting to **2% or less**, if the empty spaces are **less than 30%** of the intended fill thickness, are acceptable for "Grade I".

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RESNET Standards: Grade I Insulation

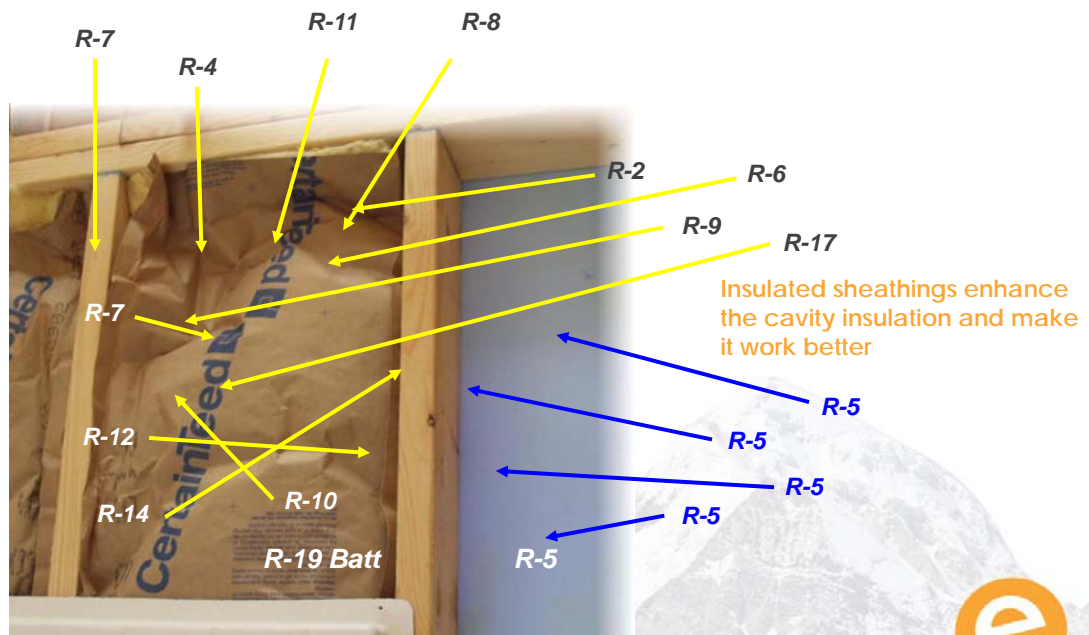


Gray areas illustrate compression

Gray areas illustrate gaps & voids



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Courtesy of DOW Building Materials



Insulation



Insulation traps pockets of air.
Stagnate air pockets create the R-value.

Air Barrier



Stops air movement,
keeping stagnate air pocket.


Now it works!

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Controlling Thermal Flow

Most insulation is NOT an air barrier

Resists conduction 

Does not resist air flow: 
That is the job of the air barrier

* An air barrier is any solid material that blocks air flow, including sealing at edges and seams.



What is the biggest insulation myth:
Insulation stops the movement of air!

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Terminology

- **Mandatory requirements**

- Requirements that must be met by every building unless there is a specific exception in the code.

- **Prescriptive requirements**

- Requirements that must be met by every building unless an approved tradeoff is utilized or unless there is a specific exception in the code.

- **Performance approach**

- An overall performance requirement for the building that replaces the individual prescriptive requirements for building systems and components.

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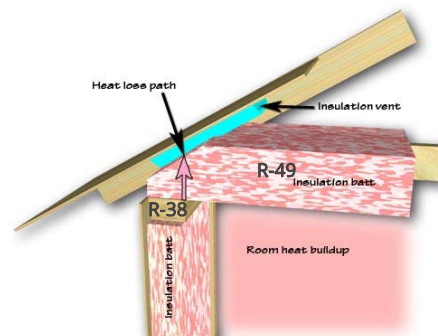
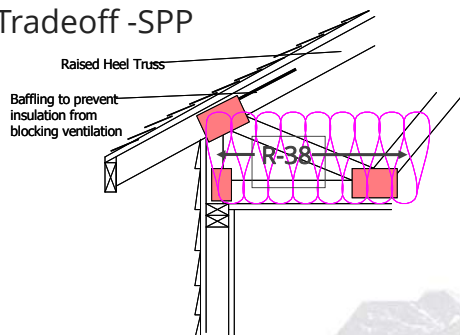


R402.2.1 Ceilings with Attic Spaces



- R-38 shall be deemed to satisfy the requirement for R-49 wherever the full height of uncompressed R-38 insulation extends over the wall top plate at the eaves.

