EnergyLogic
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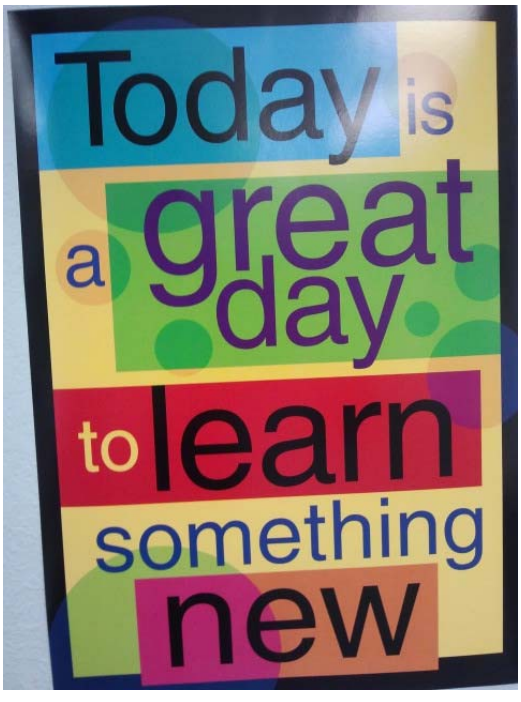
RESNET 2013 CONFERENCE
February 27 - March 1, 2013
Orlando, FL

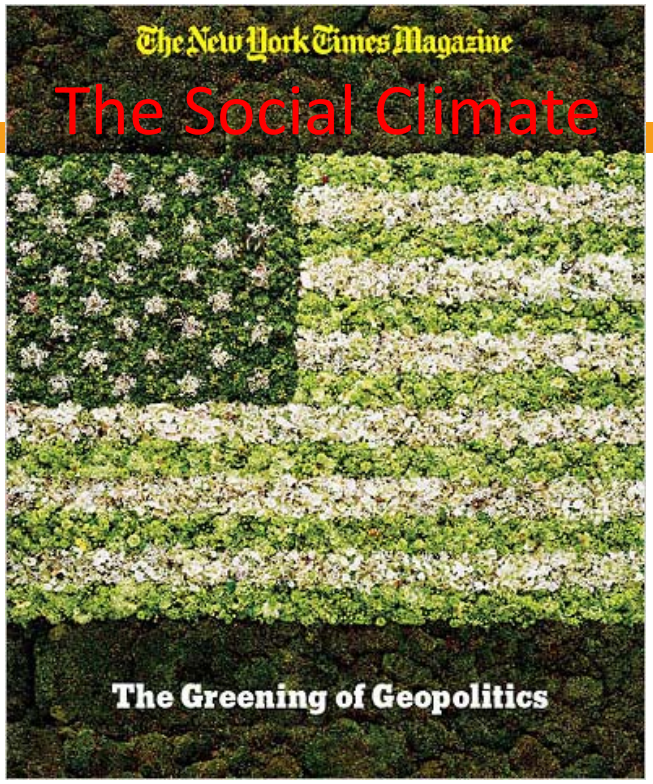
DO BUILDING CODES REALLY INCORPORATE BUILDING SCIENCE?

How can a Rater use the code to advance business?

Today



- Focus on the IECC with references to the IRC
- Back ground
- Flexibility
- Pathways
- We are Raters Right
- Building Science in the Code


The New York Times Magazine
The Social Climate
The Greening of Geopolitics


TIME
Style&Design
THE GREEN DESIGN 100
sexy green
BRAIN SEX
4 tips for permanent glow
Fashion Focus
EcoDiva's spotlight
GET GORGEOUS
10 SUPER SEXY body treatments
Preservation
THE GREEN ISSUE
PLUS PRESIDENT LINCOLN'S COTTAGE OPENS TO THE PUBLIC
VANITY FAIR
THE CASE FOR WHITE HOUSE WAR CRIMES
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MADONNA
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A BOOMER MUSIC QUIZ
Newsweek
The New Greening Of America
From Politics to Lifestyle, Why Saving The Environment Is Suddenly Hot
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ELLE
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ECO-CHIC HEATS UP
GreenCraft magazine
JUNK MAIL GETS A MAKEOVER
75+ STYLISH & SUSTAINABLE PROJECTS
REGISTER WITH EMILY ANDERSON
GREEN LINGERIE
SYDNEY
THE GREEN CITY GUIDE WITH THE POLKA DOT BRIDE!
PROJECT RUNWAY'S
NATIONAL GEOGRAPHIC
THE END OF CHEAP Oil
INSIDE THE MINDS OF IRAQ'S SHIITES
SPRAWL ON THE MALL?
VAMPIRE SQUID, FANGTOOTH FISH, AND OTHER SEA ODDITIES

Upsala Glacier, Argentina

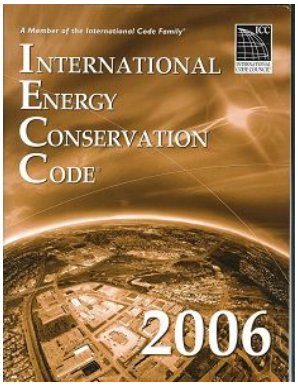
1928

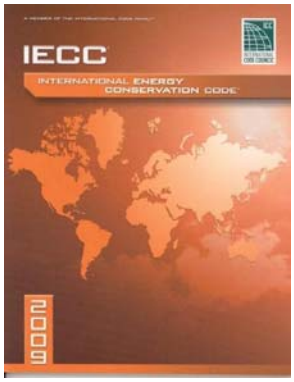
2004

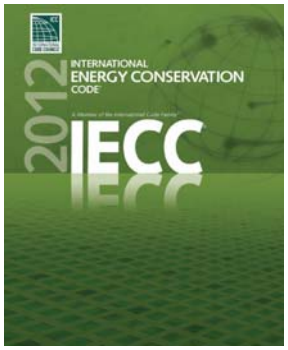
Source: Time magazine April, 2006

Focus on Housing

Today's Code(s)

