



PICK YOUR POISON AND HOW TO GET THERE

Presented By Robby Schwarz

Code Adoption Cycle

- 2012 International Energy Conservation code
- The code that got peoples attention
- Adoption and development are out of sync



Building Energy Codes Improving FASTER...

Relative to 2006 IECC (International Energy Conservation Code) Baseline



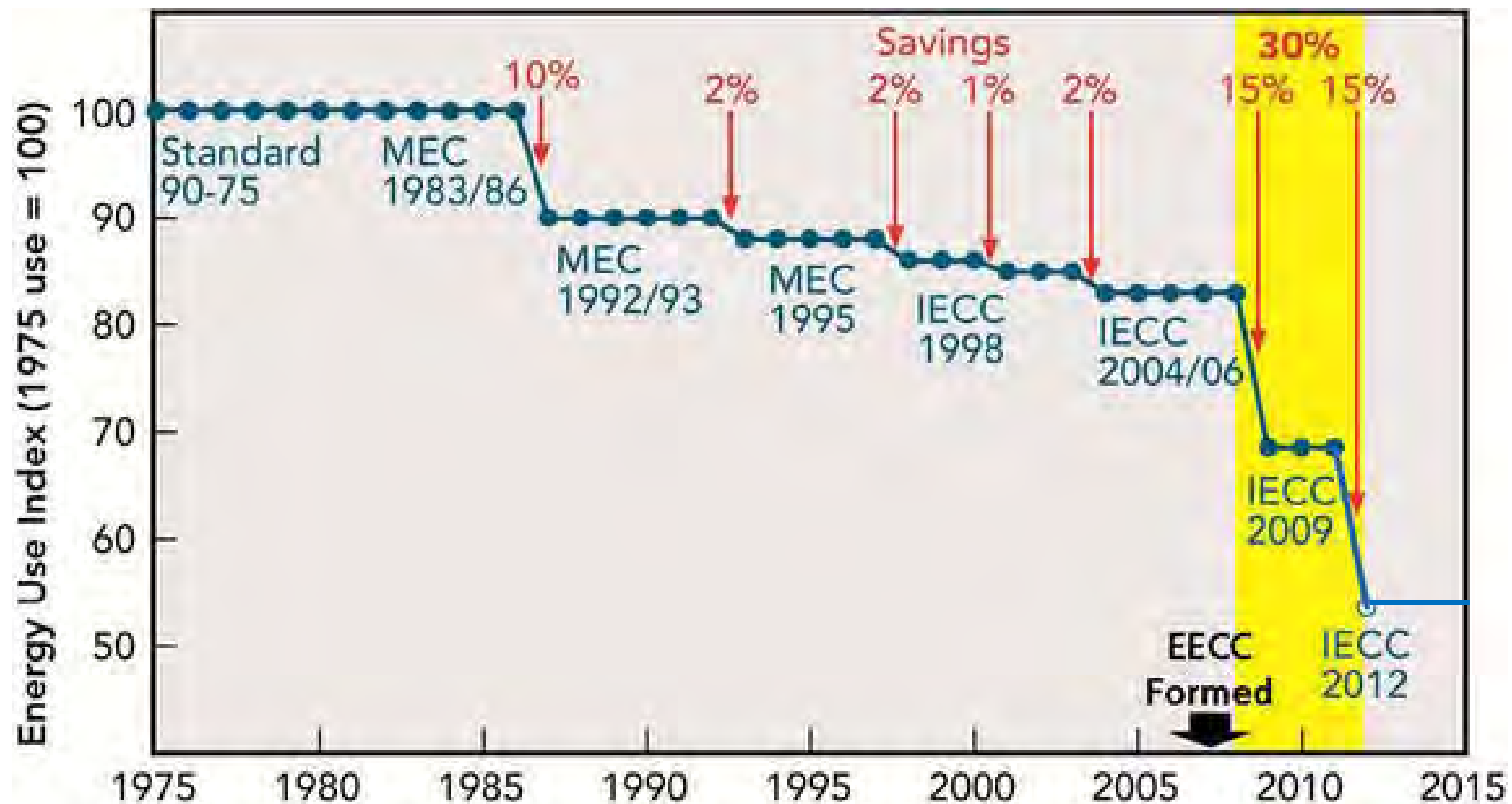
Rocky Mountain
Institute

Interpreted from: www.energycodes.gov Jun. 2012, J. Brew, RMI

Energy Code

Its not your Daddy's code?

- No longer building the minimum _ _ _ house allowable!

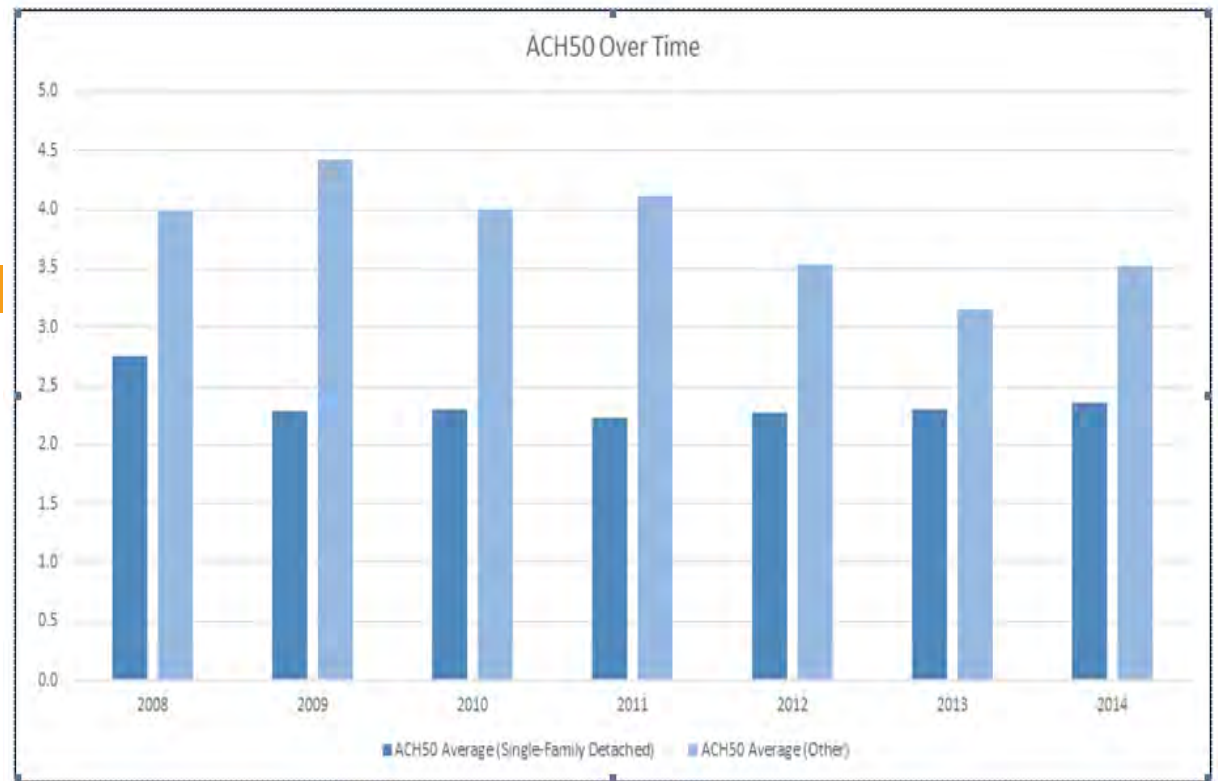


R402.4.1.2 Testing (Mandatory)

