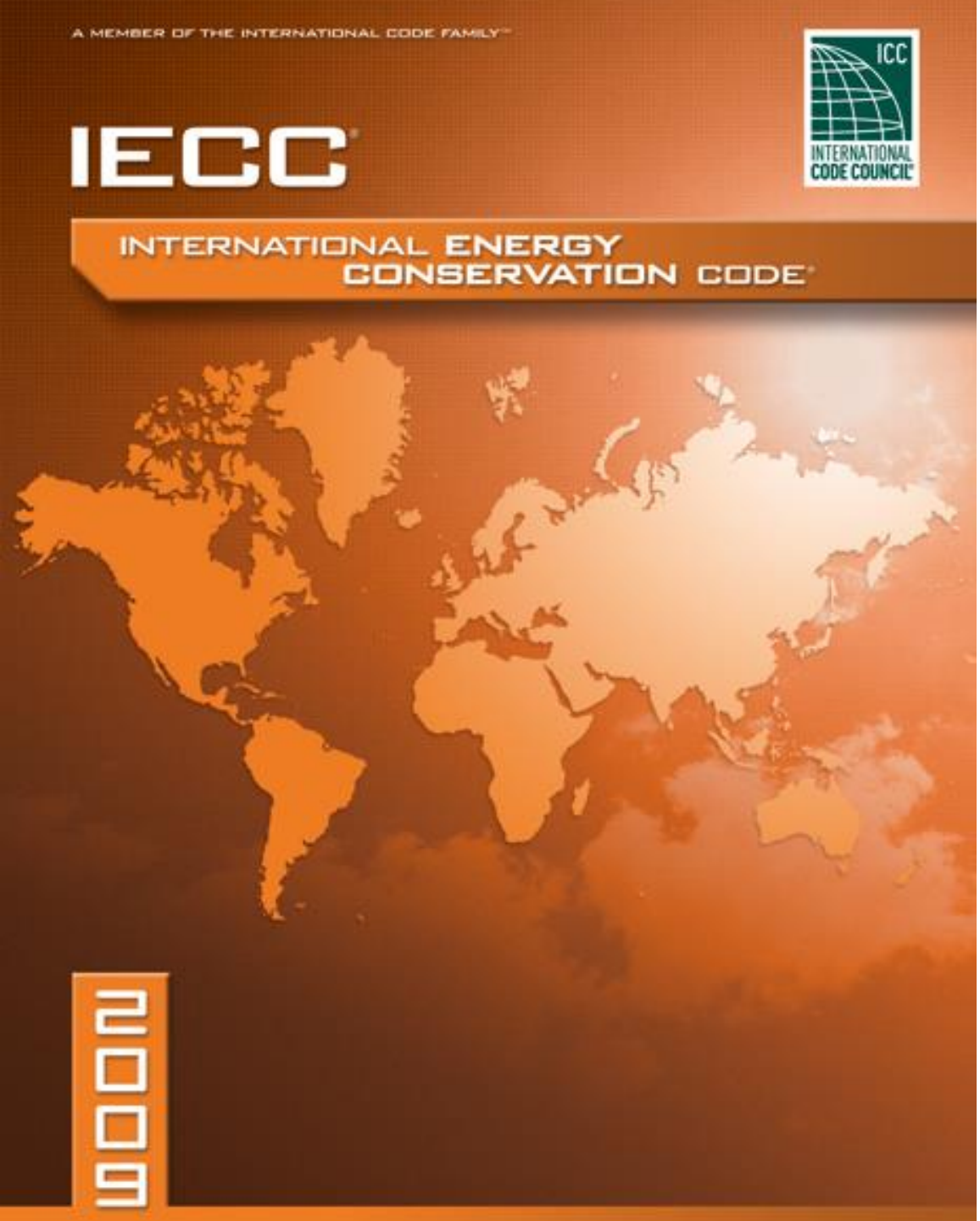
Step 1
Airtight Construction



- **Finally a code that is more than just "life and limb"**

Big Changes in the 2009 International Residential Code

- The Code is finally addressing energy efficiency instead of just health and safety of the occupants.
- Performance based code instead of prescriptive only now allows trade-offs and flexibility if modeling software is used!
- Accurate Manual J / D / S are required.
- Blower door test or an extensive checklist that requires insulation and air barrier to be properly aligned and penetrations to be air sealed.
- Duct Blaster Test and R-8 duct insulation unless ducts are in conditioned areas.
- Fresh air make-up on kitchen exhausts over 400 cubic feet per minute.
- Fresh air makeup on wood burning fireplaces and gasketed doors.
- 50% of lighting fixtures must be high-efficacy.

Raise your hand if you build an energy efficient, comfortable, durable, and healthy home?

- How do you know?
- Are you code compliant with the 2009 State of Alabama Energy Code or are you still building to the 2003 International Residential Code?

When is the contractor most at risk for construction defects?

- Code compliancy is not achieved. (Regardless of whether or not the code official passed it)
- The contract is not complied with.
- Standard practice is not accomplished.
- The manufacturer's specifications are not followed.
- Reasonable consumer expectation is not met.
- When certifications and qualifications for green building or energy efficient construction methods are advertised but not met. This is called "green washing".
- Negligence.
- Fraud and misrepresentation.

A great resource!