- Tradeoff -SPP



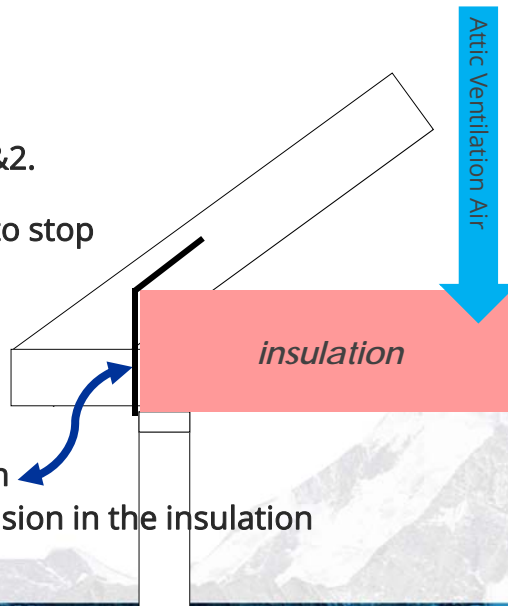
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Theory of Ventilated Attic Insulation

Baffle stops both 1&2.
May need to use continuous baffles to stop ventilation air from bypassing baffles.

1. Wind-wash
2. Wind intrusion in the insulation



Ventilation air should only drop into the top of the insulation.
The depth of the material is compensating for the inability to enclose it on all six sides.

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R402.2.3 Eave Baffle



- For air permeable insulations in vented attics, a baffle shall be installed adjacent to soffit and eave vents.
- Baffles shall maintain an opening equal or greater than the size of the vent.
- The baffle shall extend over the top of the attic insulation.



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Insulation Over the Top Plate:

ESv3: Baffle and Minimum R-21 in CZ-5



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Vaulted/Raftered Ceilings

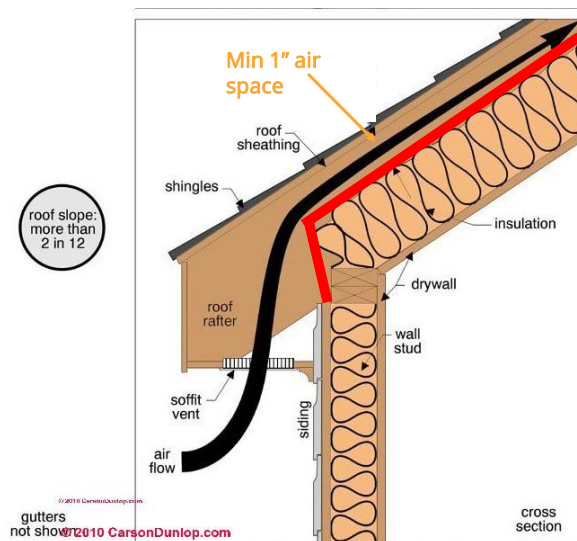
Vented or unvented?
That is the question!



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Vaulted/Raftered Ceilings

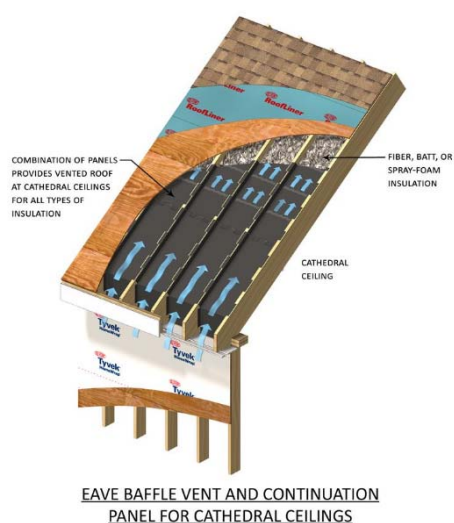


- Continuous baffled air space
- Sealed and separated from the insulation

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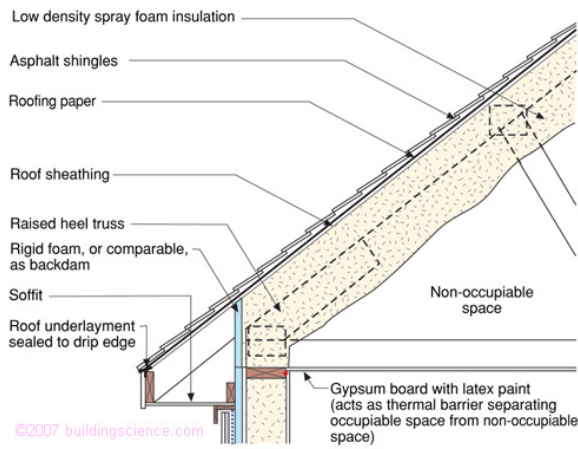
Vaulted/Raftered Ceilings



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Cathedralized Attic



Bring mechanical equipment and ductwork into conditioned space any way you can!