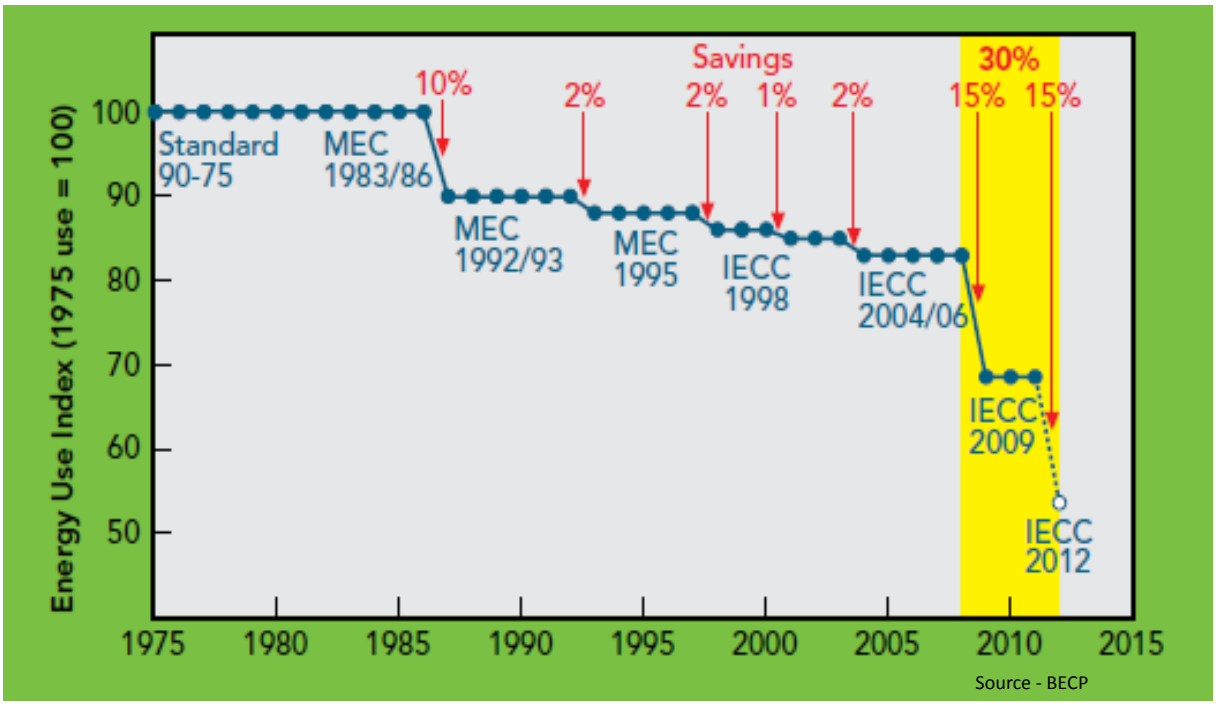


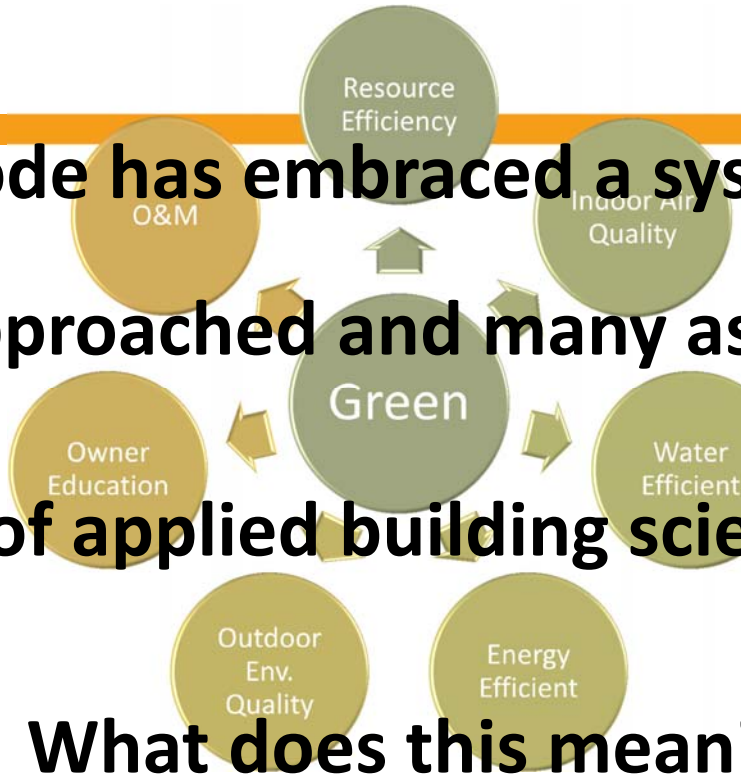




- 2006 IECC
- 2009 IECC
- 2012 IECC

Residential Energy Code Efficiency Improvements





Code has embraced a systems approached and many aspects of applied building science

What does this mean??

What is Building Science?

- Physics
- Heat
  - Conduction
  - Convection
  - Radiation
- Air
  - Wind
  - Stack Effect
  - Mechanical Fans
- Moisture
  - Bulk
  - Capillarity
  - Diffusion
  - Infiltration

- Also
- Components
  - Installation
  - Integration (e.g., flashing tied to drainage plane)
- Performance / Diagnostic Tools
  - Blower door
  - Duct pressure
  - Other HVAC

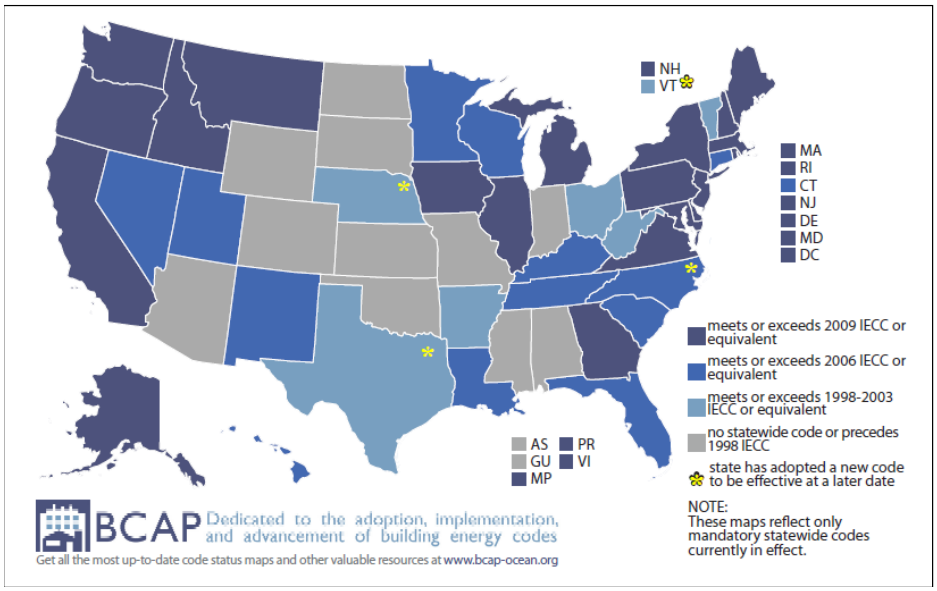
- Comfort
  - Temperature
  - Surfaces
  - Humidity
  - Airflow
- Ventilation
  - Exhaust
  - Balanced
  - Positive
- Home Operation
  - Setback
  - Base load
  - Peak load

The Code

- Does the energy code require that the house works?

Status of State Energy Codes

- Adoption
- Enforcement



Understand

- We are no longer true “builders”
- Understand building science and how things perform
- Leaders of change and innovation
  - Design – construct – test – review – learn
- Educate our trade partners
  - Systems thinking and applied building science
  - **Air flow**
  - **Thermal flow**
  - **Vapor flow**
- Inform the trades of our objectives

Codes and Applied Building Science

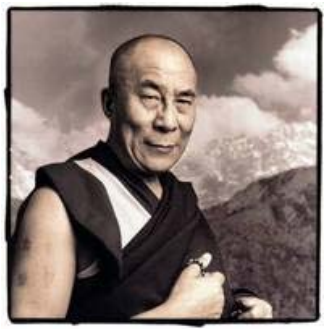
Systems Thinking:

Synergy

- **Two or more things working together to achieve something they could not achieve alone**
- Look for the impact
- Logic of the process

"Learn the rules so you know how to break them properly"

- Author: Dalai Lama
  Date: Feb 25, 2008



Intent of the 2012 IECC R101.3

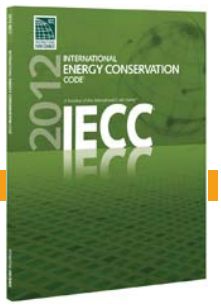
- This code shall regulate the design and construction of buildings for the effective use and conservation of energy over the useful life of each building
- This code is intended to provide flexibility
  - To permit the use of innovative approaches and techniques
- This code is not intended to:
  - Abridge safety, health or environmental requirements

Code Language?

- **R401.2 Compliance.**
  - Projects shall comply with Sections identified as "**mandatory**" and with either sections identified as "**prescriptive**" or the performance approach in Section R405.

- Path ways for code compliance
  - Prescriptive
    - R-Value or U-value equivalent
  - Total UA trade off alternative - ResCheck
  - Simulated performance path – Energy modeling

Mandatory Requirements of the 2012 IECC For all Compliance Paths



Construction Documents – what are they?

- Per the IRC Construction documents are:

"Written, graphic and pictorial documents prepared or assembled for describing the design, location, and physical characteristics if the elements of a project necessary for obtaining a building permit. Construction drawings shall be drawn to an appropriate scale."

- Plan set created by a Design Professional Architect and Engineer

2012 IECC 103.2 Information on construction documents includes but not limited to:

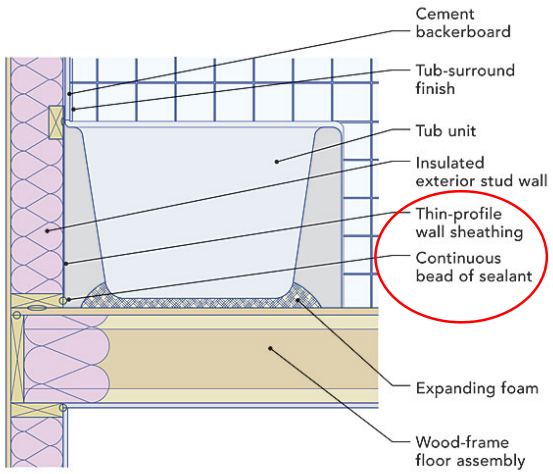
- Insulation location and R-values
- Window U-value & SHGC
- Mechanical System design criteria
  - HVAC, Water heating, Controls, Duct sealing and insulation, Lighting and wiring

New information

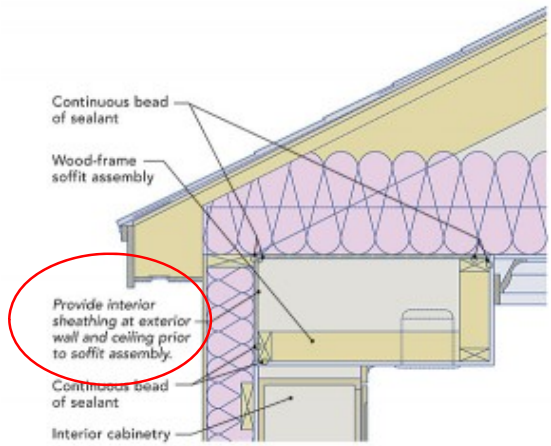
- AIR SEALING DETAILS

Example Details

Tub Air Barrier



Drop Ceiling Air Barrier



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 and building envelope leakage testing
  - Types and efficiencies of heating, cooling and service water heating equipment.