ADECA Field Guide to the 2009 IRC

http://www.adeca.alabama.gov/Divisions/energy/Documents/Codes/

The 7 Steps of Building a Synergy Home

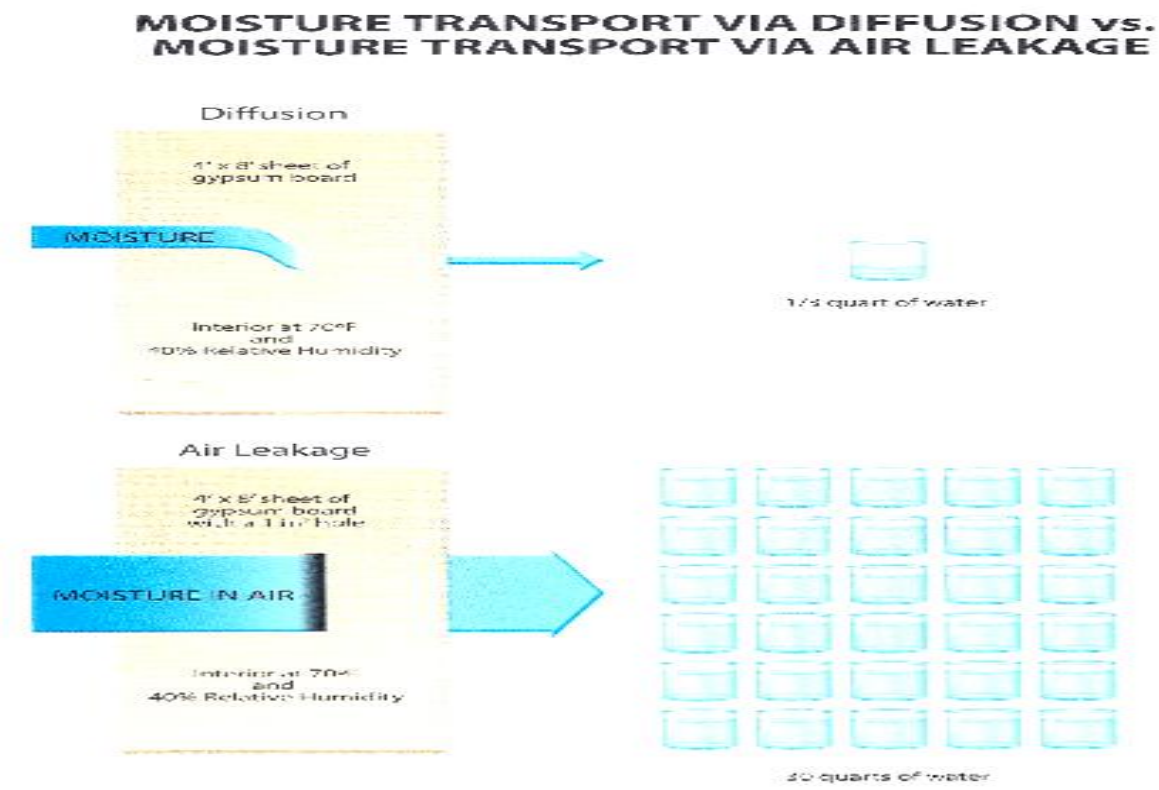
- **Airtight Construction**
- Fresh Air Ventilation
- Improved Thermal Systems
- Properly Sized, Designed, Installed, and Commissioned HVAC System
- Pressure Balanced
- Moisture Managed
- Combustion Safety

Step 1
Airtight Construction

Airtight Construction

- Is the foundation of comfort.
- Eliminates energy losses by keeping conditioned air in and unconditioned air out.
- Stops uncomfortable drafts.
- Increases comfort but requires proper HVAC sizing, design, installation, and commissioning.
- Helps with fire control.
- Helps with sound control.
- Helps with air transported moisture control.
- Helps with indoor air quality **but it can actually create issues without fresh air ventilation.**

Air transported moisture is one of our biggest concerns. 1/3 quart of water vs. 30 quarts of water.



- We must contain air before we can control it!
- We have not contained it very well in the past but the new codes are driving us in that direction.
- Containing air means we have to manage the ventilation instead of letting air leaks or luck take care of it.
- In many new homes, ventilation is not being taken care of.
- Numerous moisture, durability, comfort, and indoor air quality issues are occurring.

Air…

- Requires a hole and a driving force such as wind, the stack effect, and out of control fans.
- Always flows from high pressure to low pressure areas.
- Always seeks the path of least resistance.
- For every bit of air the exits a house, the same amount must be pulled into the house.
- Air that is pulled in often is unconditioned and comes from unintended places. It brings contaminants such as moisture, pesticides, odors, dust, insulation, radon, etc.

The 2009 IRC requires either an insulation checklist or a blower door test with 7 Air Changes per Hour (ACH) or less.

The 2012 IRC requires a blower door test at 3 ACH or less and the insulation checklist is not an option.

Refer to the 2009 International Residential Code Air Sealing Requirements Handout

Synergy
Airflow & Ventilation, LLC
We Test Others Guess.com

New Air Sealing Requirements in the International Residential Code

One of the most cost-effective ways of lowering residential energy costs is to reduce a home's air leakage rate, so it makes sense for energy codes to ratchet up air-sealing requirements. The latest (2009) version of the International Residential Code does exactly that.

Just like the earlier 2006 code, the 2009 IRC includes a requirement (in section N1102.4.1) that "the building thermal envelope shall be durably sealed to limit infiltration." The language in that section is unchanged; the code still requires that "The following shall be caulked, gasketed, weatherstripped, or otherwise sealed with an air barrier material, suitable film, or solid material:

1. All joints, seams and penetrations.
2. Site-built windows, doors and skylights.
3. Openings between window and door assemblies and their respective jambs and framing.
4. Utility penetrations.
5. Dropped ceilings or chases adjacent to the thermal envelope.
6. Knee walls.
7. Walls and ceilings separating the garage from conditioned spaces.
8. Behind tubs and showers on exterior walls.
9. Common walls between dwelling units.
10. Other sources of infiltration."

New air sealing requirements, with two compliance options

In addition to these provisions, the 2009 IRC includes further air-sealing requirements in section N1102.4.2.
This new section gives builders two options: either the builder must comply with the requirements of an air barrier and insulation inspection checklist (Table N1102.4.2), and submit to a "visual inspection," or the builder must show that "tested air leakage is less than 7ACH when tested with a blower door at a pressure of 50 pascals."

The checklist option

- Wall insulation must be "installed in substantial contact and continuous alignment with the building envelope air barrier."
- Wall corners must be insulated.
- The "space between window/door jambs and framing" must be "sealed," and "air permeable insulation" cannot be "used as a sealing material."
- Rim joists, window headers, and door headers must be insulated.
- Insulated floors such as cantilevered floors or insulated floors over garages must have insulation "installed to maintain permanent contact with the underside of the subfloor."
- There is a requirement for crawl space walls that "insulation is permanently attached to walls."
- "Showers and tubs on exterior walls" must "have insulation and an air barrier separating them from the exterior wall."
- There is a requirement for "electrical/phone box on exterior wall" requiring that the "air barrier extends behind boxes or air sealed type boxes are installed."
- "HVAC register boots that penetrate the building envelope" must be "sealed to subfloor or drywall."

The code states that the items on this list should — "where required by the code official" — be "field verified" by "an approved party independent from the installer of the insulation."

The blower-door option

If a builder chooses the blower-door option, the bar has been set quite low. While many energy-efficient builders strive for 1.5 ach50, the building code is satisfied if your home is quite leaky: All you need to show is 7 ach50.
The code is fairly specific about the circumstances of the blower door test. It requires that "testing shall occur after rough-in and after installation of penetrations of the building envelope, including penetrations for utilities, plumbing, electrical, ventilation and combustion appliances."

For more information visit http://www.synergyairflowandventilation.com/airtight-assembly.html or call Todd Witt @ (256) 616-2264

- Comfort is found in the envelope of the building.
- A thermal bypass allows air to pass through or around insulation.
- It is mandatory that the air barrier and thermal barrier be properly aligned and in full contact with one another!
- Imagine holding a blanket a couple of inches away from your skin with the wind blowing.
- Wool is a great insulator / A wind breaker is a great air barrier / Moisture wicking
- More about this is Step 3.