- 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



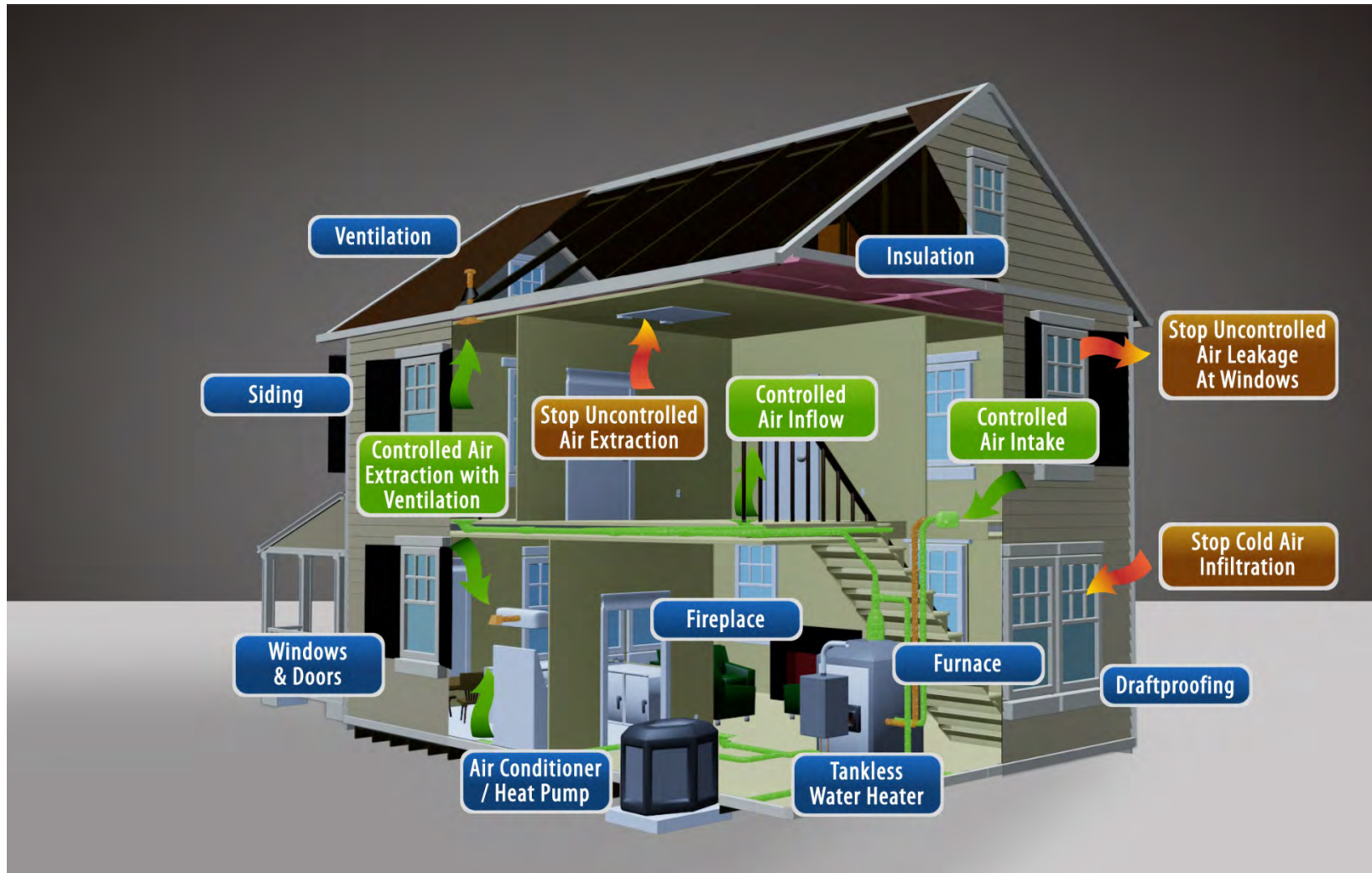
Data



Year	ACH ₅₀ Average (Single-Family Detached)	ACH ₅₀ Average (Other)
2008	2.75	3.98
2009	2.29	4.42
2010	2.30	4.00
2011	2.23	4.12
2012	2.27	3.53
2013	2.31	3.15
2014	2.35	3.52



Applied Building Science and Systems Thinking



Build Tight!



Ventilate Right!



Pathways through the 2015 IECC

- Prescriptive
- UA Trade off
- Simulated Performance
- Energy Rating Index



Quantifiable Energy Use



- Prescriptive
 - Baseline of comparison
- UA Trade off
 - Area waited U-Value
- Simulated Performance
 - Annual Cost Compliance
- Energy Rating Index
 - HERS Index



Mandatory Code Requirements



R103 for the 2012 & 2015 IECC

Construction Documents

- R103.1 General
 - Construction documents prepared by a design professional
 - I.E. set of plans
 - Different from compliance documents

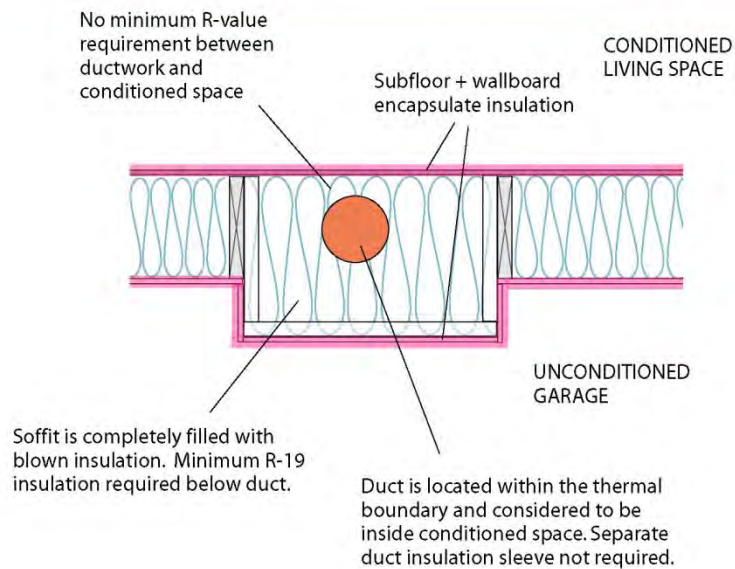
R103.2 Information on Construction documents

- Details shall include but are not limited to:
 - Insulation location and R-values
 - Window U-value & SHGC
 - Mechanical System design criteria
 - Mechanical and water heater Type, size and efficiency
 - Duct sealing, insulation and location
 - Air sealing details



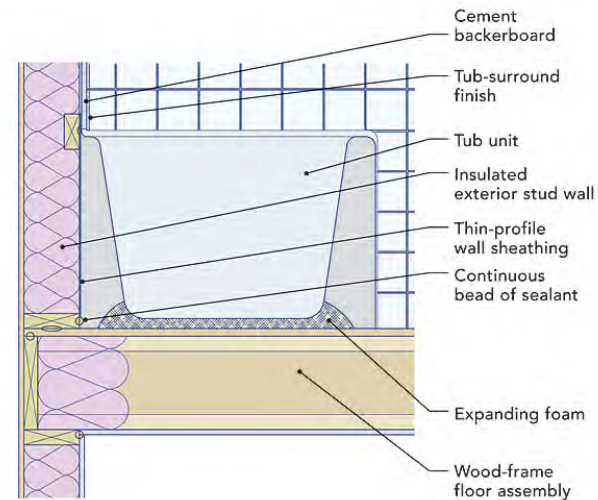
Example Details

Ductwork in floor over garage



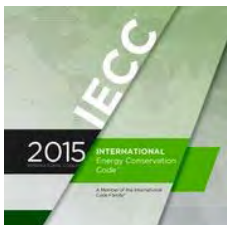
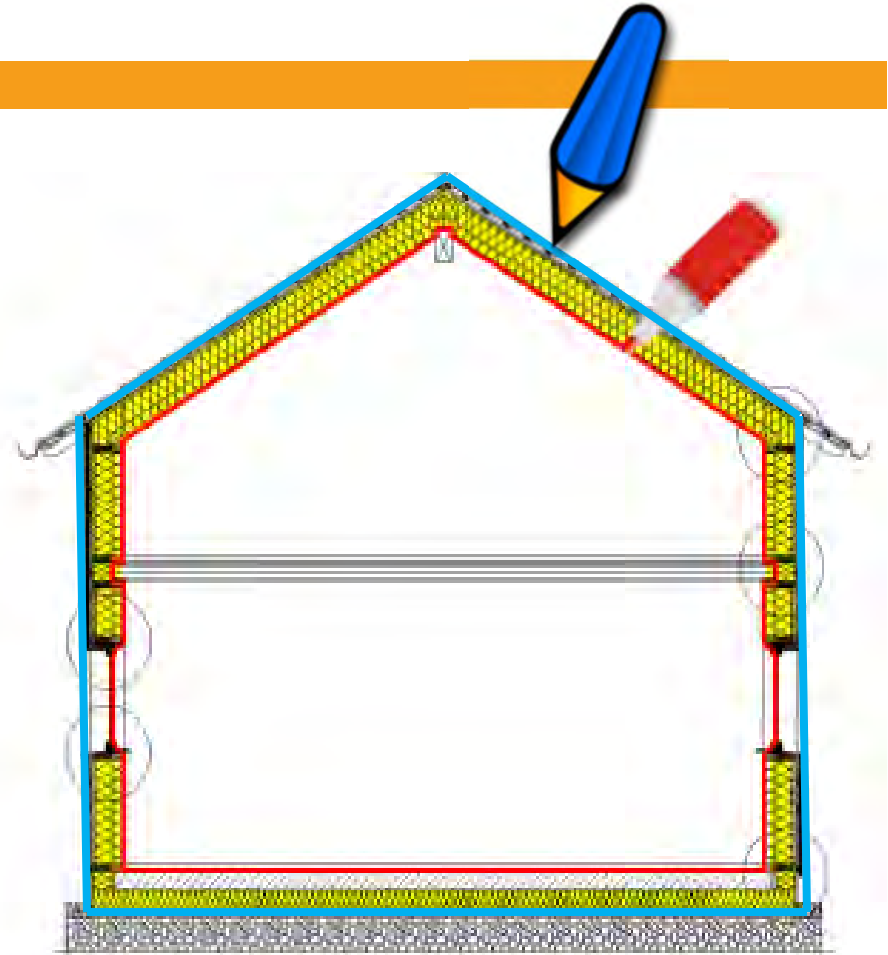
NOTE: This approach is only approved if BLOWN insulation is used to completely fill the soffit.

3/19/2012



New in the 2015

- 103.2.1 Building Thermal Envelope depiction:
 - The buildings thermal envelope shall be represented on the construction documents
 - Blue – Exterior air barrier
 - Yellow Thermal Barrier
 - Red Interior air barrier



Chapter 3: General



C303.1.2 Insulation mark installation.