2012 Prescriptive R-value Table Compliance Specification

Declare to the Code official that the pathway for compliance is the prescriptive path

TABLE R402.1.1
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

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

For SI: 1 foot = 304.8 mm.

a. *R*-values are minimums. *U*-factors and SHGC are maximums. When insulation is installed in a cavity which is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall not be less than the *R*-value specified in the table.

b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration. Exception: Skylights may be excluded from glazed fenestration SHGC requirements in Climate Zones 1 through 3 where the SHGC for such skylights does not exceed 0.30.

c. "15/19" means R-15 continuous insulation on the interior or exterior of the home or R-19 cavity insulation at the interior of the basement wall. "15/19" shall be permitted to be met with R-13 cavity insulation on the interior of the basement wall plus R-5 continuous insulation on the interior or exterior of the home. "10/13" means R-10 continuous insulation on the interior or exterior of the home or R-13 cavity insulation at the interior of the basement wall.

d. R-5 shall be added to the required slab edge *R*-values for heated slabs. Insulation depth shall be the depth of the footing or 2 feet, whichever is less in Climate Zones 1 through 3 for heated slabs.

e. There are no SHGC requirements in the Marine Zone.

f. Basement wall insulation is not required in warm-humid locations as defined by Figure R301.1 and Table R301.1.

g. Or insulation sufficient to fill the framing cavity, R-19 minimum.

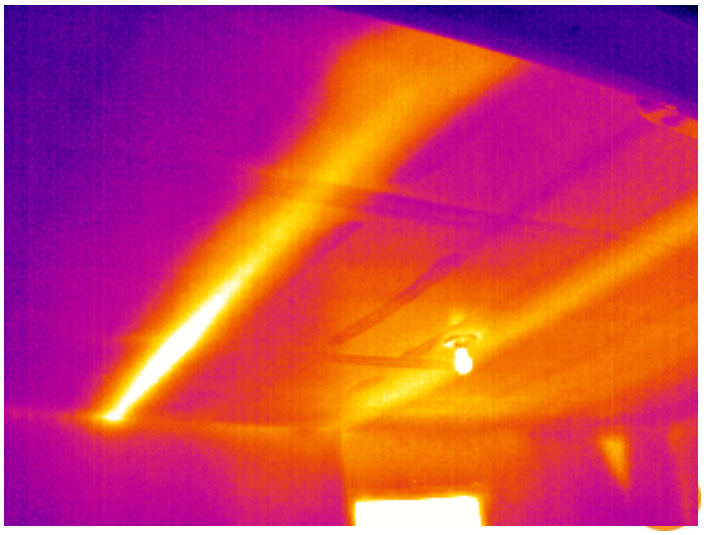
h. First value is cavity insulation, second is continuous insulation or insulated siding, so "13+5" means R-13 cavity insulation plus R-5 continuous insulation or insulated siding. If structural sheathing covers 40 percent or less of the exterior, continuous insulation *R*-value shall be permitted to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

i. The second *R*-value applies when more than half the insulation is on the interior of the mass wall.

Ducts in Garage Ceiling

Old Installation methods

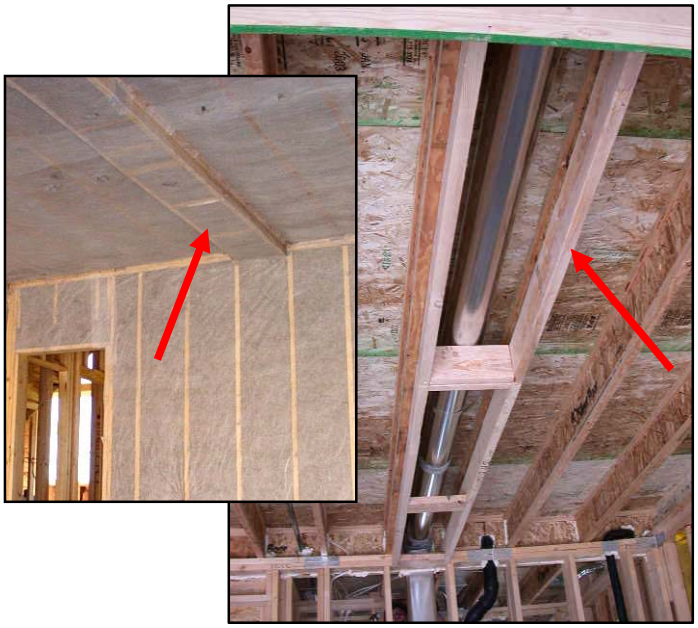
What about obstructions in the floor system



Ducts in Garage Ceiling

Code requirements

- Insulation in complete contact with subfloor
- Insulation encapsulates duct
- IECC Table 402.1.1, footnote G
- **Minimum R-19 below duct**



R402.1.3 U-factor alternative

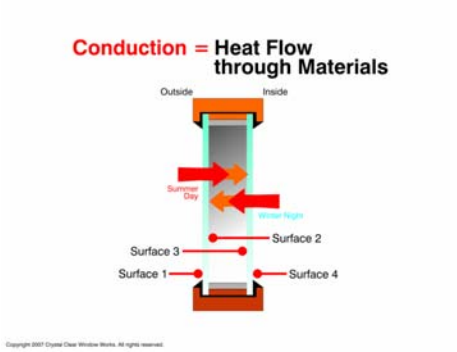
TABLE R402.1.3
EQUIVALENT *U*-FACTORS[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR	SKYLIGHT *U*-FACTOR	CEILING *U*-FACTOR	FRAME WALL *U*-FACTOR	MASS WALL *U*-FACTOR[b]	FLOOR *U*-FACTOR	BASEMENT WALL *U*-FACTOR	CRAWL SPACE WALL *U*-FACTOR
1	0.50	0.75	0.035	0.082	0.197	0.064	0.360	0.477
2	0.40	0.65	0.030	0.082	0.165	0.064	0.360	0.477
3	0.35	0.55	0.030	0.057	0.098	0.047	0.091[c]	0.136
4 except Marine	0.35	0.55	0.026	0.057	0.098	0.047	0.059	0.065
5 and Marine 4	0.32	0.55	0.026	0.057	0.082	0.033	0.050	0.055
6	0.32	0.55	0.026	0.048	0.060	0.033	0.050	0.055
7 and 8	0.32	0.55	0.026	0.048	0.057	0.028	0.050	0.055

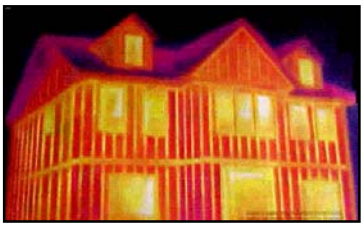
- **<u>An assembly</u>** with a U-factor equal to or less than that specified in Table R402.1.3 shall be permitted as an alternative to the R-value in Table R402.1.1.
- Example: Climate zone 5 framed wall
  - U-.057 = R-17.54
  - R-value table requires cavity insulation at R20 or 13+5
  - 1/20 = U-.05

R402.1.4 Total UA alternative

- A method for performing conductive energy trade offs
  - Trading off the R-values and U-values of the thermal envelope
  - Mathematically making the R-value and U-value paths equal



- If the total building thermal envelope UA (sum of U-factor times assembly area) is less than or equal to the total UA resulting from using the U-factors in Table R402.1.3 (multiplied by the same assembly area as in the proposed building), the building shall be considered in compliance with Table R402.1.1. The US calculation shall include the thermal bridging effects of framing materials.



What is a Reference Design

- **Reference Design**
  - **A standard set of house specifications that generate a specific level of quantifiable energy performance**
- The concept that Code uses to show compliance with the UA Trade Off (ResCheck) and the Simulated Performance Path

The <u>Actual built</u> homes performance will be less than or equal to the performance of the code standard reference design

The Standard reference design for code is the prescriptive path of compliance built in Table 402.1.3

Twin Houses

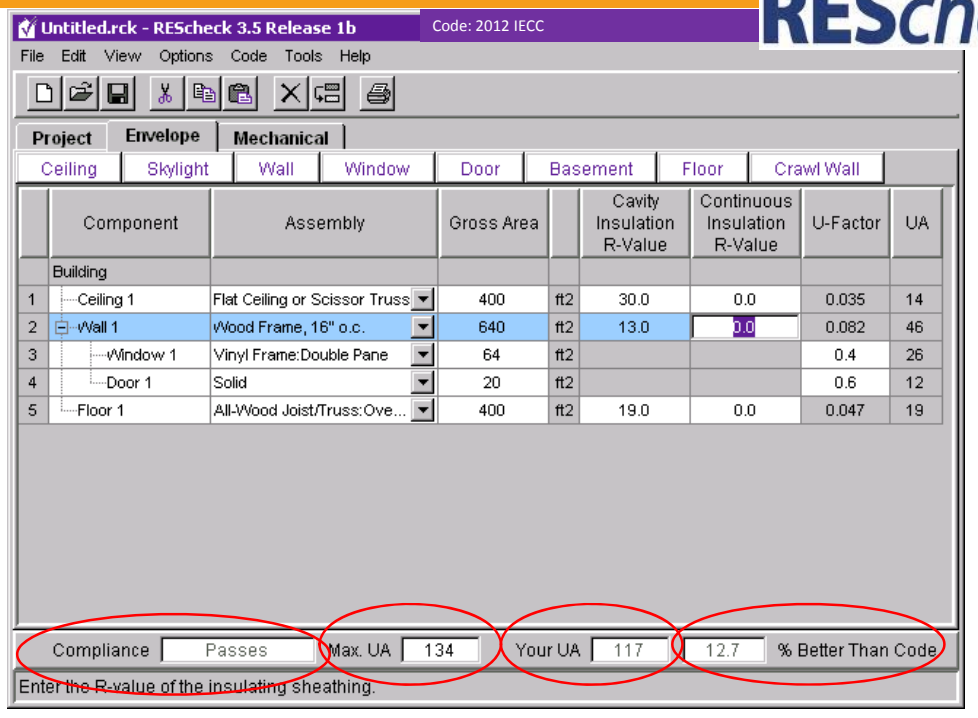
2012 IECC reference design house **vs.** **Builder's desired house**