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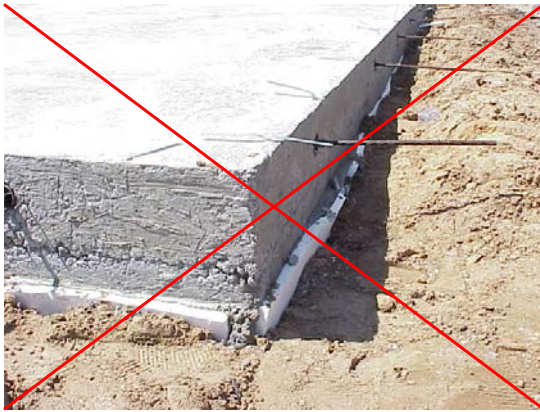
R402.2.10 Slab-On-Grade Floors

- Slab-on-grade floors with a floor surface less than 12 inches (305 mm) below grade shall be insulated in accordance with Table R402.1.2. **The insulation shall extend downward from the top of the slab on the outside or inside of the foundation wall.**
- Insulation located below grade shall be extended the distance provided in Table R402.1.2 by any combination of vertical insulation, insulation extending under the slab or insulation extending out from the *building*.
- Insulation extending away from the *building* shall be protected by pavement or by not less than 10 inches (254 mm) of soil.
- The top edge of the insulation installed between the *exterior wall* and the edge of the interior slab shall be permitted to be cut at a 45-degree (0.79 rad) angle away from the *exterior wall*. Slab-edge insulation is not required in jurisdictions designated by the *code official* as having a very heavy termite infestation

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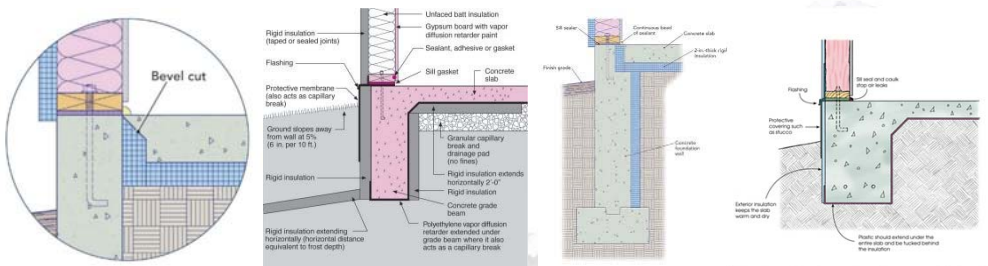
Slab on Grade and Walkouts



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R402.2.10 Slab-On-Grade Floors



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Table 402.4.1.1

Component – General Air Barrier/Thermal Barrier



Air Barrier Criteria

- 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.

Insulation Installation Criteria

- **Air-permeable insulation** shall not be used as a sealing material.

General requirements	A continuous air barrier shall be installed in the building envelope. The 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.
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Section R202 General Definitions



- Air barrier
 - Material(s) assembled and joined together to provide a barrier to air leakage through the building envelope. An air barrier may be a single material or a combination of materials.
- Continuous air barrier
 - A combination of materials and assemblies that restrict or prevent the passage of air through the building thermal envelope.

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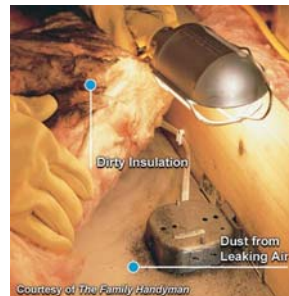
5 Key Air Barriers Attributes

- **Continuity:** The most important element in 3D structures with many different components to ensure alignment between insulation and the air ABS.
- **Impermeability:** The ABS must be impermeable to air after installation.
- **Strength:** The ABS must be designed to transfer the full designed wind load, stop external or internal air movement into the assembly, and continue to be impermeable.
- **Durability:** The ABS must continue to be impermeable throughout its service life, or at the IECC says, "over the useful life of the building."
- **Stiffness:** The ABS must be stiff enough so that irregularities in the building found at installation of the ABS do not change its permeance.

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Air-Permeable Insulation Shall Not Be Used as a Sealing Material

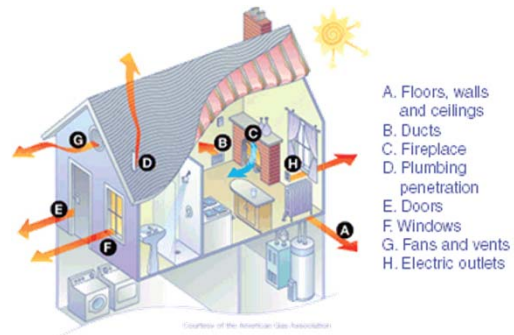


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Insulation Take Away

- Fully filled cavity
- Enclosed on six sides
 - Exception - insulation in a ventilated attic and rim joist
- Adjacent and contiguous to thermal boundary with fully aligned air barriers
- Limited gaps, voids, or compressions
- No thermal bypass
- Grade 1 installs
 - Heading toward blown products



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Table 402.4.1.1 Component – Ceiling / Attic



Air Barrier Criteria

- 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.