- Insulating materials shall be installed such that the **manufacturer's R-value mark is readily observable** upon inspection.

R303.1.1 Building thermal envelope insulation

- The insulation installer **shall provide a certification listing the type, manufacture, and R-value of insulation** installed in each element of the building thermal envelope

R303.2 Installation

- Materials, systems and equipment **shall be installed in accordance with the manufacturer's instructions** and the International Building Code or International Residential Code, as applicable



Examples of Manufacture 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.



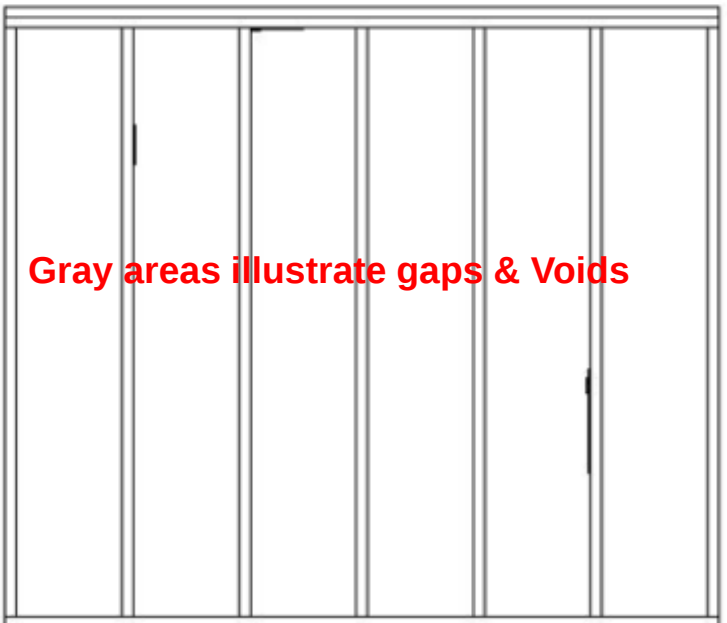
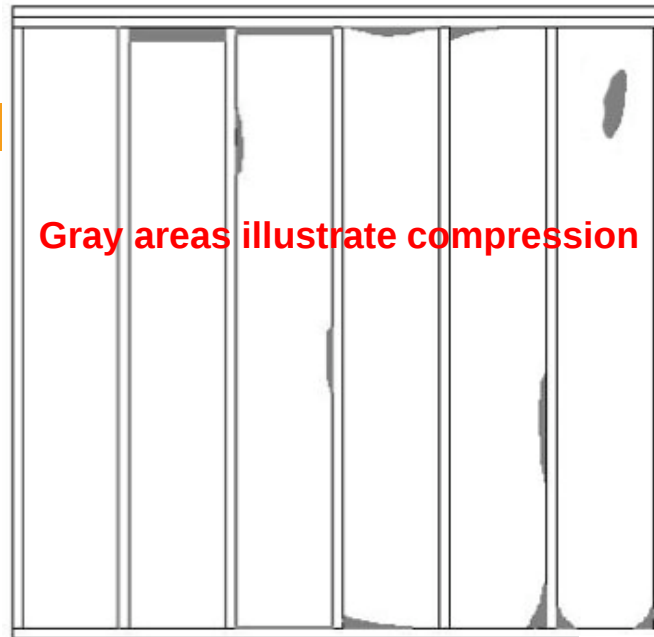
RESNET Standards Grade 1 Insulation Installation

- 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".

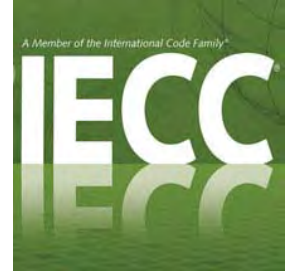


RESNET Standards – Grade I Insulation



R401.3 Certificate (Mandatory)

- A permanent certificate **shall be completed and posted** on or in the electrical distribution panel by the builder or registered design professional
- The certificate shall list....
 - R-values of insulation
 - R-values of ducts outside conditioned spaces
 - Window U-value and SHGC
 - Results of duct system and building envelope air leakage testing
 - Types and efficiencies of heating, cooling and service water heating equipment.



2015 IECC Certificate

1234 Place to Live, Denver, CO 80221

Building Envelope Insulation

Ceiling	R-49.0
Above Grade Walls	R-20.0
Foundation Walls	R-15.0
Exposed Floor	R-30.0
Slab	R-0.0 Edge, R-0.0 Under
Infiltration	Htg: 3.00 Clg: 3.00 ACH50
Duct	Uninsulated
Total Duct Leakage	80.00 CFM @ 25 Pascals

Window Data

	U-Factor	SHGC
Window	0.320	0.320

Mechanical Equipment

HEAT: Fuel-fired air distribution, Natural gas, 92.1 AFUE.

COOL: Air conditioner, Electric, 13.0 SEER.

DHW: Conventional, Natural gas, 0.62 EF, 40.0 Gal.

Builder or Design Professional

Signature _____



402.4 Air Leakage and Air Barriers (Mandatory)

- 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

2012 IECC Table

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.

2015 IECC Table

TABLE 402.4.1.1 (N1102.4.1.1)
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.



TABLE 402.4.1.1 REVISED

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
<u>General Requirements</u>	<u>A continuous air barrier shall be installed in the building envelope.</u> <u>Exterior thermal envelope contains a continuous air barrier.</u> <u>Breaks or joints in the air barrier shall be sealed.</u>	<u>Air-permeable insulation shall not be used as a sealing material..</u>
<u>Ceiling / attic</u>	<u>The air barrier in any dropped ceiling/soffit shall be aligned with the insulation and any gaps in the air barrier sealed.</u> <u>Access openings, drop down stair or knee wall doors to unconditioned attic spaces shall be sealed.</u>	<u>The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.</u>
<u>Walls</u>	<u>The junction of the foundation and sill plate shall be sealed.</u> <u>The junction of the top plate and top of exterior walls shall be sealed.</u> <u>Knee walls shall be sealed.</u>	<u>Corners and headers shall be insulated.</u> <u>Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.</u>

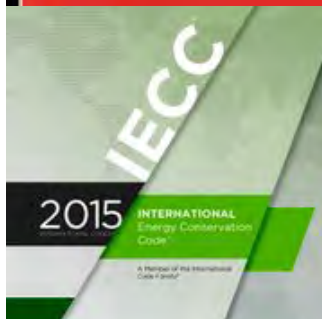


Table 402.4.1.1

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

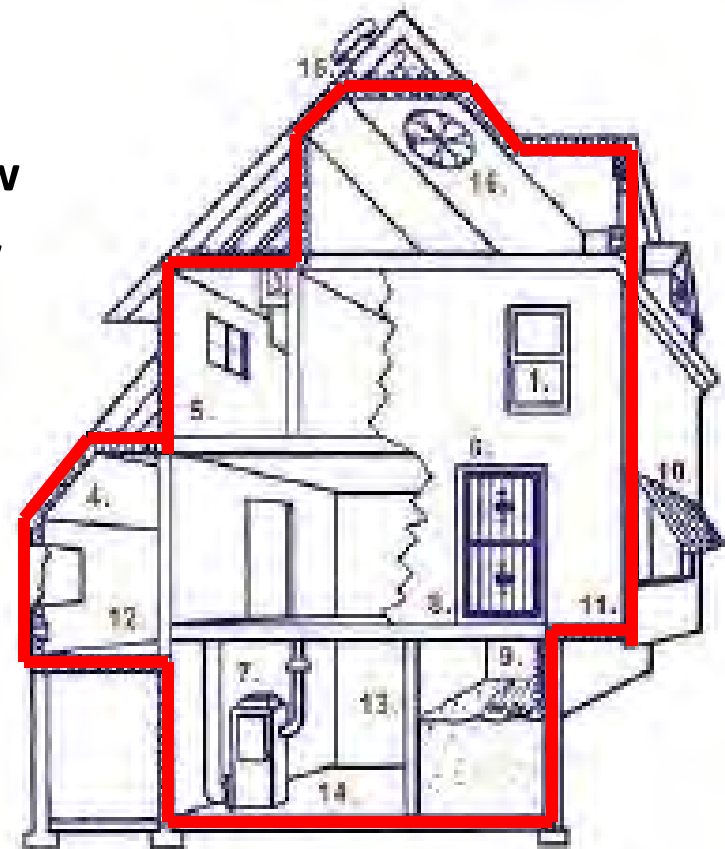
- Air-permeable insulation shall not be used as a sealing material



What / Where is the Thermal Envelope?