- Geometric Twin
- 2012 IECC prescriptive envelope U-Values in (Table 402.1.3)

- Geometric Twin
- Envelope U-Values based on Builder's Specification

If the Builder's house has the same or lower area weighted U-values then it meets the intent of code

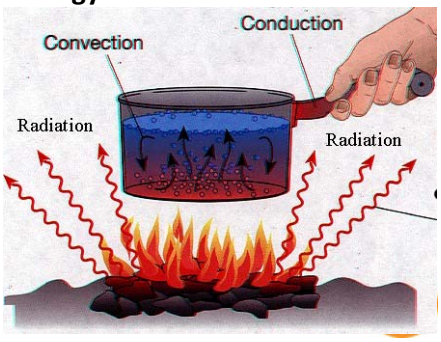
Example



R405.3 Performance-based compliance

- Energy Analysis
  - A method for performing whole house performance energy trade offs
    - **Conduction** - Trading off R-values and U-values
    - Convection – Energy moving with air infiltration and exfiltration
    - **Radiation** – Trade offs created by energy moving form areas of high concentrations to low concentration through open space.

Energy moves from warm to cold



The Reference Home/Twin Home Concept Used by **modeling software for Code**

2012 reference design house Built from table 405.5.2(1)

vs.

Rated Home: Builders desired house

- The reference home is the **geometric twin** of the rated home ***configured to a standard set of thermal performance characteristics***:
- I.e. The 2012 IECC Prescriptive path

- The home you are building and evaluating, compared to the "Reference" home in order to quantify performance and demonstrate compliance with the Energy code.

Energy Costs?

- **405.3 Performance-based compliance.** Compliance based on simulated energy performance requires that a proposed residence (proposed design) be shown to have an **annual energy cost** that is less than or equal to the annual energy cost of the standard reference design.

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2012 IECC ANNUAL ENERGY COST COMPLIANCE

Date: February 01, 2012 Rating No.: 16805

This home MEETS the annual energy cost requirements and verifications of Section 405 of the 2012 International Energy Conservation Code based on a climate zone of 5B. In fact, this home surpasses the requirements by 14.4%.

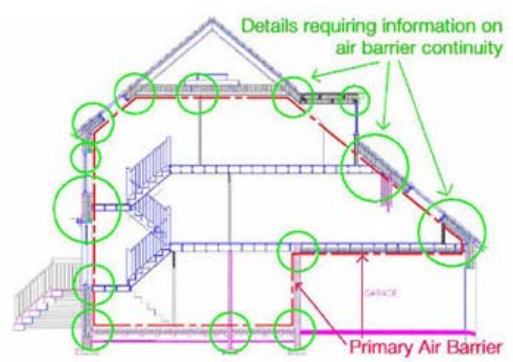
Duct Leakage (Section 403.2.2): PASSES

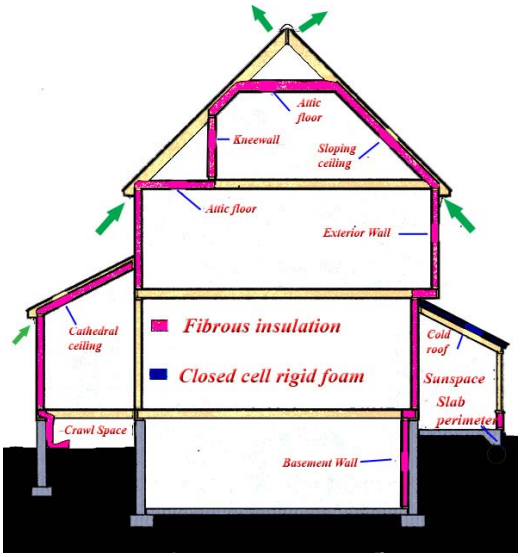
This home MEETS the annual energy cost requirements and verifications of Section 405 of the 2012 International Energy Conservation Code based on a climate zone of 5B. In fact, this home surpasses the requirements by 14.4%.

Name: Robby Schwarz Signature:

Organization: EnergyLogic Inc. Date: February 01, 2012

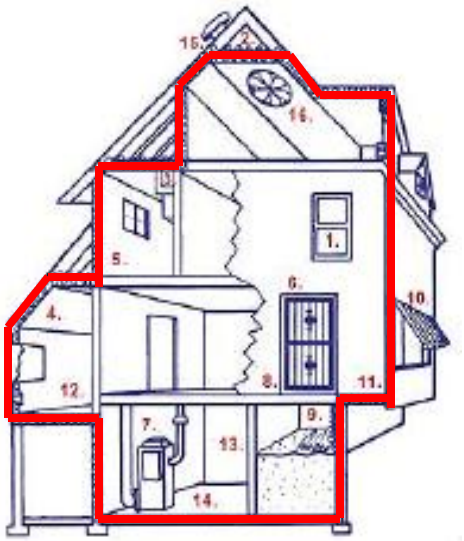
Codes Focus on the Thermal Envelope





What is the Thermal Envelope?

- Air barrier and thermal barrier alignment
  - Throughout the house to define the conditioned space
- Code Says:
  - Continuous Air barrier
  - Air-permeable insulation is not used as a sealing material
  - Interior or exterior air barrier?
    - Code vs. best practice
- Control
  - **Air Flow**
  - **Moisture Flow**
  - **Thermal Flow**



R402.4 Air leakage (Mandatory 2 Step Process)

R402.4.1.1 Installation

- 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 the Table
- Where required by the code official, an approved third party shall inspect all components and verify compliance

R402.4.1.2 Testing

- The building shall be tested and verified as having an air leakage rate of:
  - 5 ACH@50 in Climate Zones 1 and 2
  - 3 ACH50 in Climate Zones 3 through 8
  - Requirement of a written report

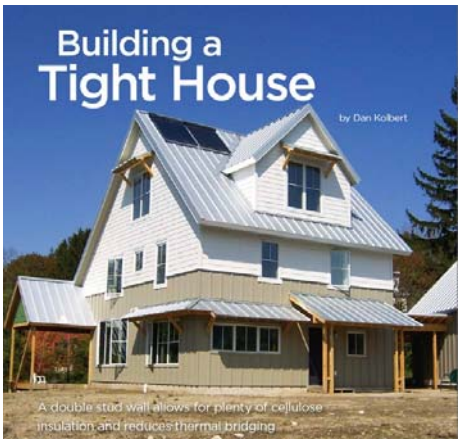
TABLE R402.4.1.1
AIR BARRIER AND INSULATION INSTALLATION

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

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?

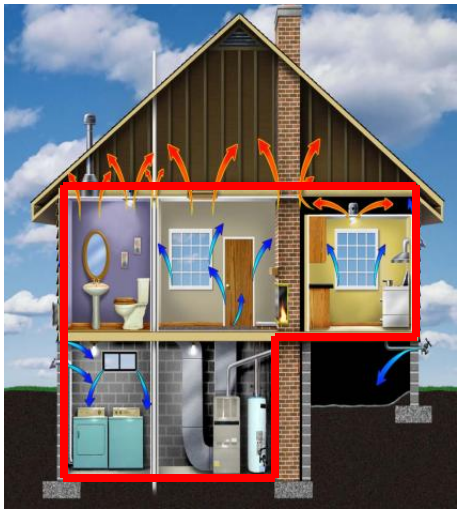
YES!

Build Tight and Ventilate Right

Why Is Air Movement a Problem?