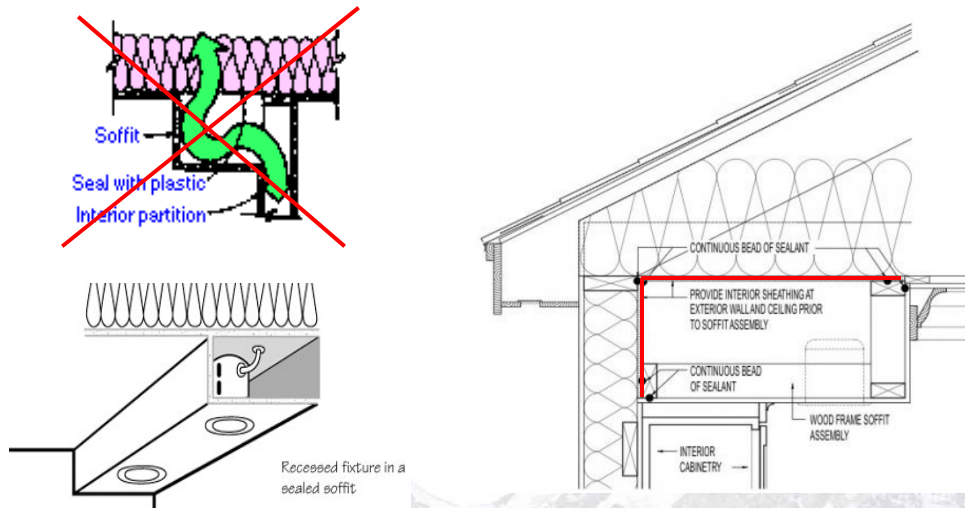
Insulation Installation Criteria

- The **insulation** in any dropped ceiling/soffit shall be aligned with the air barrier.

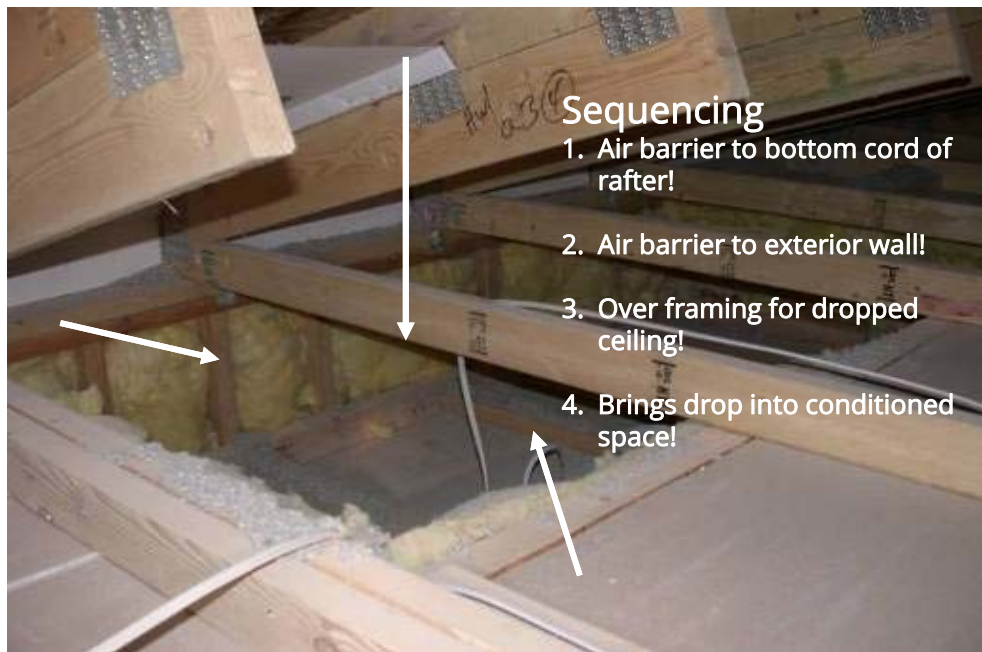
Ceiling/attic	The air barrier in any dropped ceiling/soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed. Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.	The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.
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Dropped Ceiling / Soffit Full Air Barrier Aligned with Insulation