- Control
 - Air Flow
 - Moisture Flow
 - Thermal Flow



Section R202 General definitions



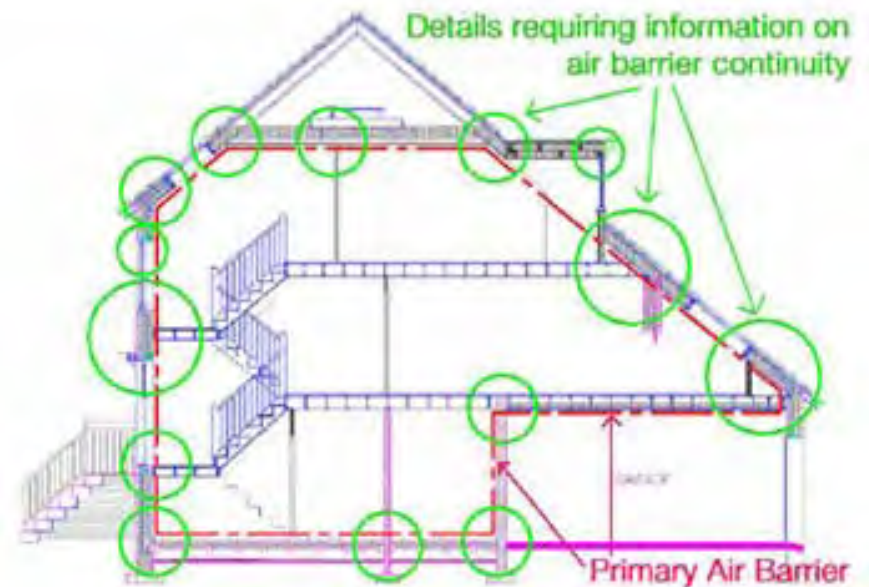
- Air Barrier
 - Material(s) assembled and joined together to provide a barrier to air leakage through the building envelope. An air barrier may be a single material or a combination of materials

- Continuous Air Barrier
 - A combination of materials and assemblies that restrict or prevent the passage of air through the building thermal envelope



Two Functions of an Air Barrier

- Interior vs. Exterior air barrier
- At its simplest form
 - Interior drywall
 - Exterior sheathing
 - Drainage Plan
- Function
 - Insulation encapsulation
 - Air control



CONTROLLING THERMAL FLOW

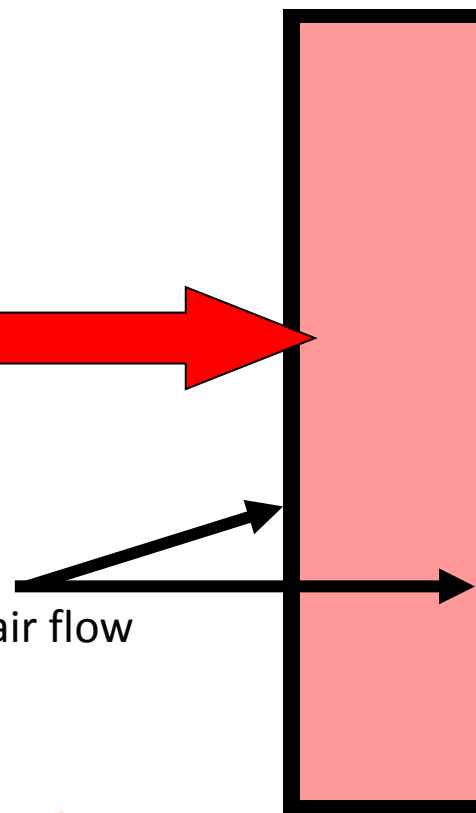
Most insulation is NOT an air barrier

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!**



5 key Air Barriers Attributes

- **Continuity:** The most important element in 3D structures with so many different components
- **Impermeability:** The ABS must be impermeable to Air
- **Strength:** The ABS must be designed to transfer the full designed wind load and continue to be impermeable
- **Durability:** The ABS must continue to be impermeable throughout its service life
- **Stiffness:** The ABS must be stiff enough so that irregularities do not change its permeance



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



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

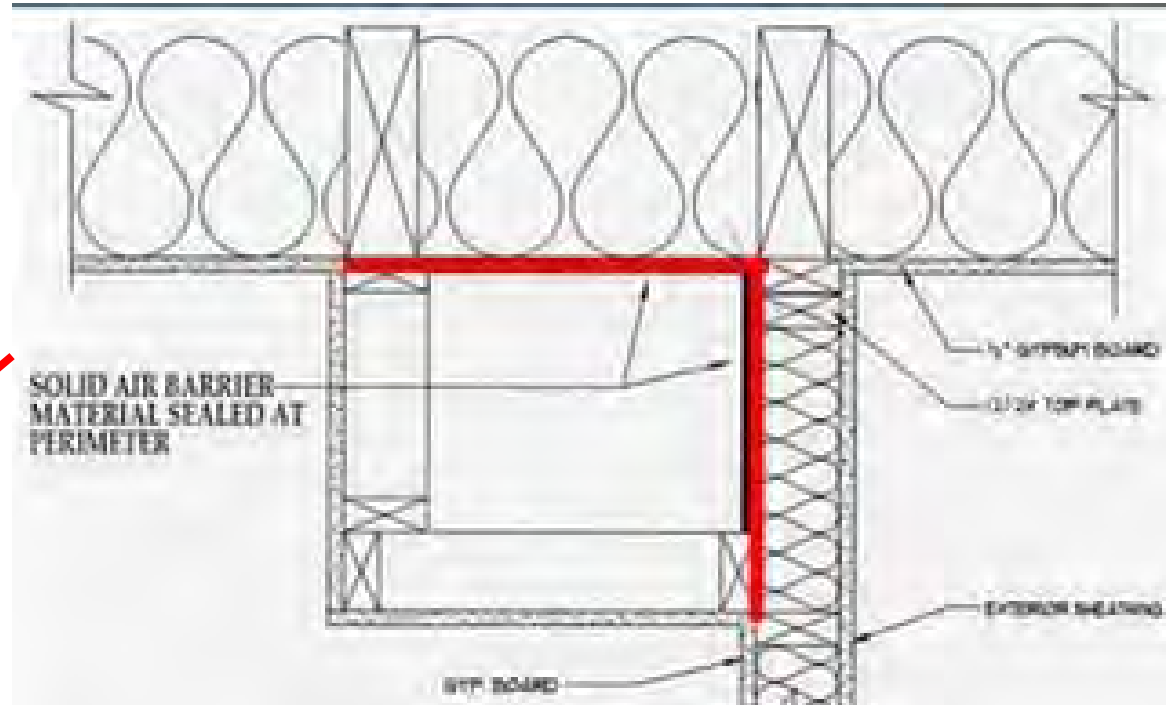
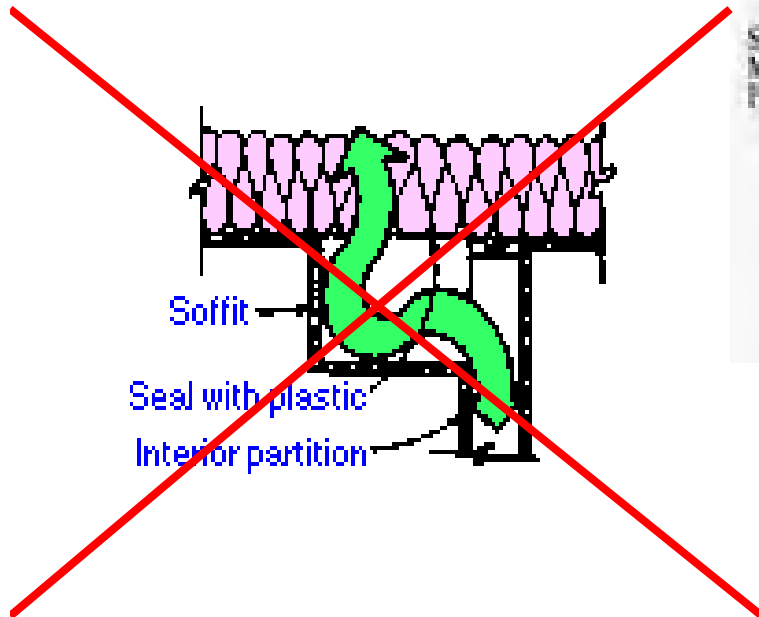
Insulation Installation Criteria

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



Dropped Ceiling / Soffit

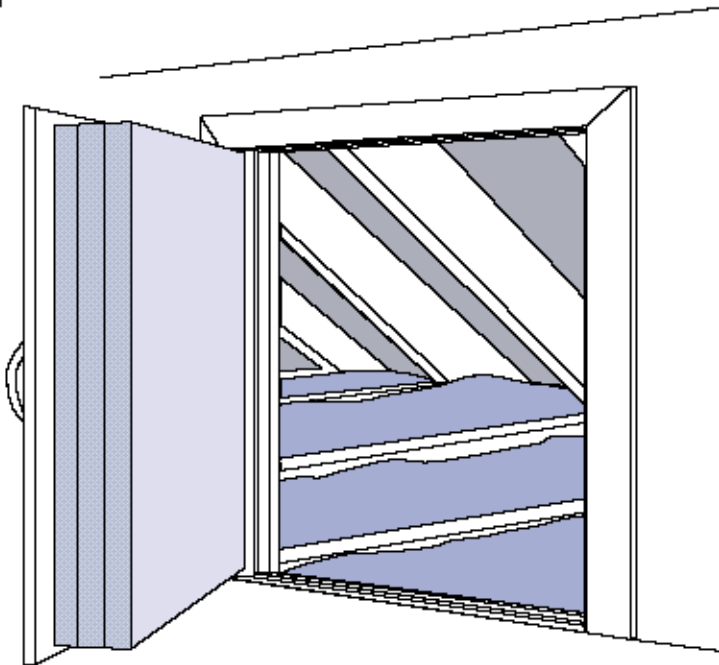
Full Air Barrier Aligned with Insulation





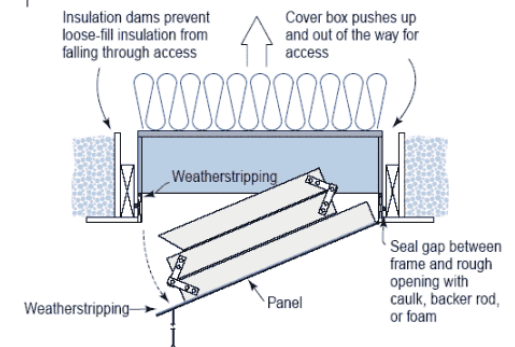
Ceiling Access Openings

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.