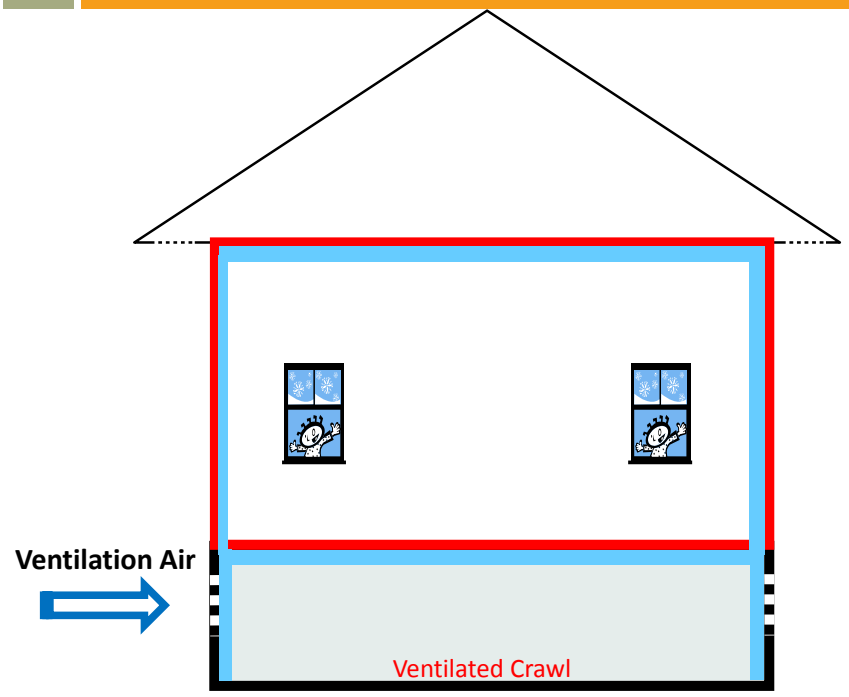
Air is an effective transport mechanism!

- Moisture / energy / pollutants
- Issues for the code?
  - Energy
  - Moisture
  - Ventilation
- Predictability and Control



Air In = Air Out / Air Out = Air In

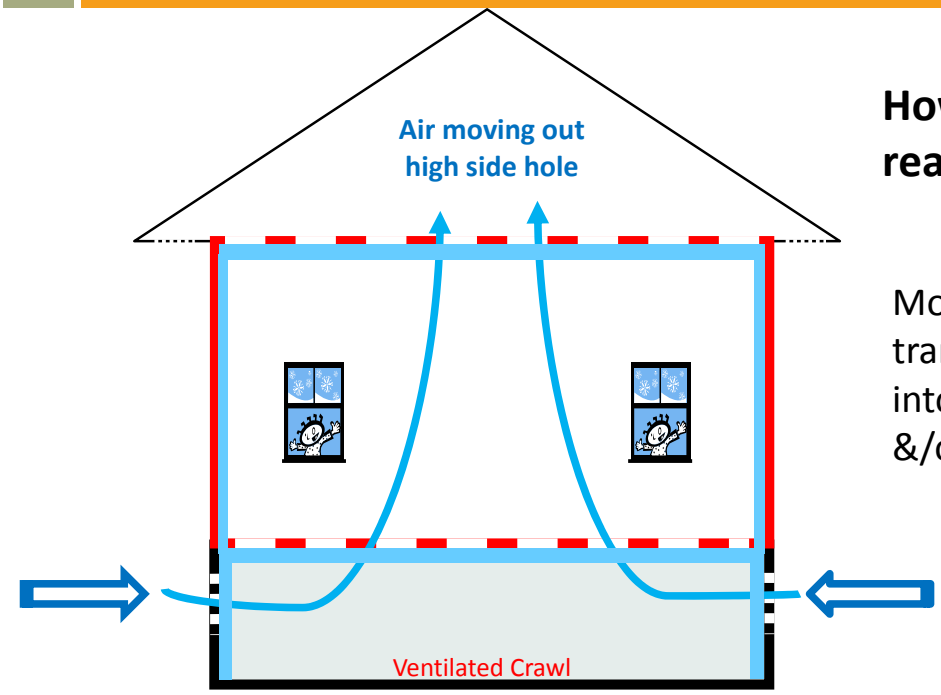
Vented Crawl Space



How the code thought it worked

Moisture removed from house

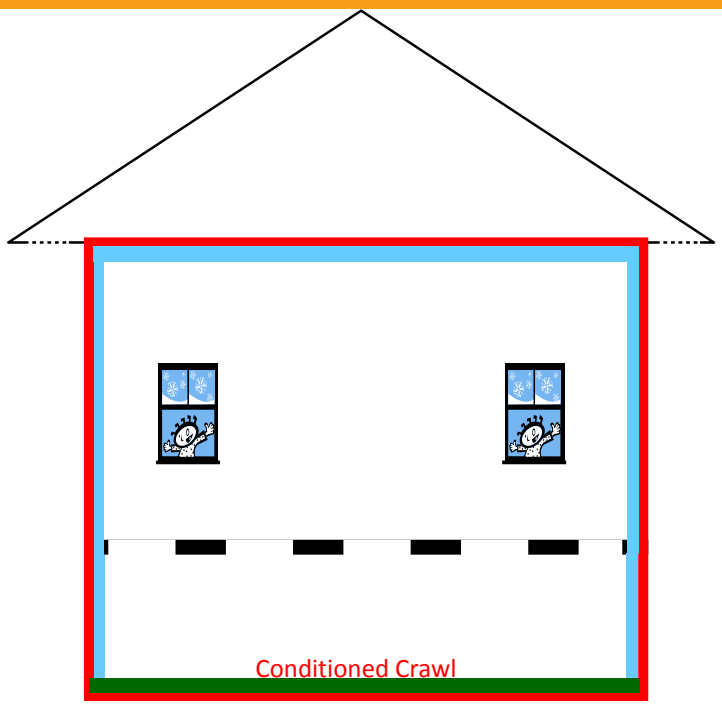
Vented Crawl Space



How it really works

Moisture transported into house &/or attic

Conditioned Crawl Space



A building science solution

- Moisture controlled at sourced
- Thermal envelope defined
- Connection between crawl and house OK
- Short basement

Vapor + Air

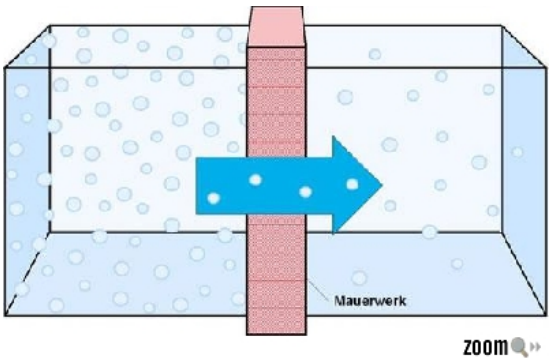
- Air = transport mechanism
- Vapor travels with air
- Move air, move moisture
- Summary
  - Hole / driving forces
  - If one or the other is missing, no flow
  - Equilibrium: No air in, No air out

Control the air by building tight!

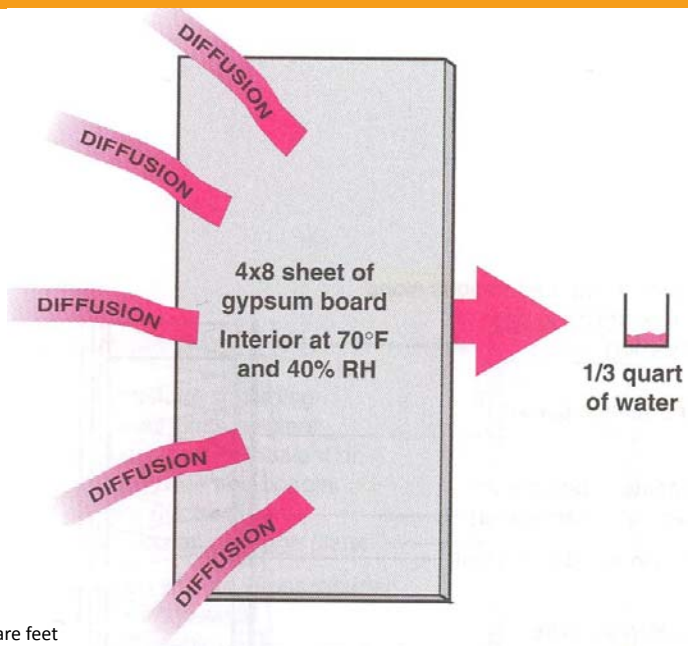
Vapor Flow

Traditional Code Focus: **Vapor Diffusion**

- Moisture moving directly through a material
  - From More to Less
  - Vapor pressure pushes water at a microscopic level through a material
- Function of
  - Temperature
  - Relative humidity