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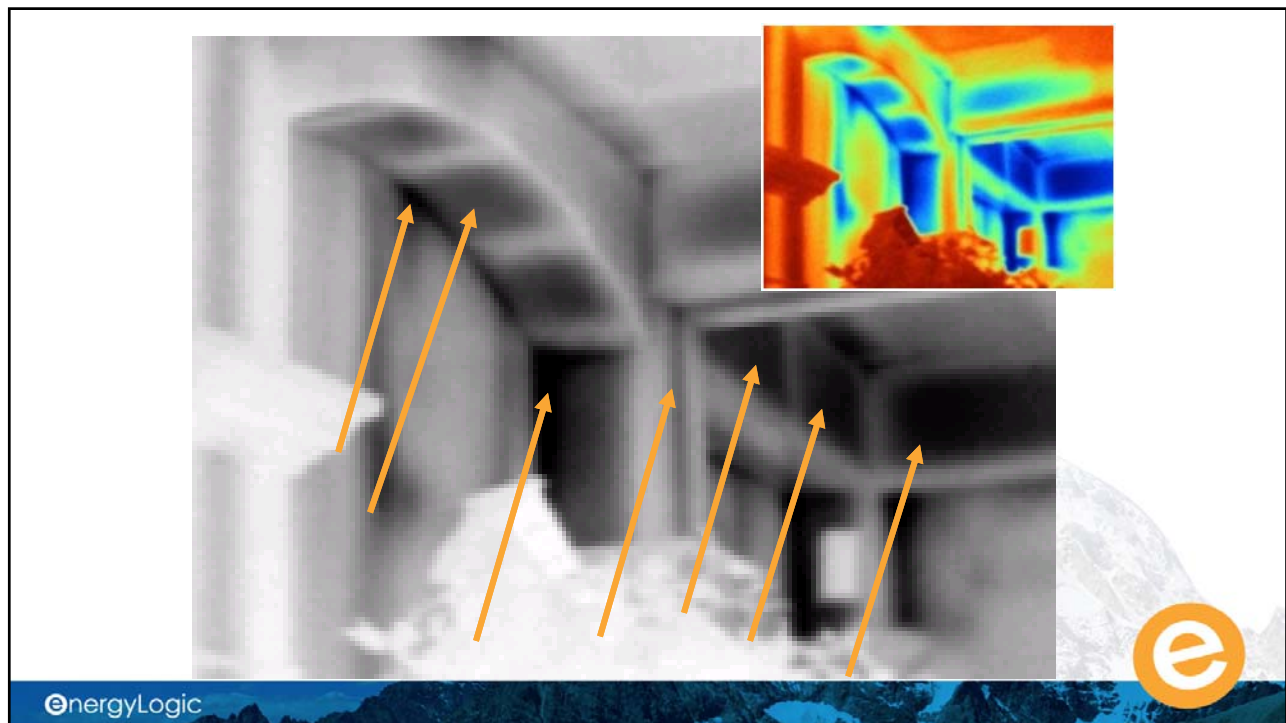
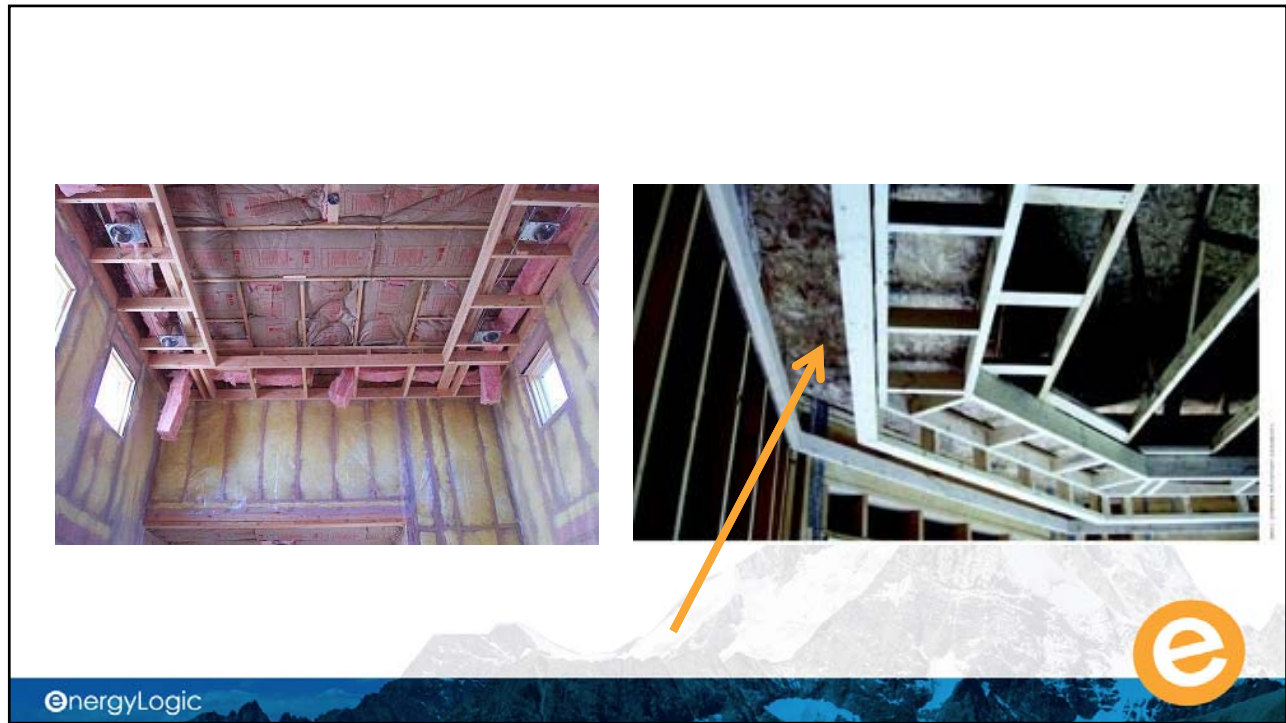