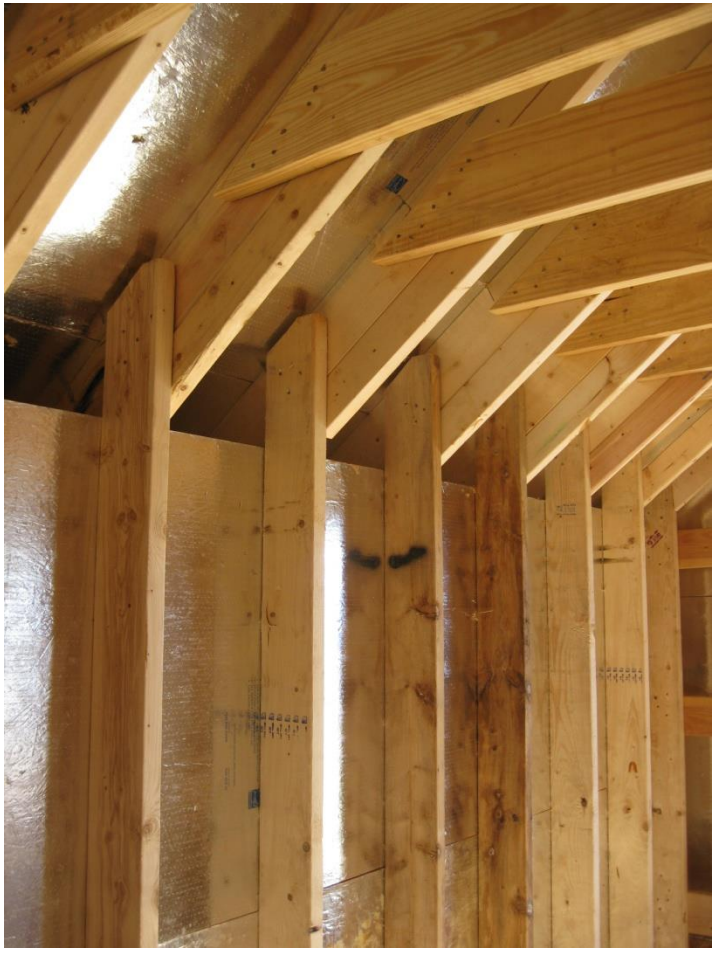
Proper framing techniques…

- Provide structural integrity in a building.
- Are the foundation of airtight construction.
- Make it easy to align the air barrier and the thermal barrier so that your insulation performs.
- Protect the insulation.
- The Devil is in the Details.

Synergy Airflow and Ventilation LLC uses visual inspections, blower door testing, and infrared imaging to help us locate air leakage areas and framing bypasses in a home.

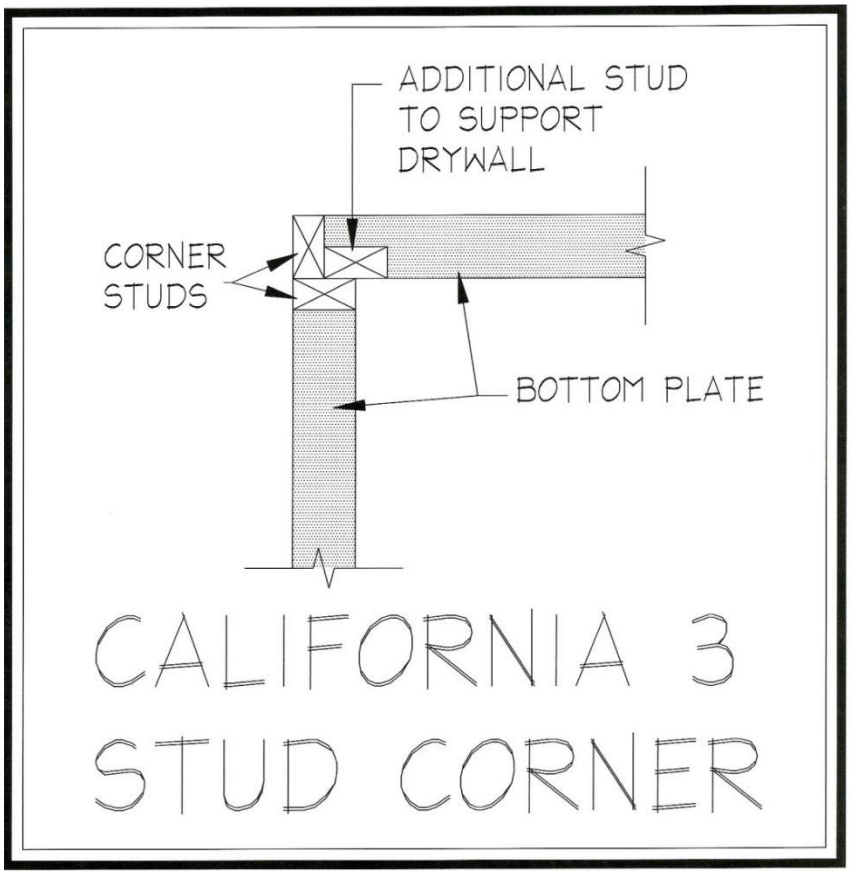
The optimal cavity has six sides!

These stud cavities need to be capped at the top. Notice that the radiant barrier is facing the wrong direction. Radiant barriers are unnecessary with properly insulated walls.



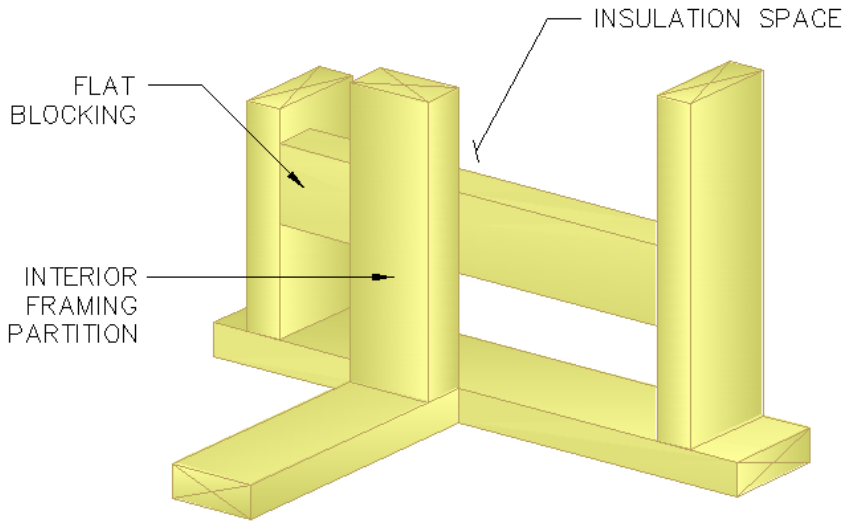
Traditional framed corners promote condensation and sheetrock issues. The R-value of wood is 1 and wherever you put wood you cannot put insulation. Notice the 4 studs. Can someone tell me why and at what cost?

California Corners require turning one of the studs so insulation can be installed.