Vapor Diffusion a Slow Small Process

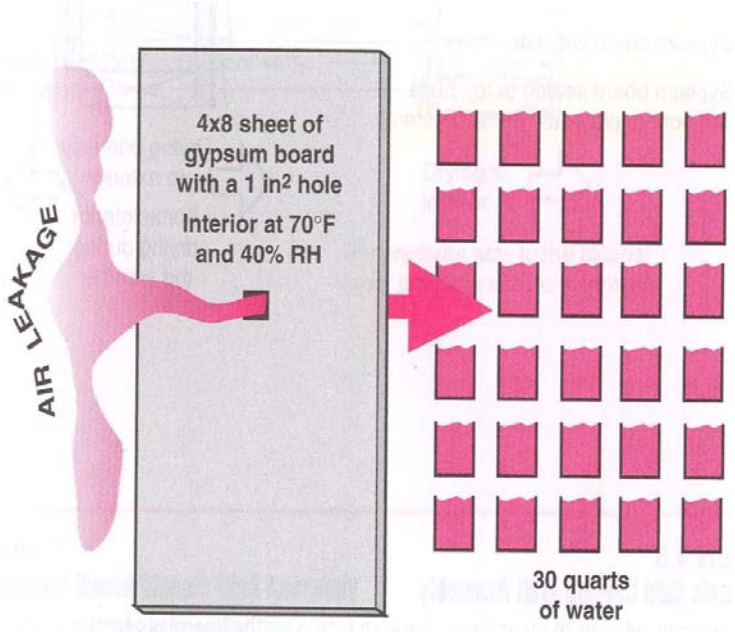


32 Square feet

From EEBA Builder's Guide to Cold Climates by Joseph Lstiburek

The Problem with Air - the 4 M's

- Much
- More
- Moisture
- Movement



32 Square feet

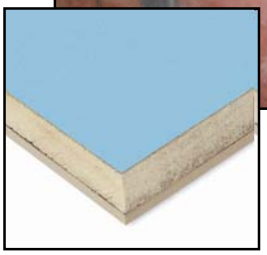
From EEBA Builder's Guide to Cold Climates by Joseph Lstiburek

Vapor Barrier and/or Air Barrier

- Vapor barrier
  - Slows the migration of water via vapor diffusion
  - Water vapor pressure (more to less)
- Air barrier
  - Stops air movement across a pressure plane (high pressure to low)
- Moisture moves both by **diffusion** and **with air**

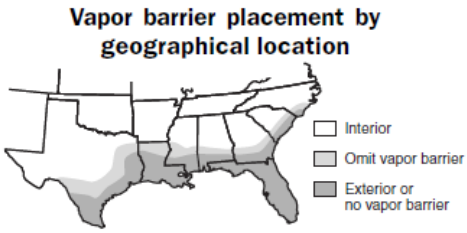
Vapor Barrier/Air Barrier Challenges

- Challenges
  - Vapor barriers can be air barriers
    - Rarely installed well
    - How will the assembly dry?
  - Air barriers can be vapor barriers
    - Not for the process of diffusion
    - Material selection is important
- Impermeable exterior sheathing
  - OSB – more and more glues
  - Extruded polystyrene (XPS)
  - Structural Insulated Sheathing (SIS)
  - Foil-faced polyisocyanurate
- **Buildings get wet – How will they dry?**



A code too far…

- Early codes pushed vapor barriers way too far south



Vapor Barriers & the 2012 IECC

First, it is no longer there, you must go to IRC

- R702.7 Vapor Retarders: Class l or ll vapor retarders are required on the interior side of frame walls in Zones 5,6,7,8, and Marine 4.
  - Exceptions
    - Basement walls
    - Below grade portion of any wall
    - Construction where moisture or its freezing will not damage the materials
  - R702.7.1 Class lll vapor retarders:
    - Class lll vapor retarders shall be permitted where any one of the conditions in table R702.7.1 is met.
- R702.7.2 Material Vapor Retarder Class:
  - Class l: sheet polyethylene , umperforated aluminum foil
    - 0.1 perm or less
  - Class ll: Kraft-faced fiberglass batt
    - 1 perm or less and greater than 0.1 perm
  - Class lll: Latex or enamel paint
    - 10 perm or less and greater than 1.0 perm

IRC 702.7.3 Minimum Clear Air Space and Vented Opening for Vented Cladding

- For the purposes of this section, vented cladding shall **include** the following minimum clear air spaces
- Other opening with the equivalent vent area shall be permitted
  - Vinyl lap or horizontal aluminum siding applied over weather restive barrier
  - Brick Veneer with a clear airspace
  - **Other approved vented claddings**

The Drainage Plane

Common drainage plane materials

- Is a drainage plane surface enough in our climate?
  - Felt paper
  - House wraps
  - Foam sheathing
- Do we need a designed air gap?
  - Home slicker
  - Furring strips
- Does lap siding have enough of an air gap for our climate?

Predictability & Control

Build Tight

Ventilate

Right

R403.5 Mechanical ventilation (Mandatory)

- The building shall be provided with ventilation that meets the requirements of the International Residential Code or International Mechanical Code
- Outdoor air intakes and exhausts shall have automatic or gravity dampers that close when the ventilation system is not operating

R403.5.1 Whole-house mechanical ventilation system fan efficacy

- Mechanical ventilation system fans shall meet the efficacy requirements of Table R403.5.1. (**Efficient fans needed**)
- Exception: Where mechanical ventilation fans are integral to tested and listed HVAC equipment, they shall be powered by an **electronically commutated motor**

Ventilation: M1507.1 General

- **Where local exhaust or whole-house** mechanical ventilation is provided, the equipment shall be designed in accordance with this section

ASHRAE
Advancing HVAC&R to serve humanity and promote a sustainable world

ASHRAE Standard 62.2 – 2010

- Both Whole House **Controlled Mechanical Ventilation** and **Spot ventilation** standard
- This standard applies to spaces intended for human occupancy within **single-family houses and multifamily structures of three stories or fewer** above grade, including manufactured and modular houses

Local Exhaust Ventilation Sometimes referred to as "Spot Ventilation" Removes pollutants, Moisture, and odors at their source

M1501.1 Outdoor discharge

- The air removed by **every** mechanical exhaust system **shall be discharged to the outdoors** in accordance with Section M1506.2
- Air shall not be exhausted into an attic, soffit, ridge vent or crawl space
- Appliance
  - Dryer
  - Range Hoods
  - Bath Fans

TABLE M1507.4

Baths:

- **50 CFM intermittent**
- **20 CFM continuous**

•Kitchens:

- **100 CFM intermittent**
- **25 CFM continuous**
- **Ducted to outside**

M1507.3 Whole-house mechanical ventilation system

- **M1507.3.1 System design:** The whole-house ventilation system shall consist of: Supply Side, Exhaust Side, Balanced systems, or combination there of
- **M1507.3.2 System controls:** The whole-house mechanical ventilation system shall be provided with controls that enable manual override
- **M1507.3.3 Mechanical ventilation rate: The whole house** mechanical ventilation system shall provide outdoor air at a continuous rate of not less than that determined in accordance with Table M1507.3.3(1).
- **Exception:**
  - **Permitted to operate intermittently** where the system has controls that enable operation for not less than 25-percent of each 4-hour segment and the ventilation rate prescribed is multiplied by the factor determined in accordance with Table M1507.3.3(2).

TABLE M1507.3.3(1)

CONTINUOUS WHOLE-HOUSE MECHANICAL VENTILATION SYSTEM AIRFLOW RATE REQUIREMENTS

DWELLING UNIT FLOOR AREA (square feet)	NUMBER OF BEDROOMS				
	0 – 1	2 – 3	4 – 5	6 – 7	> 7
	Airflow in CFM				
< 1,500	30	45	60	75	90
1,501 – 3,000	45	60	75	90	105
3,001 – 4,500	60	75	90	105	120
4,501 – 6,000	75	90	105	120	135
6,001 – 7,500	90	105	120	135	150
> 7,500	105	120	135	150	165

- Chart vs. ASHRAE 62.2 Formula:

Fan flow (CFM) = 0.01 CFM x your floor area + 7.5 x (# of bedrooms + 1)

- For a 1,510 square foot 4-bedroom home,

(0.01 X 1510) + (7.5 x 5)

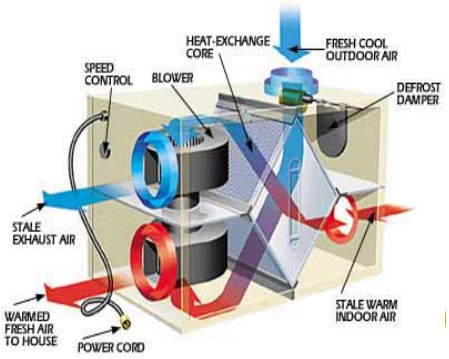
Formula Result: 52.5 CFM

Chart Result: 75 CFM

Pick Your Ventilation Strategy Carefully to Maximize Performance

Built Tight / Ventilate Right

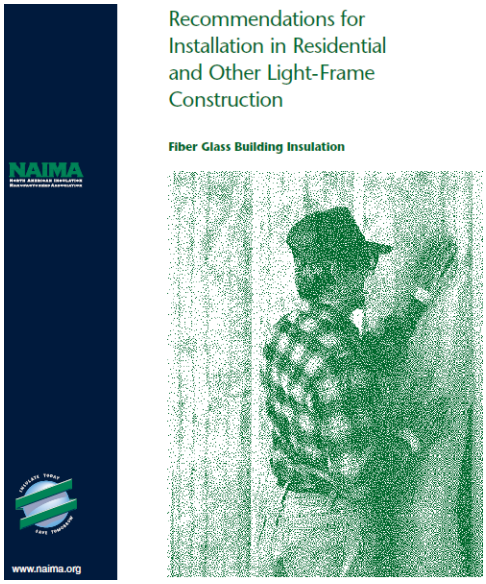
- Supply Ventilation
  (Furnace blower must be ECM/ICM)
- Exhaust Ventilation
  - Possible configuration with reversed dampered designed opening to outside
- Balanced Ventilation



Section 402.4.2 2009 IECC
Air sealing and insulation

N1101.13 (R303.2)

- Installation All materials, systems and equipment shall be installed in accordance with the manufacturer's installation instructions and this code.