PULL-DOWN ATTIC STAIRS



An attic stair cover box is made from rigid insulation. It drops down from the attic side to seal and insulate the pull-down stairs.



Attic Access

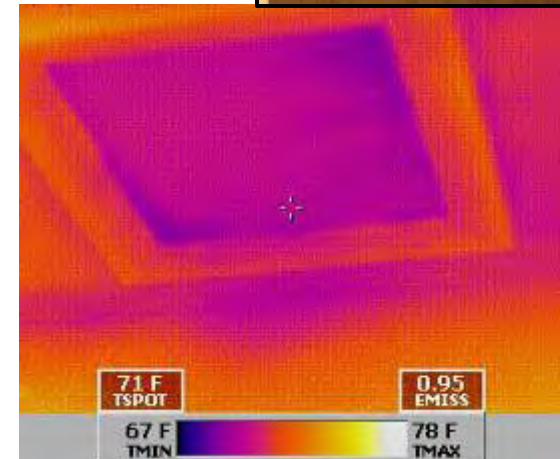
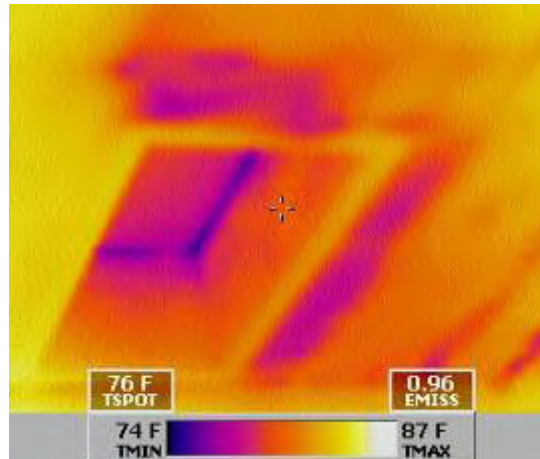


Table 402.4.1.1

Component – Walls



Air Barrier Criteria

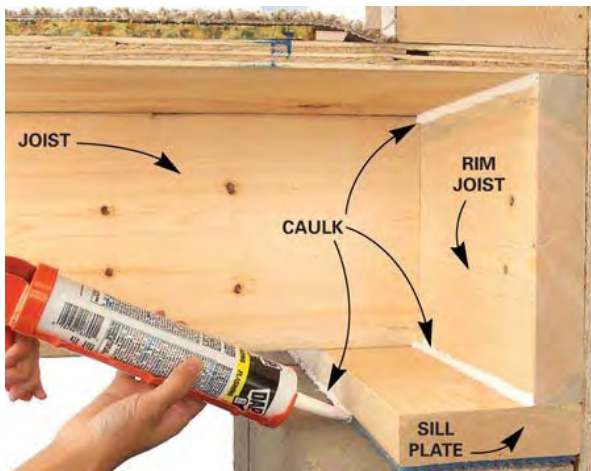
- The junction of the foundation and sill plate shall be sealed
- The junction of the top plate and top of exterior walls shall be sealed
- Knee walls shall be sealed

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



Junction of foundation and sill plate is sealed



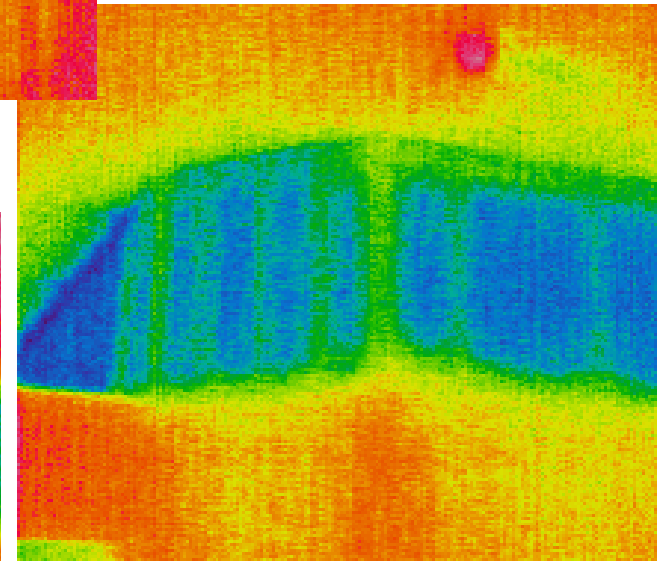
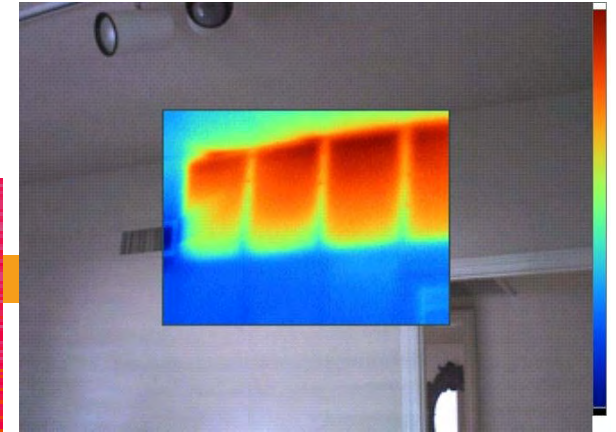
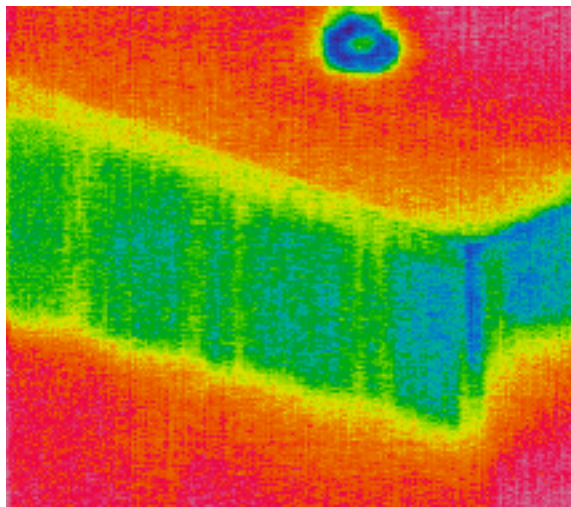
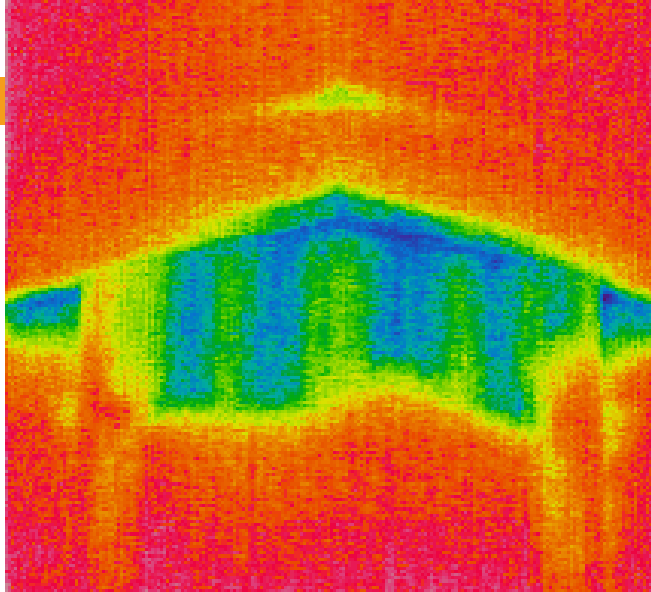
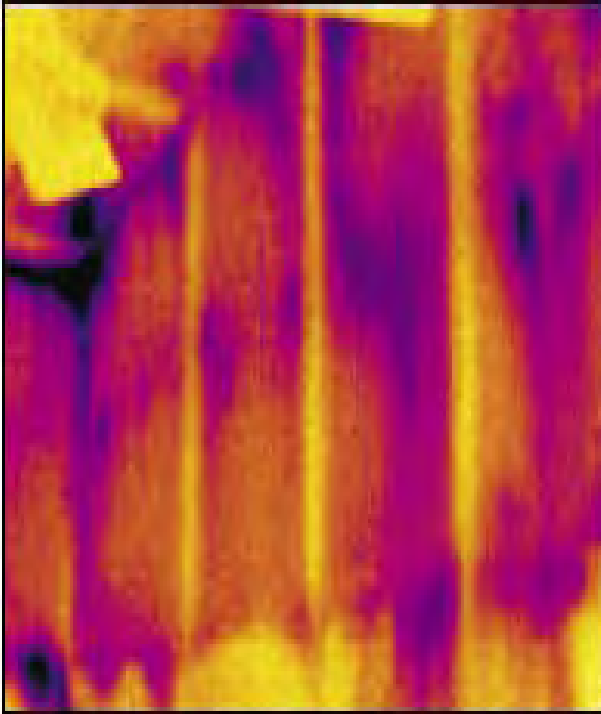
The junction of the top plate and top of exterior walls shall be sealed