Wood conducts heat and contracts and expands at different rates than sheetrock which leads to nail pops, cracks, and “ghost marking.” Vent free units and candles in a jar contribute to these issues.

Ladder framing T's eliminates dead spaces, allows for insulation, and uses scrap lumber. Notice the 2 x 6 framing on 24" centers. 2 x 6's are allowed by code, allow more insulation, and are generally straighter than 2 x 4's.



- The blower door and infrared camera show that traditional fiberglass batt insulation and cellulose insulation does not stop air flow. It must be in full contact with the interior air barrier or it simply works as an air filter.
- You can build an airtight home that performs well under blower door conditions without properly insulating the home.
- Be wary of “energy professionals” that blower door test without infrared imaging!
- See Step #3 for more info.

There must be an air barrier over the insulation behind the tub and shower. Otherwise, air transported moisture moves into the wall cavity and creates serious issues.

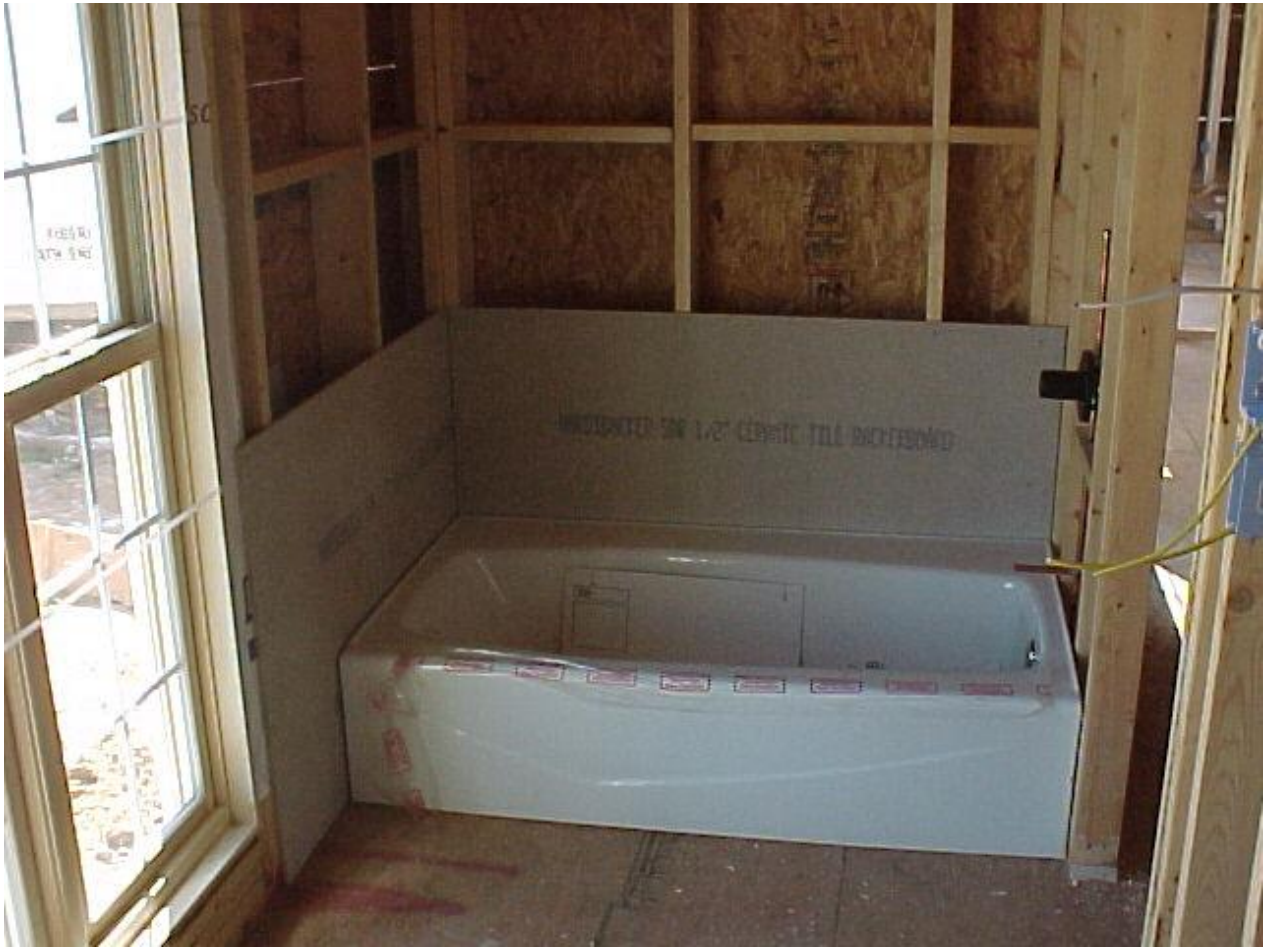
The typical installation is wrong. New processes must be adapted.

One solution is to install “Thermoply” as the air barrier over traditional fiberglass batts or cellulose and then air-seal the seams. This is rarely performed correctly in the field.

Correct

Incorrect

A cement air barrier behind the tub instead of sheetrock. Always attempt to locate plumbing on an interior wall.



Foam works as insulation and air barrier. Note that blown cellulose wall insulation is not an air barrier.

House-wrap is not an air barrier. House-wrap is a bulk moisture barrier only. Note that this is a production builder's "EnergyRight" home in Madison County.

Air-seal the plumbing penetrations. Notice the non-performing fiberglass batts stuffed in the band joists.

Fireplaces installed on exterior walls require air barriers or they will leak air for the life of the home. Cold air blowing in and around a fireplace is definitely a comfort issue.

The way fireplaces are typically insulated is not working!

This fireplace pedestal and chase requires very specific detailing unless foam is used.

These knee-walls need backing to prevent conduction through the wood framing. It also helps align the insulation with the air barrier as well as stopping airflow.

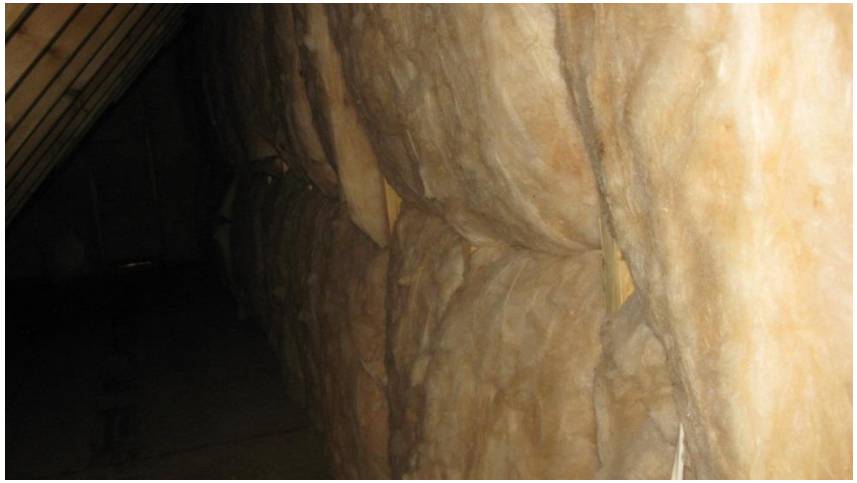
These knee-walls have proper backing. Notice the horizontal framing members below the knee-walls that provide a “6-sided” assembly.