Examples of Manufacture Instructions

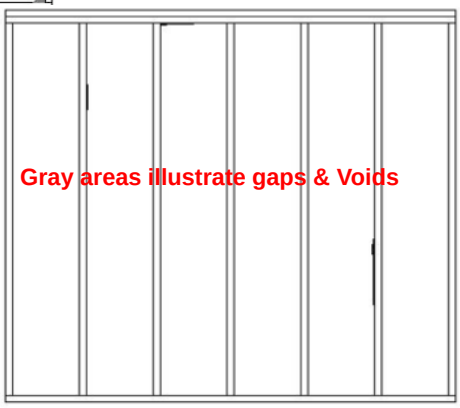
- When insulating walls, place the insulation in the cavity and check to be sure **it completely fills the cavity**, top to bottom.
- Gently press the insulation at the sides into the framing cavity, usually about 3/4 inch, until the outside edge of **the flange is flush with the face of the framing.**
- **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



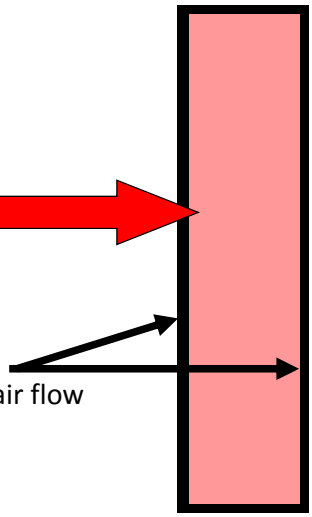
CONTROLLING THERMAL FLOW

Most insulation is NOT an air barrier

Resists Conduction

Does not resist Air Flow:

That is the job of the air barrier



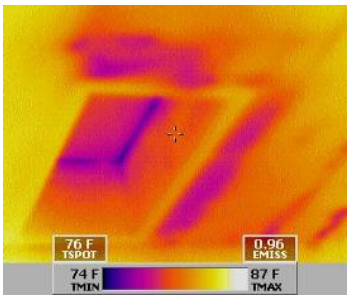
* An Air Barrier is any solid material that blocks air flow including sealing at edges and seams

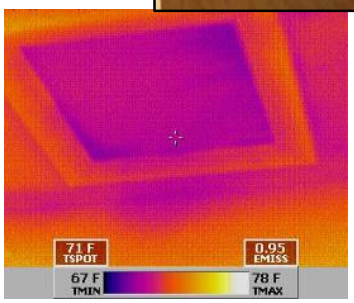
Insulation Myth:
"Insulation stops the movement of air!"

Attic Access





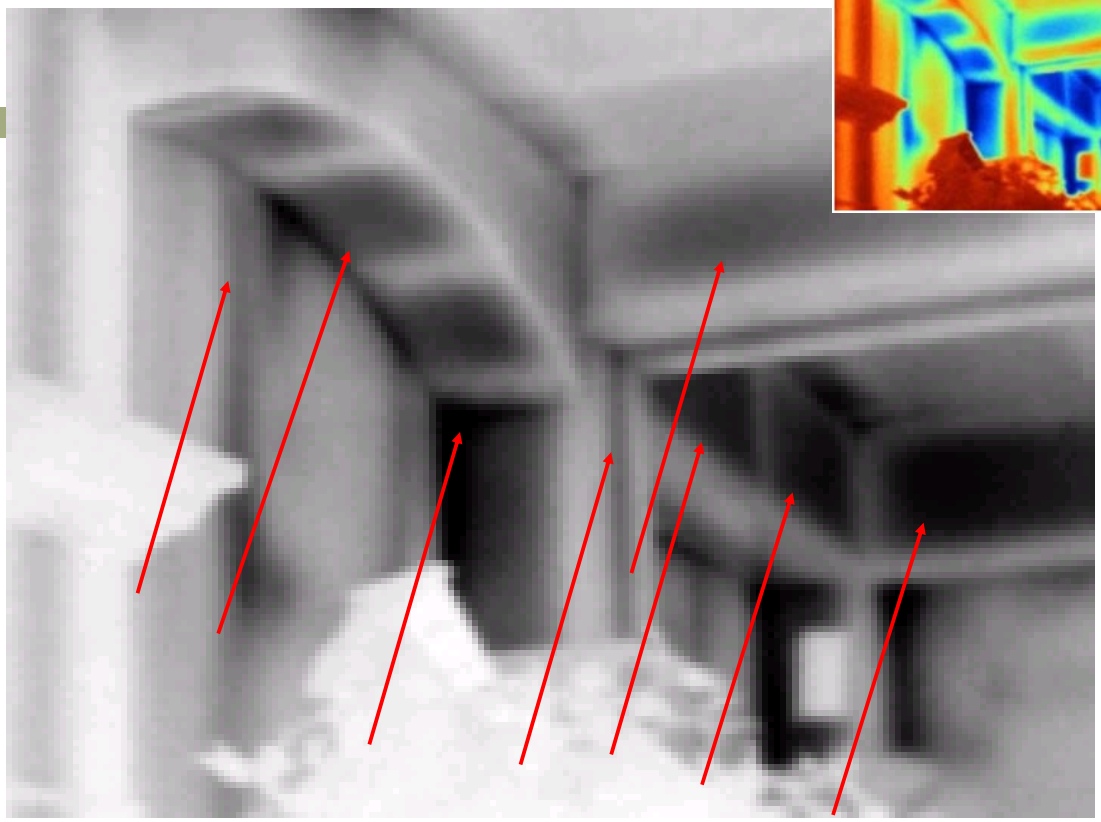




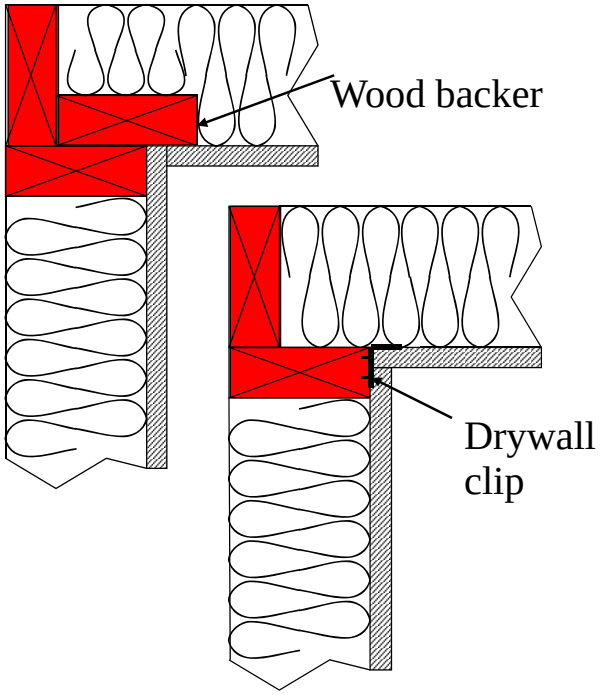
402.4 Air Leakage and Air Barriers (Mandatory)

- 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

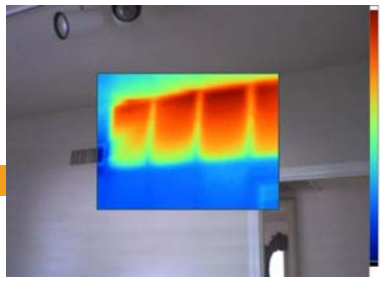
COMPONENT	CRITERIA*
Air barrier and thermal barrier	A continuous air barrier shall be installed in the building envelope. Exterior thermal envelope contains a continuous air barrier. Breaks or joints in the air barrier shall be sealed. Air-permeable insulation shall not be used as a sealing material.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