Attic Knee Walls



Attic Knee Walls



Doing it Right

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



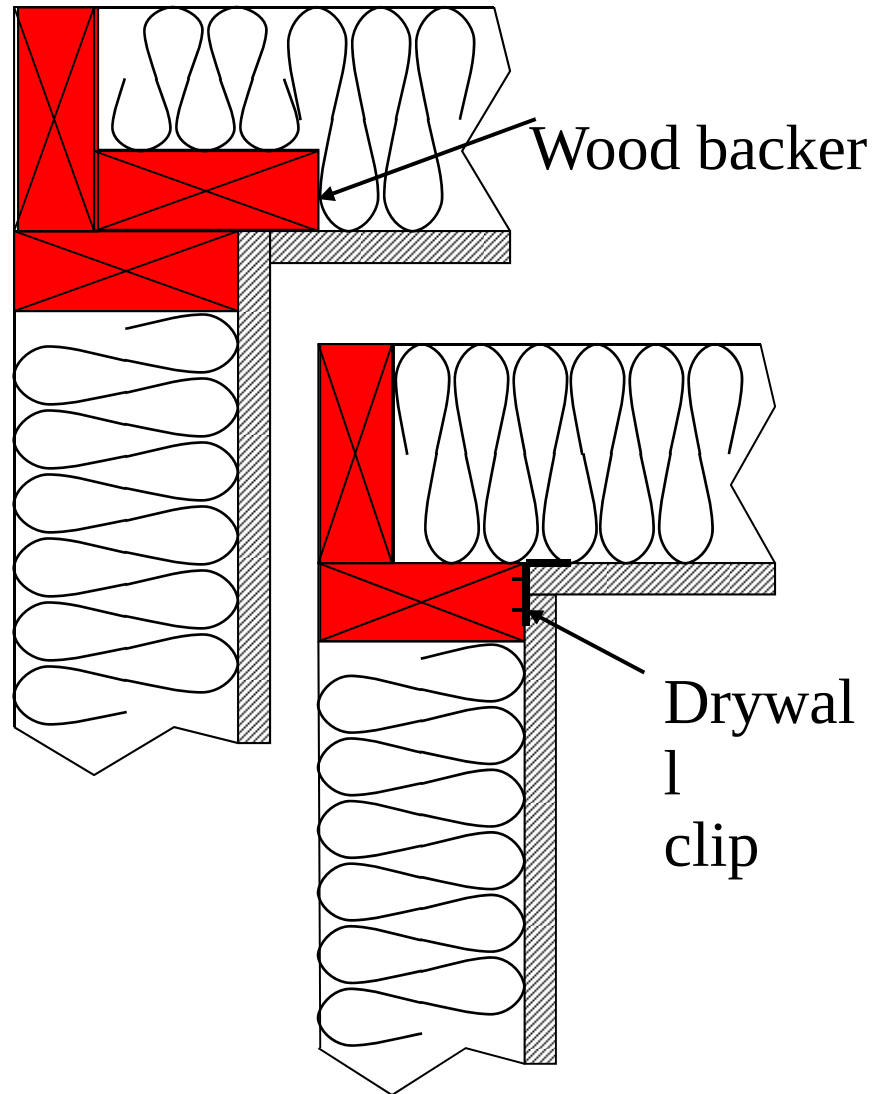
The Solution



The Problem



Corners and Headers shall be Insulated



Interior wall meets exterior wall

Ladder Blocking

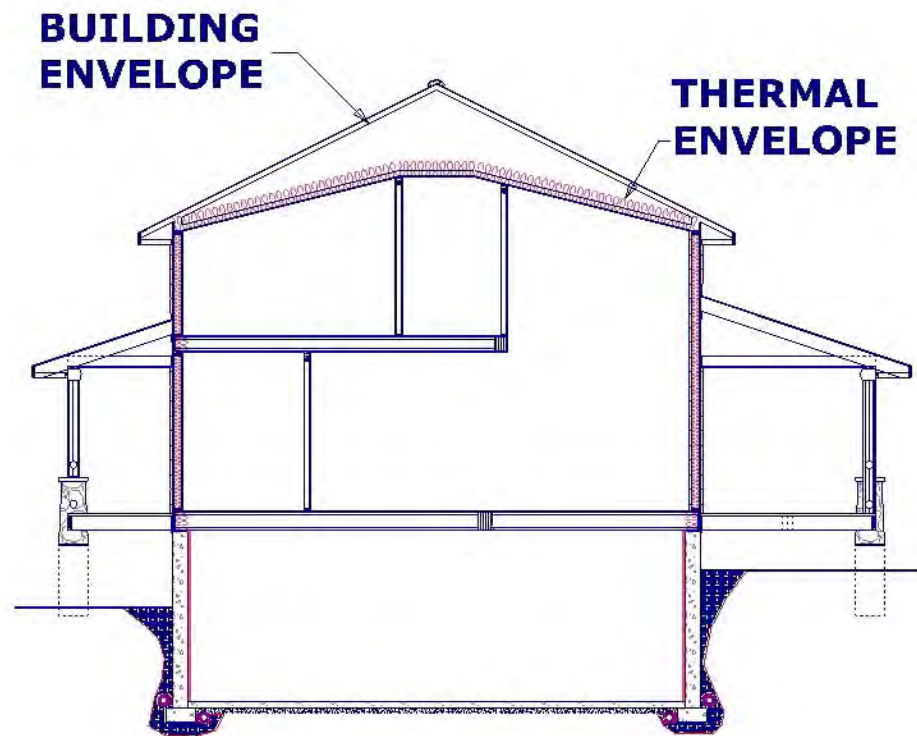


Continuous 2x6 behind 2x4



Other wall assemblies

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





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

This image shows a close-up of a double wall construction. The wall consists of two vertical studs with a horizontal stud in between. The space between the studs is filled with yellow insulation. The wall is sheathed with OSB (Oriented Strand Board). A thermal barrier is visible, which is a layer of material that prevents heat from escaping. The text 'Double Walls: Define where the thermal barrier is make a choice' is overlaid on the image.



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

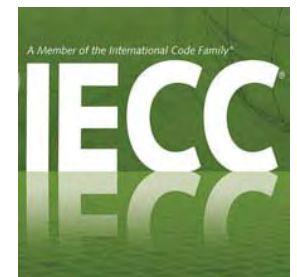
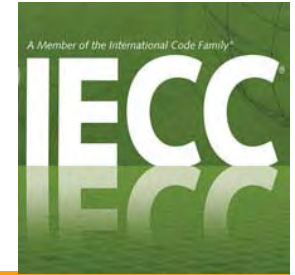


Table 402.4.1.1

Component – Rim Joists



Air Barrier Criteria

- Rim joists shall include the air barrier



Insulation Installation Criteria

- Rim joists shall be insulated

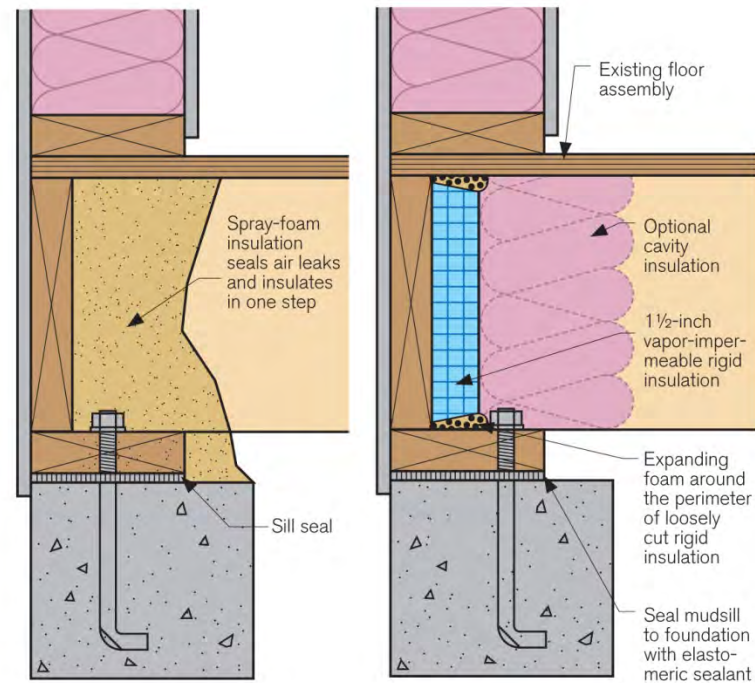


Table 402.4.1.1

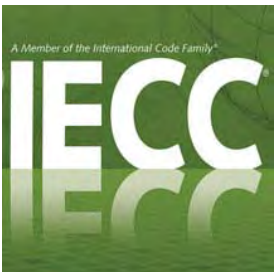
Component — Floors (including above garage & cantilever floors)

Air Barrier Criteria

- The air barrier shall be installed at any exposed edge of insulation

Insulation Installation Criteria

- Floor framing cavity insulation shall be installed to maintain permanent contact with underside of subfloor decking
- 2015 IECC introduction
 - or floor framing cavity insulation shall be permitted to be in contact with the topside of sheathing or continuous insulation installed on the bottom side of floor framing and extends from the bottom to the top of all perimeter floor framing members.