House-wrap is not an air barrier. It especially does not work in a knee-wall assembly. Notice the 7” gap between the house-wrap and the insulation. Another “EnergyRight” certified production built home in Madison County.

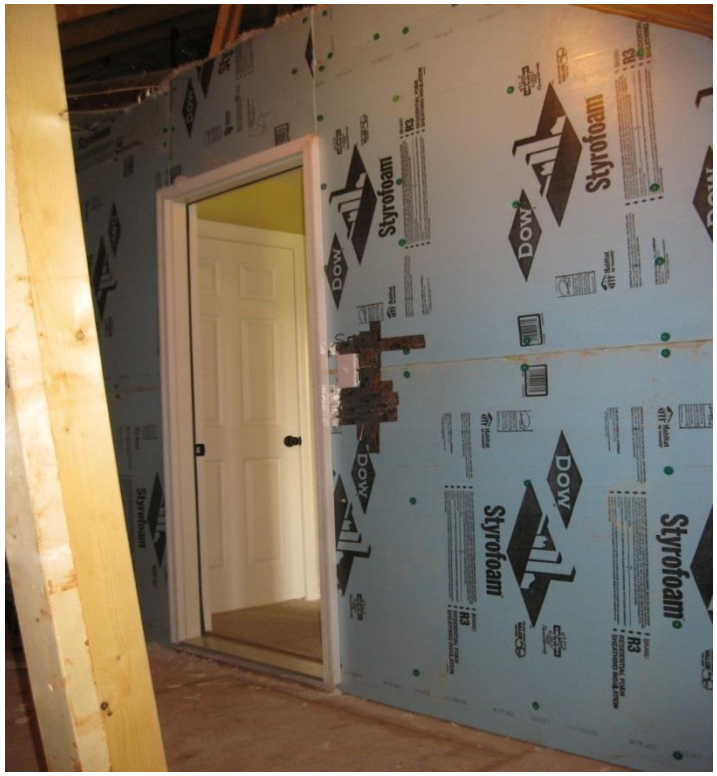
Reasons house-wrap is not an air barrier:

- All seams must be sealed.
- Top and bottom edges must be sealed.
- All the edges where it is cut around rough openings must be sealed.
- It is rarely detailed correctly on inside corners.
- Rips, tears, cuts, and unsealed edges allows air to move through it.
- It helps with infiltration but not exfiltration.
- It is a bulk moisture barrier.
- It does not stop water vapor.

These fiberglass batts look neat from the front but they are not working! The picture on the left is one of my pictures from years ago promoting our neatness. Neatness rarely matters.



Blueboard installed on the backside of walls that are open to the attic do an incredible job. We often add blueboard to kneewalls in existing homes. However, it is mandatory that you air-seal around the door jambs and seams.



Dow Structural Insulated Sheathing is a great product for exterior sheathing. It combines OSB, blueboard/pinkboard, and housewrap into a single product.

Zip systems work great!

The best option is to eliminate the need to insulate the knee-walls by encapsulating the attic and spraying the rafters with foam.

Skylights are notorious for air leakage and energy losses. Notice how the pink insulation has turned gray from filtering dust from the air. Blue-board stops conduction through the studs in addition to providing added insulation.

This band is open to the outside. It needs to be hard-decked and air sealed. A fiberglass batt will only serve as an expensive air filter.

Foam works the best for band joists/rim joists. Batts cannot be used anymore. Note that combining cellulose and fiberglass does not work.

Using cellulose in combination with fiberglass batts usually means that you think you are building efficiently but you didn't want to take the time to frame correctly and air seal correctly. I did that in almost every home I insulated up until I learned it was not working.

Adding blocking at the band joists that are open to the exterior, but how do you handle the band on the left? I can almost guarantee you that the interior trim will crack in a few years.

Good try at blocking but it is in the wrong place!

The interior of this house is connected to the garage.

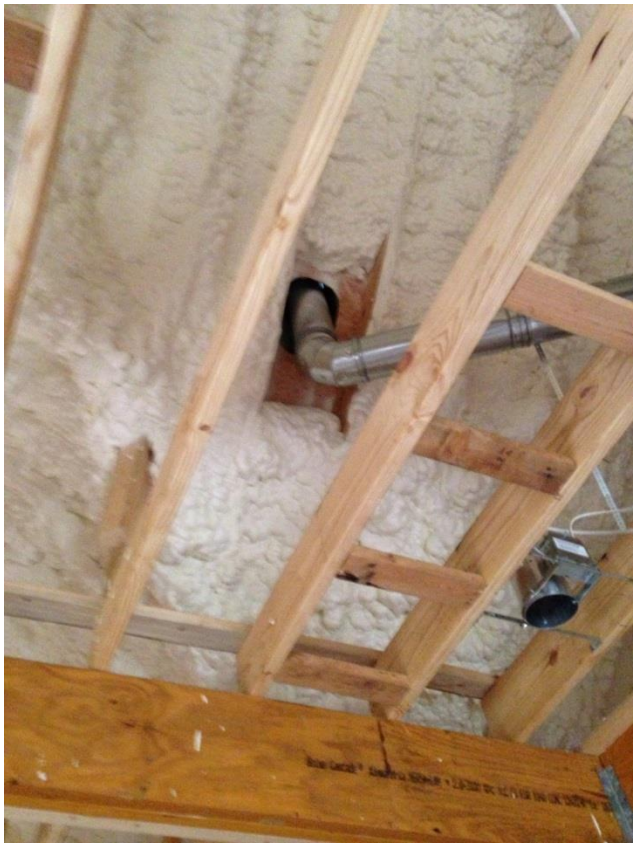
Why bother insulating at all? Turning up the ends doesn't do the job either. You need hard decking on the ends and the insulation must be in complete contact with the subfloor. Insulation supports do not work.

Foam is the perfect product for bonus room floors/garage ceilings/cantilevers.

This complicated framing system is open to the attic

Fireplace chases and shafts need to be capped. Batt insulation only serves as an expensive air filter.

How do we handle fireplace venting through spray foam encapsulated attics?



Do you spot any issues? Our infrared camera has taught us so much.

The shower unit in the previous picture is a thermal bypass. The standard insulation is not performing at all.