Sequencing

1. Air barrier to bottom cord of rafter!
2. Air barrier to exterior wall!
3. Over framing for dropped ceiling!
4. Brings drop into conditioned space!

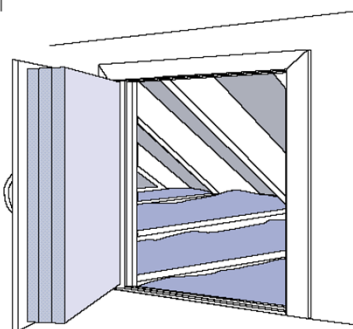
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Ceiling Access Openings

KNEE-WALL DOOR



Add R-value to a knee-wall door by adhering rigid insulation boards (sandwiched together with construction adhesive and screws) to the back of the door. Pay special attention to the clearance between the insulation and the door frame and air sealing details.

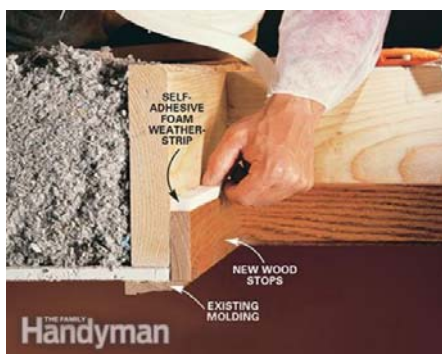
Insulated hatch that is heavy enough to create a seal on weather stripping. Recommend MDF or SIP hatches.



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Attic Access



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Table 402.4.1.1 Component – Walls



Air Barrier Criteria

- 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.
- Knee walls shall be sealed.

Insulation Installation Criteria

- Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance of R3 per inch minimum.
- Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier

Walls	The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the top of exterior walls shall be sealed. Knee walls shall be sealed.	Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance of R-3 per inch minimum. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.
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Junction Of Foundation and Sill Plate Is Sealed

What Is Sill Seal Meant To Do?

Capillary Break



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The Junction of the Top Plate and Top of Exterior Walls Shall Be Sealed



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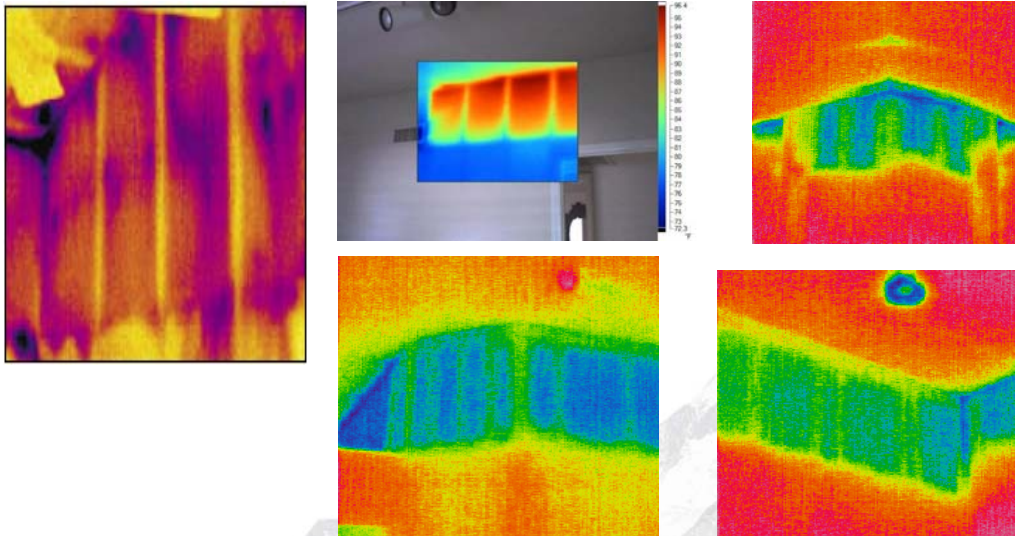
Attic Knee Walls