2012 IECC table 402.4.1.1

Crawl – Insulation is permanently attached to walls, earth covered and sealed with Class 1 vapor barrier

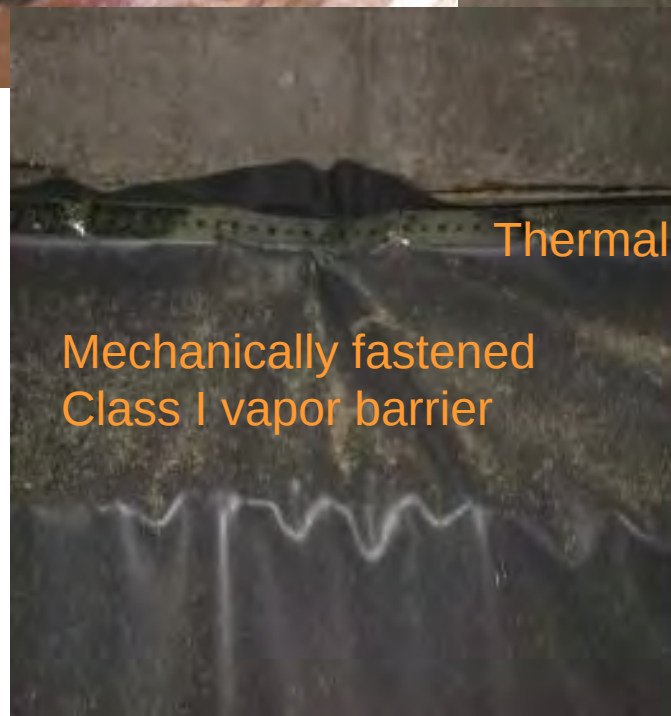


Table 402.4.1.1

Component – Recessed lighting



Air Barrier Criteria

- Recessed light fixtures installed in the building thermal envelope shall be sealed to the drywall



Insulation Installation Criteria

- Recessed light fixtures installed in the building thermal envelope shall be air tight, IC rated



Table 402.4.1.1

Component – Plumbing and Wiring



Air Barrier Criteria



Insulation Installation Criteria

- 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



Plumbing and Wiring

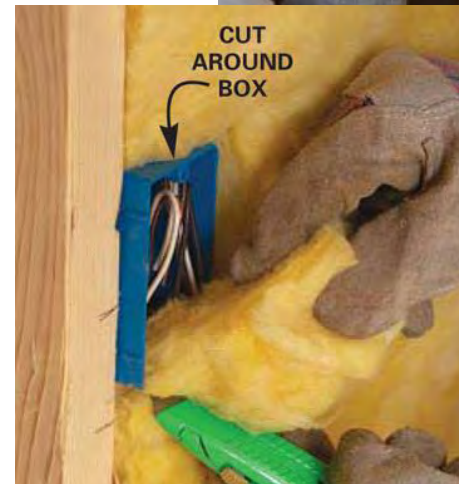
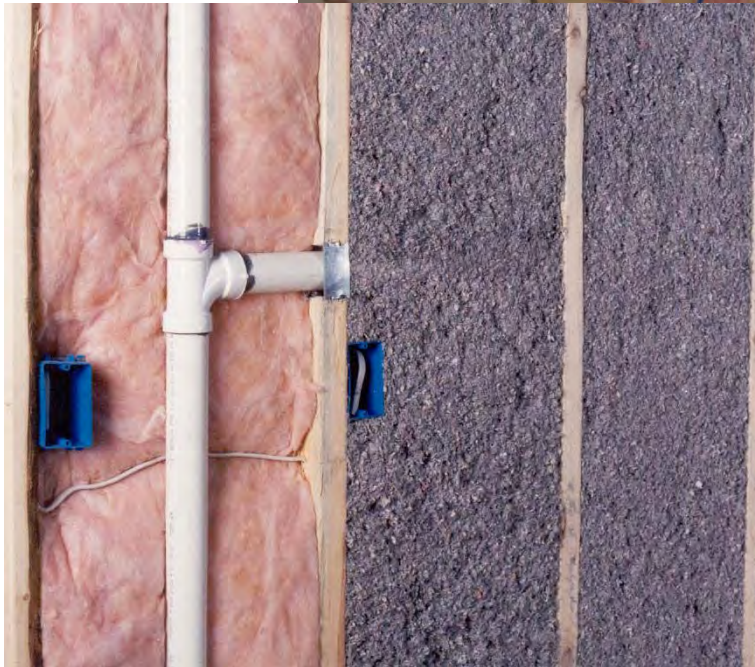


Table 402.4.1.1

Component – Shower/tub on exterior wall



Air Barrier Criteria

- The air barrier installed at exterior walls adjacent to showers and tubs shall separate them from the showers and tubs

Insulation Installation Criteria

- Exterior walls adjacent to showers and tubs shall be insulated



Tubs and Showers

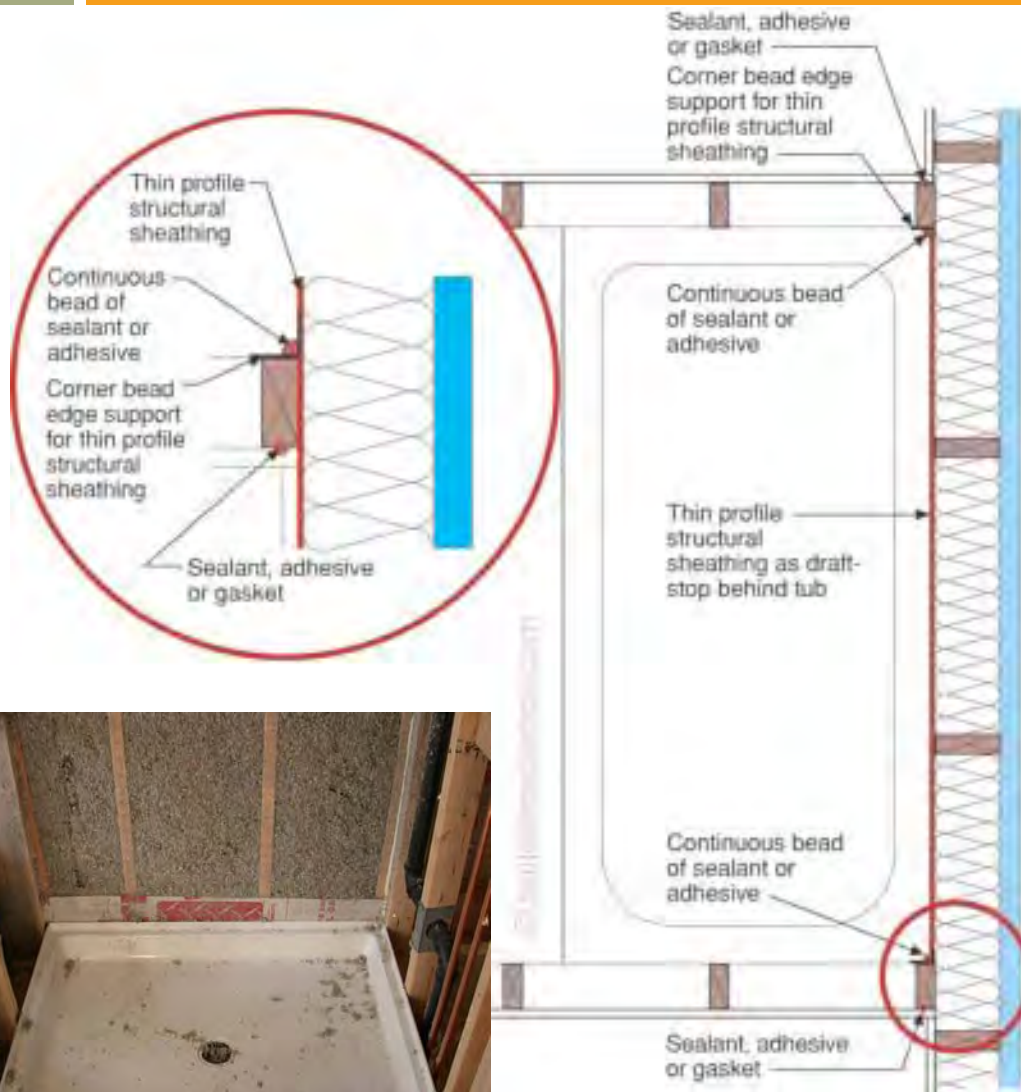


Table 402.4.1.1

Component – Electrical/phone box on exterior walls

Air Barrier Criteria

- The air barrier shall be installed behind electrical or communication boxes or air sealed boxes shall be installed

Insulation Installation Criteria



Electrical/phone box on exterior walls



Table 402.4.1.1

Component – HVAC Register boots



Air Barrier Criteria

- HVAC register boots that penetrate building thermal envelope shall be sealed to the subfloor or drywall