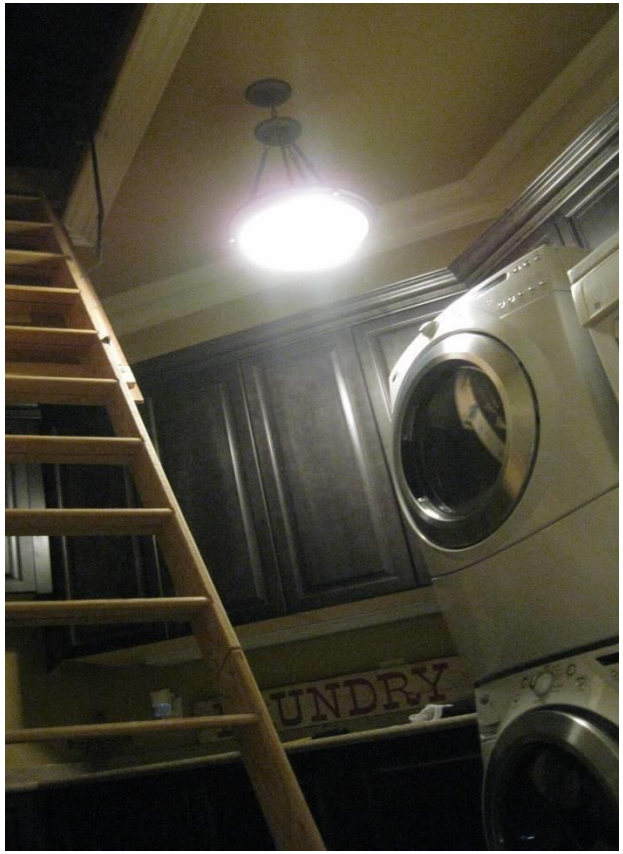
This is an interior shaft that allows attic air to circulate through interior walls. Always construct the ceiling as one continuous plane unless you are encapsulating the rafters with spray foam. You would be surprised at how often the thermostat is located on this wall.

A small bypass that happens to contain the thermostat. Hot or cold attic air short-circuits the thermostat and gives it a false reading. Notice that the thermostat on the right has been moved for this reason.

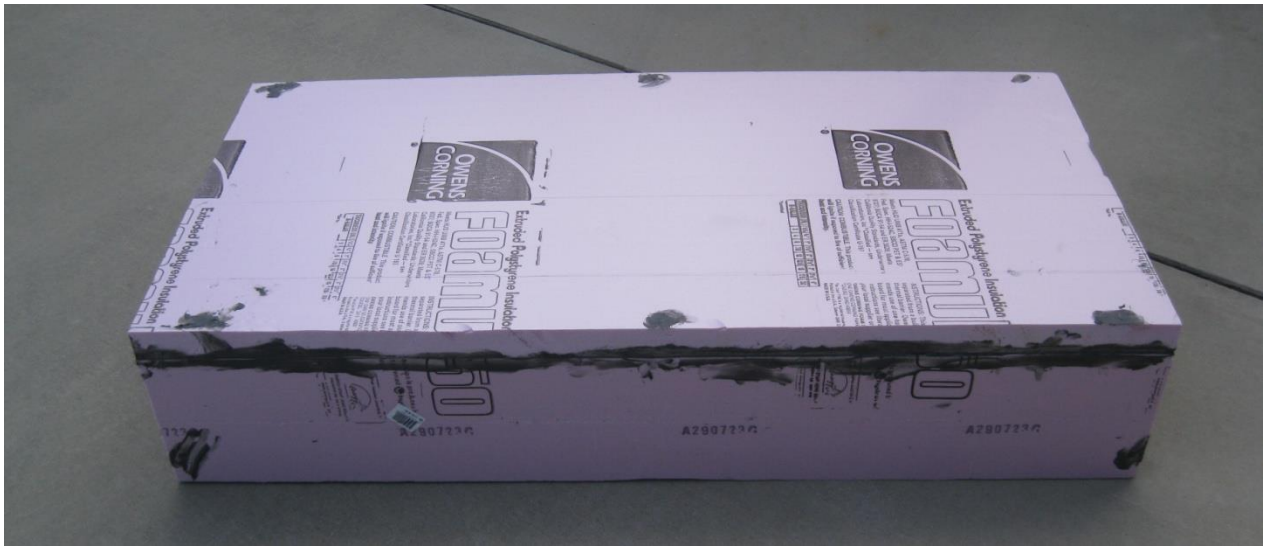
This attic access is made of cardboard. 10 square feet of un-insulated attic access turns 1000 square feet of R30 into R23. It is best to completely remove attic accesses from the conditioned space.

Motorized attic fans most often pull conditioned air out of the house instead of hot air out of the attic. If the attic is air-sealed and properly insulated, attic fans are not needed.

Note the unsealed attic accesses directly over the clothes dryer.



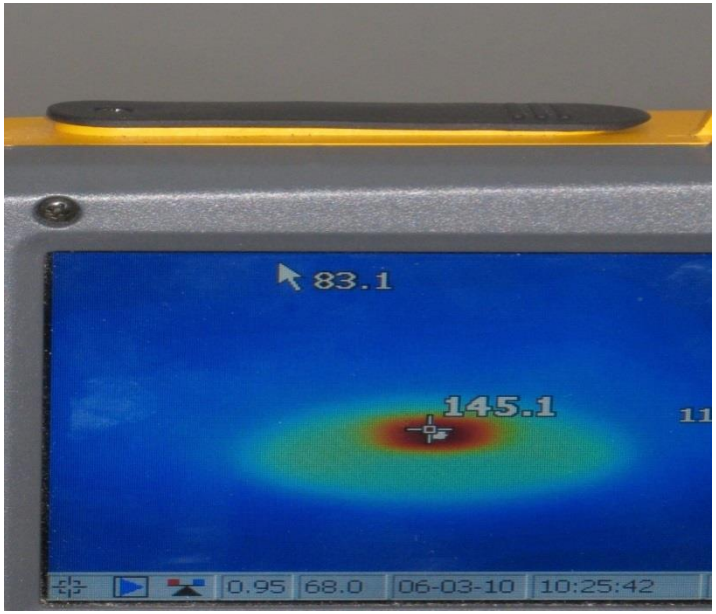
We build and install these attic access covers in existing homes. The 2009 IRC requires attic accesses to be insulated at the same levels of the attic.



We recommend encapsulating the attic with foam or removing the attic accesses from the conditioned space.

Attic access doors are rarely properly air sealed.

Recessed can lights are one of the biggest problem areas we experience. Most electricians buy the “cheap” recessed can lights from the big box retailers. Spider webs indicate air leakage.



Most air-tight rated cans are not air-tight. Notice how the white insulation has turned gray by filtering air. The insulation around the can is only a few inches thick.

We often use a smoke machine used in conjunction with the blower door to illustrate the air leakage through ceiling penetrations.

Air leaks in the ceiling in combination with interior pressure issues lead to dust, insulation, moisture, and other contaminants being pulled into the home.