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Attic Knee Walls



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Doing It Right

Sequencing

1. Top plate
2. Bottom plate
3. Side Studs
4. Attic side sheathing
5. Interior drywall is the sixth side



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The Problem



The Solution



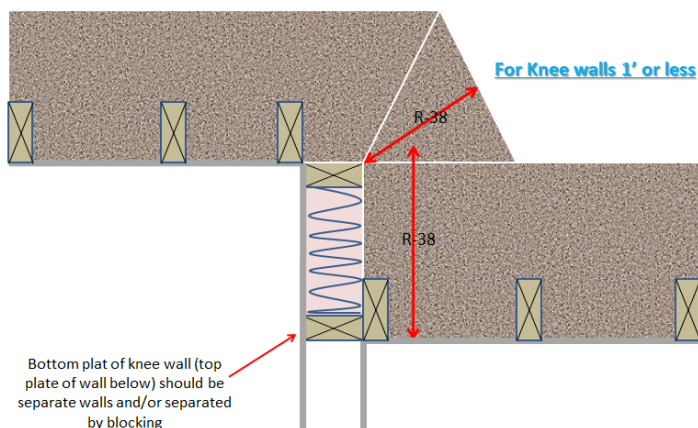
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Small Attic Knee Walls

Knee walls 1' or Less

The installed depth of the insulation must be \geq the height of the kneewall in order to forego kneewall backing. The installed insulation angle should not exceed 45 degrees to ensure that the mounded insulation provides a minimum acceptable insulation depth over the corner of such structures and to ensure that it will not slide off. The depth of the insulation as illustrated by the two red arrows shall be equal hence ensuring at least and R-38 over the outside edge of the knee wall.

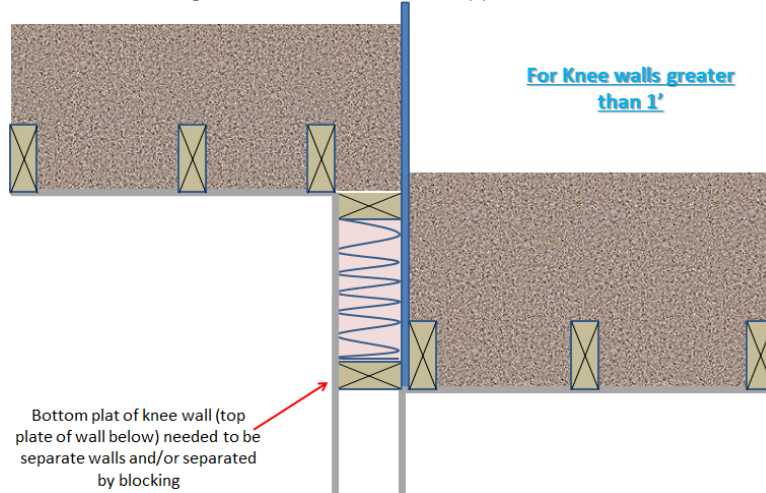


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Knee wall greater than 1'

For short knee walls and for raised ceilings that are $\geq 1'$ and or are taller than the ceiling below, the best practice is to install a full attic side air barrier and six sided enclosed cavity insulation. The air barrier should extend above the raised ceiling, to act as an insulation dam, to ensure that the higher insulation does not fall off the top plate onto the insulation below.



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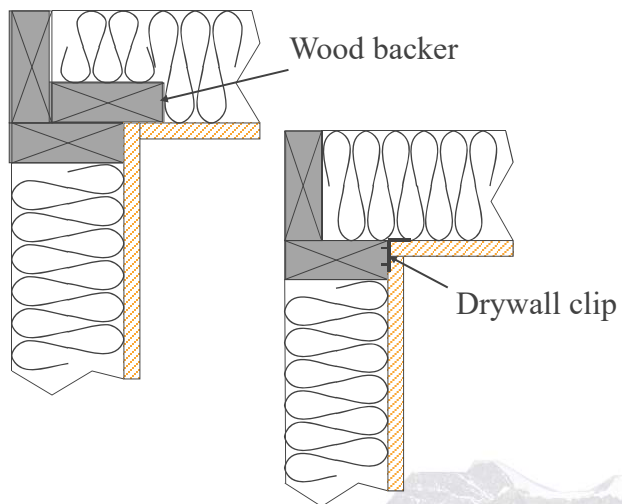
Small Knee Wall Done Right



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Corners and Headers Shall Be Insulated



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Interior Wall Meets Exterior Wall

Ladder Blocking



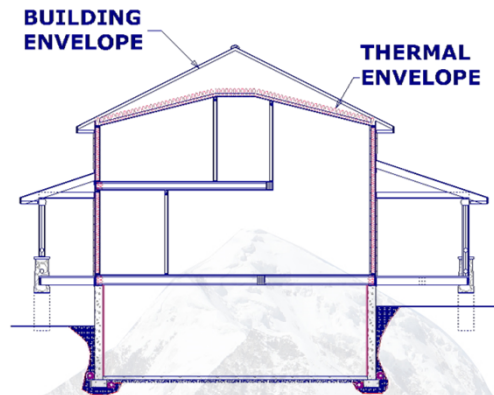
Continuous 2x6 Behind 2x4



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Other Wall Assemblies

- Exterior thermal envelope insulation for framed walls shall be installed in **substantial contact and continuous alignment** with the air barrier.