Insulation Installation Criteria



Table 402.4.1.1

Component – Fireplace



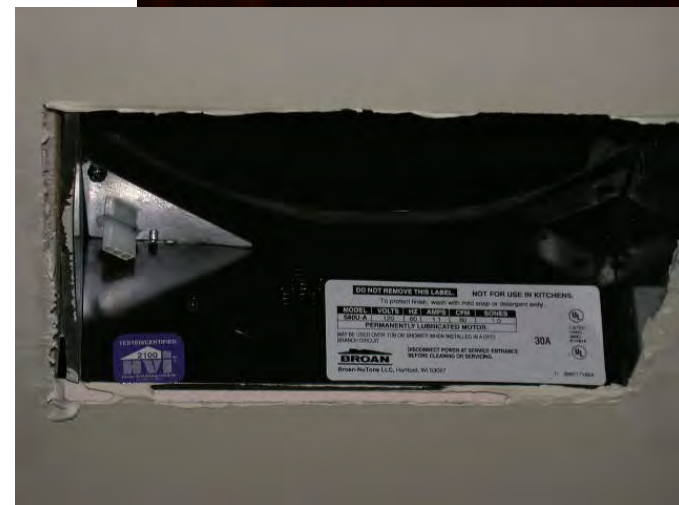
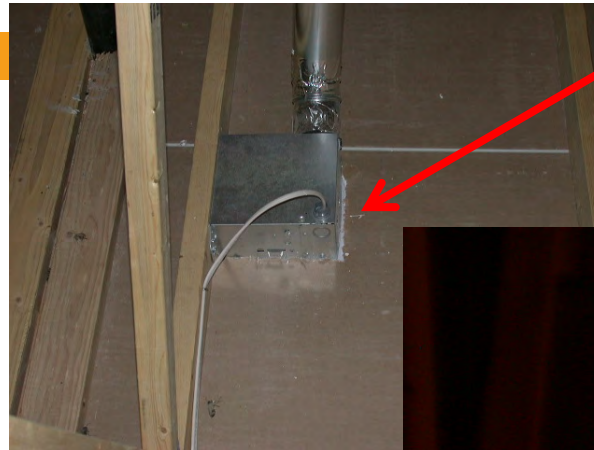
Air Barrier Criteria

- This section was moved in the 2015 IECC
- An air barrier shall be installed on fireplace walls
- Fireplaces shall have gasketed doors

Insulation Installation Criteria



Other Potential Problem Areas



Traps: Seal them!



Table 402.4.1.1

Component – Concealed Sprinklers



Air Barrier Criteria

- When 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

Insulation Installation Criteria



Fire Sprinklers and air leakage?

Keep them inside!!



Fire Code and Energy Code

Not on the same page

- 2009 IECC
 - Common wall: Air barrier is installed in common wall between dwelling units
- 2012 and 2015 IECC
 - Not mentioned in the table



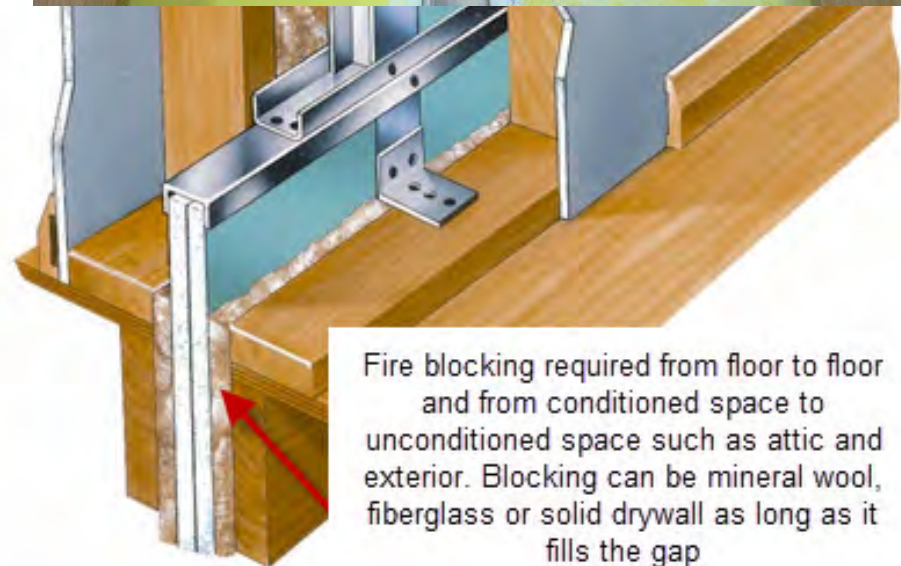
The Problem



The Solution

- Replace air permeable draft stop materials with air impermeable draft stop materials
- Compartmentalize all wall/floor components
 - Basement common/party wall rim joist
 - 1st floor common/party wall
 - common/party wall rim joist between 1st and 2nd floor
 - 2nd floor common/party wall
- If allowed by jurisdiction air seal





Fire blocking required from floor to floor and from conditioned space to unconditioned space such as attic and exterior. Blocking can be mineral wool, fiberglass or solid drywall as long as it fills the gap



Beware of foundation and rim connections



If allowed seal the gap as well





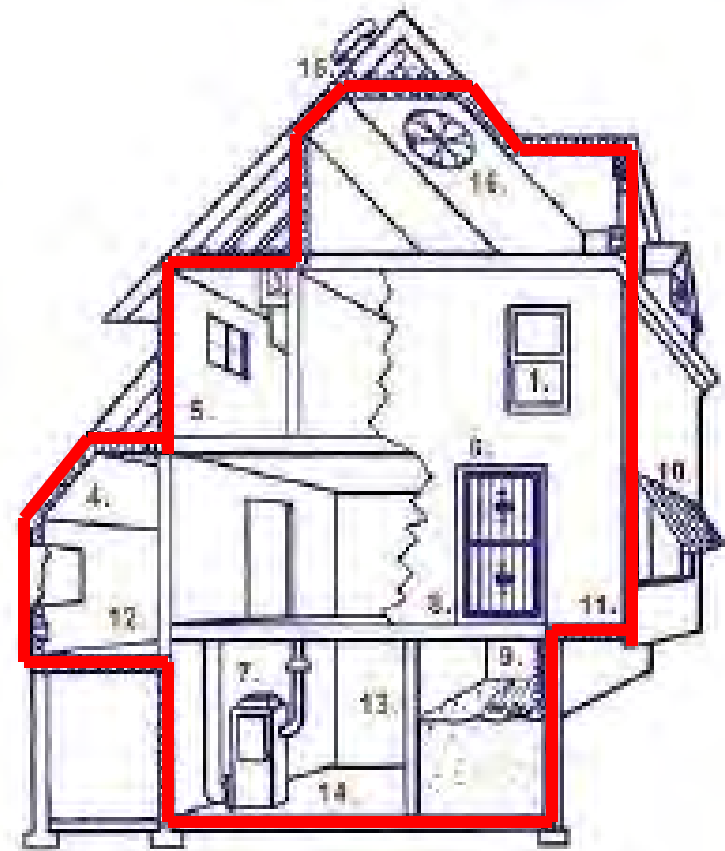
■ **Treat Common / Party Walls Like Exterior Walls and require all air sealing and air barriers adjacent to the assembly**

- Tubs
- Showers
- Fire places
- Drop ceilings
- Ect.

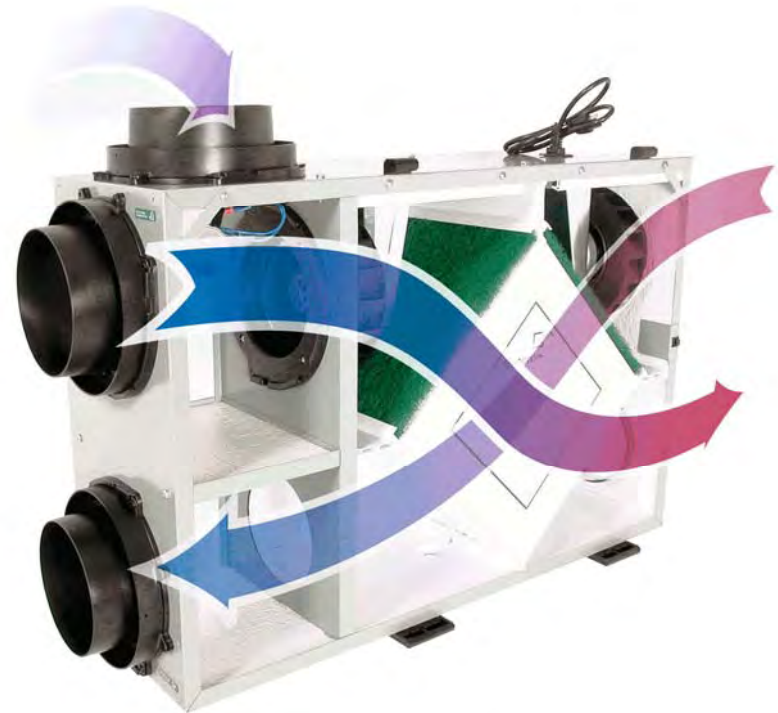


Create a Sound Thermal Envelope!

- The code gives us a pathway for success
- Follow it



Don't Forget Ventilation





Thank you!

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