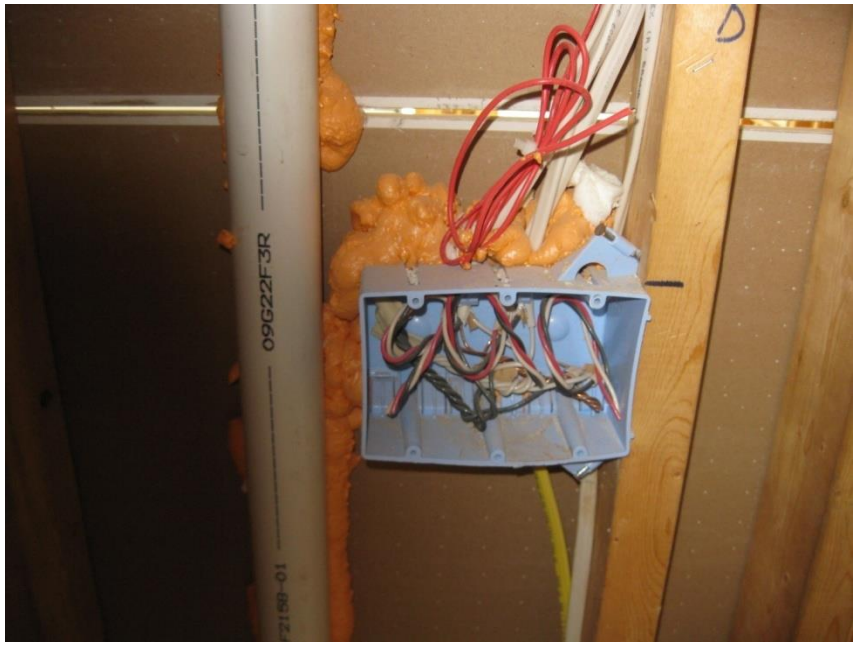
Correcting the problem costs around $35 per can and disturbs the insulation. Why not do it properly the first time?

Sheetrock penetrations must be sealed to the sheetrock. Supply duct boots and electrical outlets are common areas we deal with.

Electrical and plumbing penetrations have to be foamed properly. In this situation the rafters were foamed and it eliminated the need.

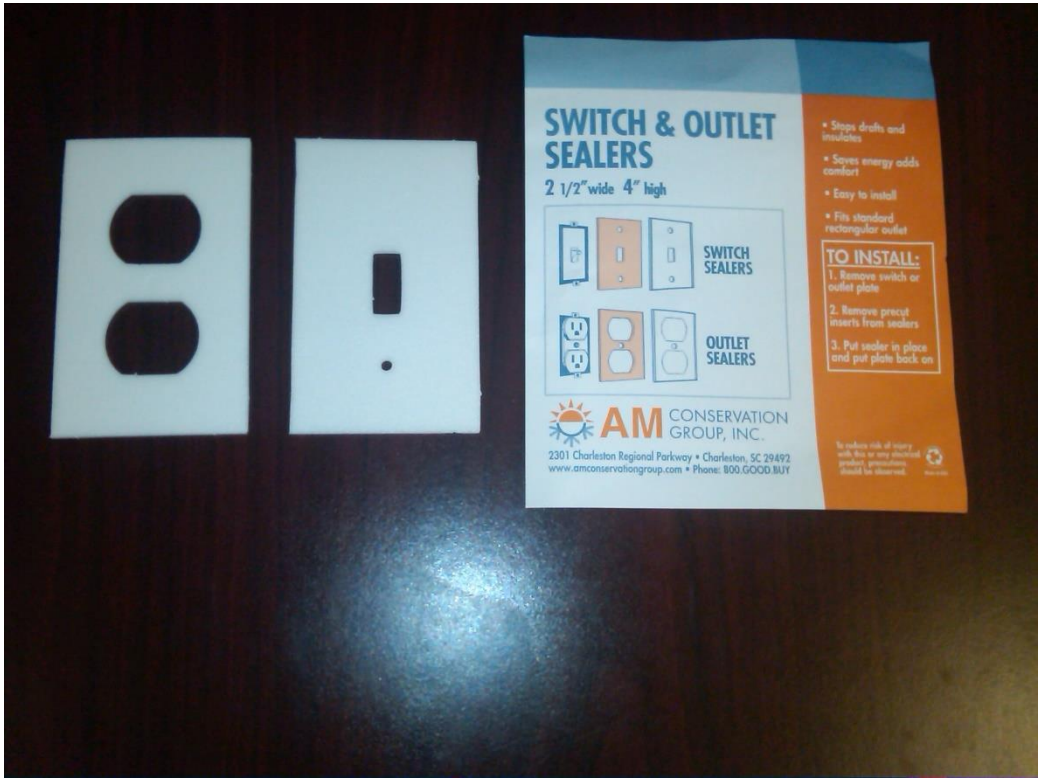
Electrical outlets are major areas of air leakage. Notice the four studs on the right.

Air-sealing with foam behind electrical outlets is mandatory with fiberglass batt insulation and blown cellulose wall insulation.