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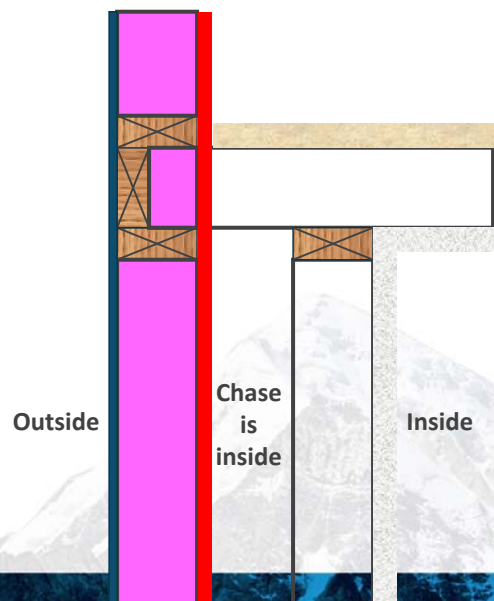
Double Walls:
Define where the
thermal barrier is
make a choice.
Sequencing



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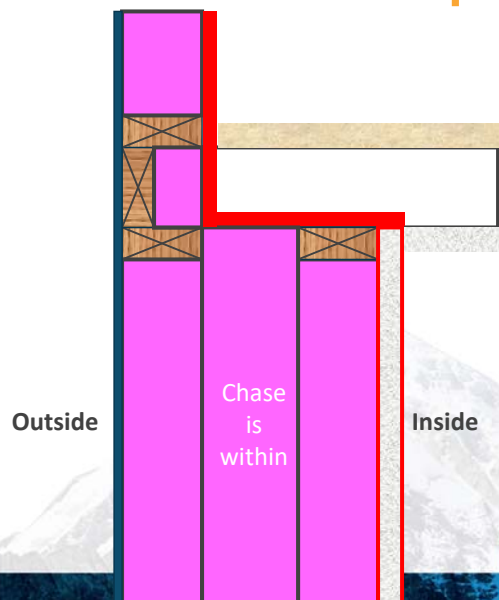
Chase: Where Is the Thermal Envelope?



EnergyLogic



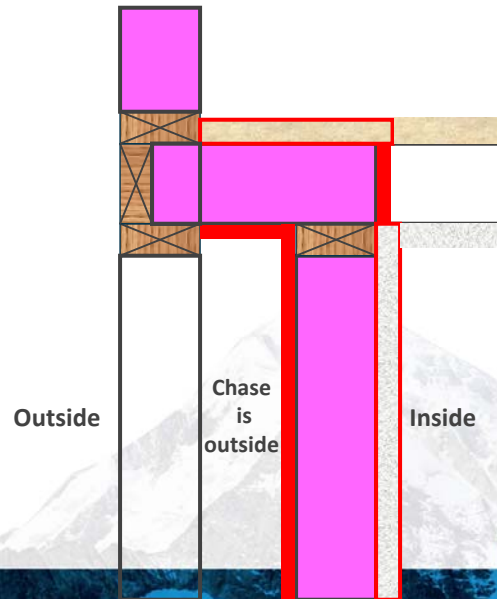
Chase: Where Is the Thermal Envelope?



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Chase: Where Is the Thermal Envelope?



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Table 402.4.1.1

Component – Windows, Skylights, and Doors



Air Barrier Criteria

- The space between window/door jambs and framing and skylights and framing shall be sealed.

Insulation Installation Criteria



Windows, skylights and doors

The space between window/door jambs and framing, and skylights and framing shall be sealed.

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Openings Between Window/Door Jams Sealed



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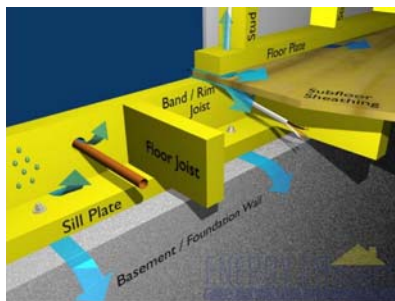


Table 402.4.1.1 Component – Rim Joists



Air Barrier Criteria

- Rim joists shall include the air barrier.



Insulation Installation Criteria

- Rim joists shall be insulated.

Rim Joist

Box Sill



Rim joists

Rim joists shall include the air barrier.

Rim joists shall be insulated.

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