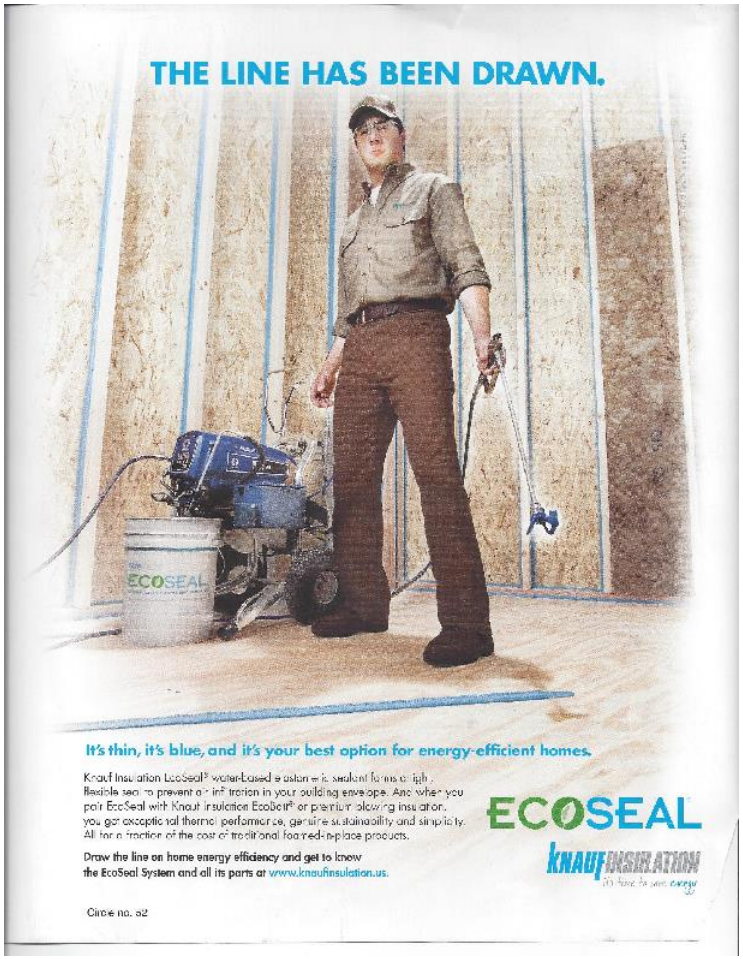


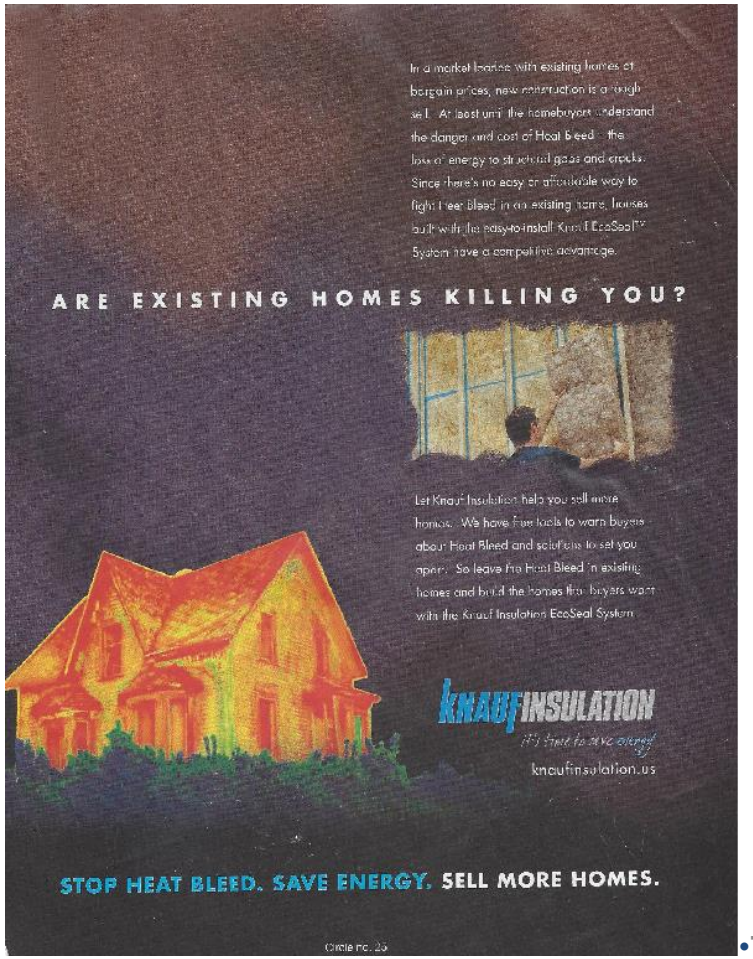
We recommend using air-tight electrical outlets as well as foaming.

The TVA Energy Right program sends out these “gems” that do not work at your expense.



Fiberglass manufacturer's are selling Ecoseal sealant because batts do not air-seal. What about the houses without it?





This column is directly connected to the attic and leaking large amounts of conditioned air out of the home. Large amounts of dust and insulation are being pulled into the home as well.

Many people believe caulk, caulk, and more caulk is the answer to air-sealing.

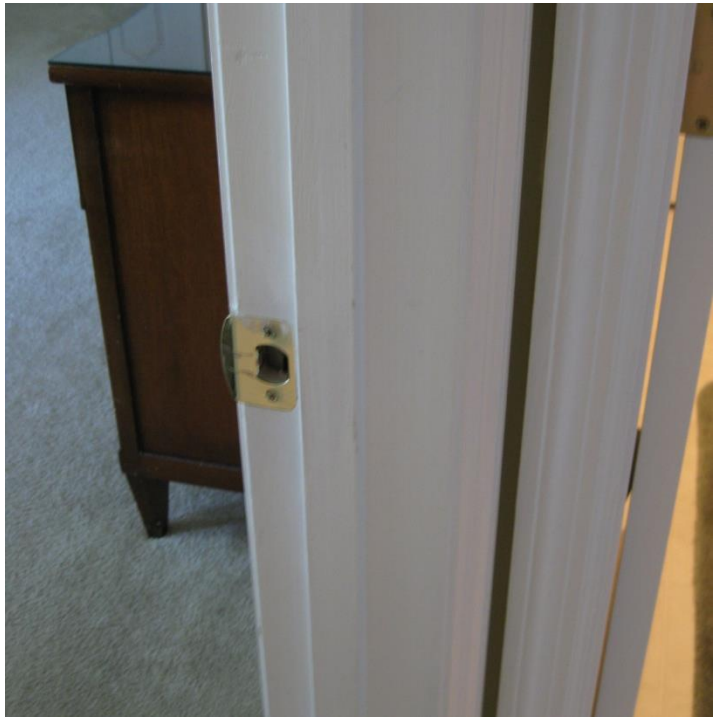
- Caulking is not the same as air-sealing.
- Caulking the exterior of the home rarely stops airflow.
- Install Dow Sill Seal foam under the sill plate of the exterior walls.
- Caulk under all sill plates on exterior walls.
- Caulk all vertical seams where studs meet.
- Caulk horizontal seams on top plates.

Seal windows, doors, and penetrations with non-expanding foam, caulk, or backer rod. Stuffing windows with fiberglass does not stop the air flow and it provides an R-Value of less than 1. It is in direct violation of the code.

Sill plate leaks allow large amounts of air leakage. We recommend Dow Sill Seal. Blower door testing on slab construction homes oftentimes pulls in large amounts of sheetrock dust.

Notice how the caulk has not formed an air-seal.

Interior door latches are major sites of air leakage in many of the homes we test. Improper air-sealing, depressurization due to the lack of fresh air ventilation, and interior pressure issues caused by improper HVAC design, installation, and commissioning compound the problem.



Almost every double door we test has significant leakage.

The Stack Effect

- Hot air rises and escapes through ceiling penetrations such as recessed can lights, pull-down stairs, etc…..
- Bad air is pulled in from low areas below the neutral pressure plane.
- With air-sealing, always start at the top, and work your way down.
- Use air-tight IC rated recessed cans.
- Seal every sheetrock penetration.
- The stack effect is affected by the height of the ceilings and the temperature difference between the interior and the exterior.

Many houses have multiple unsealed ceiling penetrations.

Many people are overly concerned with radiant barriers while neglecting basic air sealing around windows and doors. Radiant barriers provide only marginal return on investment.

If windows and/or doors are installed after the house has been air-sealed and insulated, make sure they are properly air-sealed with minimal expanding foam. This entrance door from the garage will more than likely be left unsealed.

Blower door testing, infrared testing, and commissioning of the home should be performed upon completion of the home.

We oftentimes test homes and find fatal flaws that can easily be corrected that would have otherwise go undetected.

www.WeTestOthersGuess.com