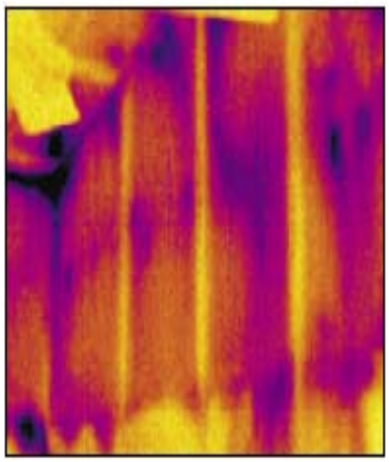


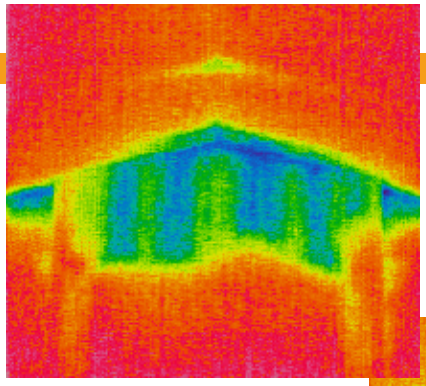
Advanced framing:
Three or Two Stud Corners

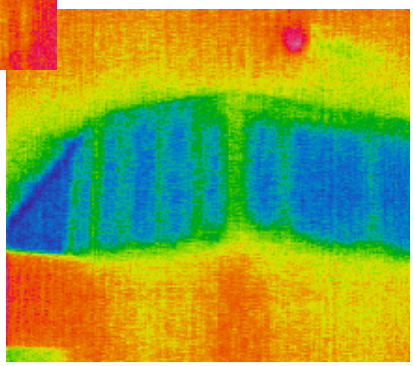


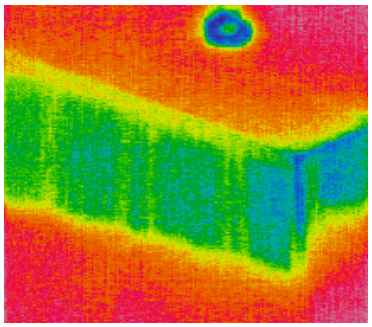
Attic Knee Walls



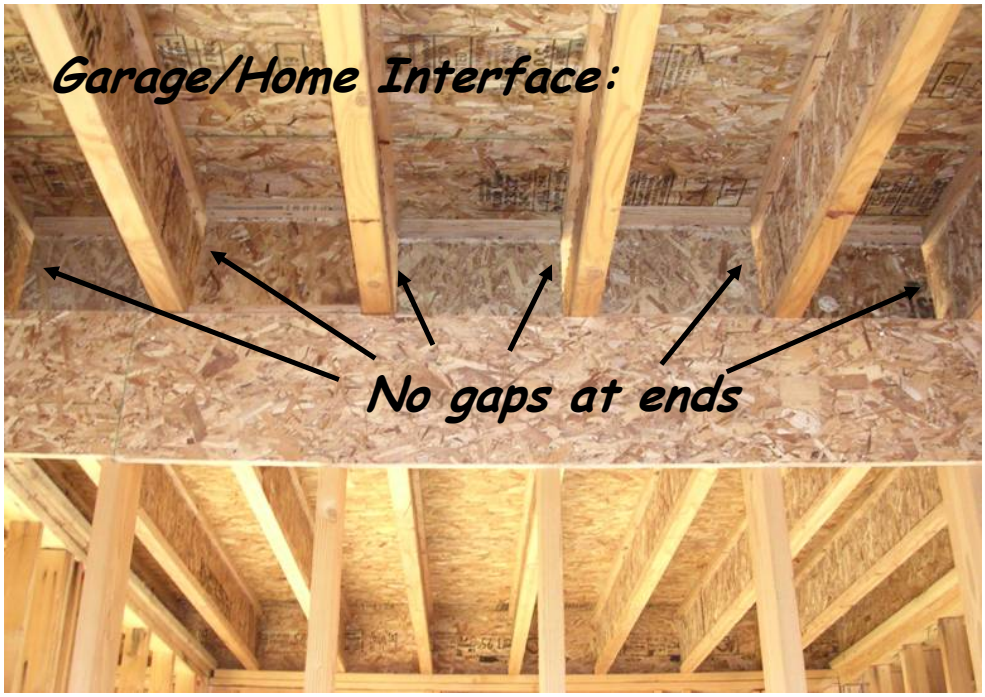








The air barrier shall be installed at any exposed edge of insulation



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 - 8
- *Where required by the code official,* Testing shall be conducted by an approved third party
- Reporting

R403.6 Equipment Sizing (Mandatory)

- **Heating and cooling** equipment shall be sized in accordance with ACCA Manual S based on building loads calculated in accordance with ACCA Manual J or other approved heating and cooling calculation methodologies

R403.1 Controls (Mandatory)

- The thermostat shall initially be programmed with a heating temperature set point no higher than 70°F and a cooling temperature set point no lower than 78°F

R403.2 Ducts.

R403.2.1 Insulation (Prescriptive)

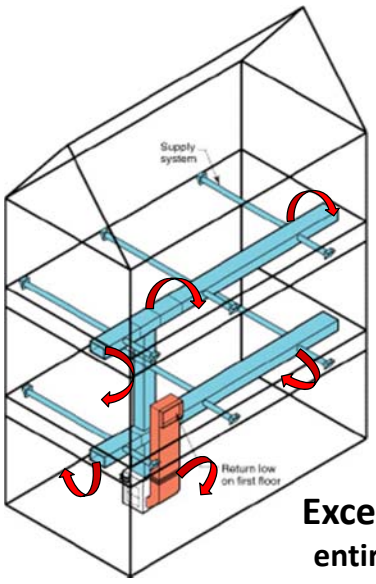
R403.2.2 Sealing (Mandatory)

- Ducts, air handlers, and filter boxes shall be sealed

R403.2.2 Sealing (Mandatory)

Duct tightness shall be verified by either of the following:

Total Duct Leakage

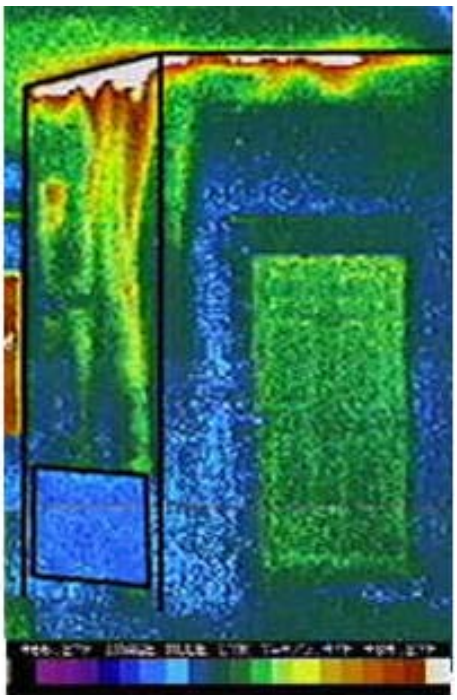


- Rough In Test
  - ≤ 4 CFM 25 per 100 sqft of conditioned floor area
  - 2000 sqft house ≤ 80 CFM 25 total
- Post Construction
  - ≤ 4 CFM 25 per 100 sqft of conditioned floor area
    - 2000 sqft house ≤ 80 CFM 25 total
- Anytime without AHU
  - ≤ 3 CFM 25 per 100 sqft of conditioned floor area if air handler has not been installed
    - 2000 sqft house ≤ 60 CFM 25 total

Exception: if the air handler and All ducts are entirely within the building thermal envelope

R403.2.3 Building cavities (Mandatory)

Building framing cavities shall not be used as ducts or plenums

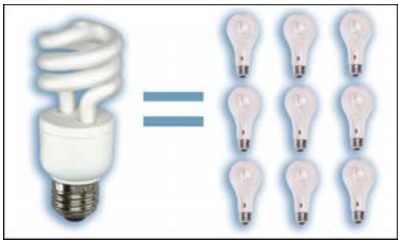


R403.2.2.1 Sealed air handler

- Air handlers shall have a manufacturer's designation for an air leakage of no more than 2 percent of the design air flow rate when tested in accordance with ASHRAE 193
- 5 ton AHU = 40 cfm_{25} of leakage!

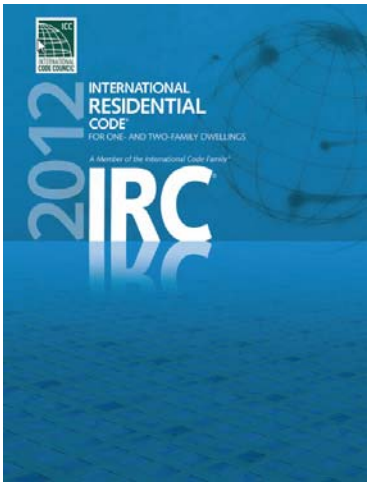
R404.1 Lighting equipment (Mandatory)

- A minimum of 75% of the lamps in permanently installed lighting fixtures shall be high-efficacy lamps



What Else is in the Codes?

- Flexibility – Systems Approach
  - ICFs & Sips in the IRC
- Reliance on Manufactures instructions
- Create a durable building enclosure
  - Drainage IRC R401.3
  - Foundation Drainage IRC R405
  - Foundation Damp proofing IRC R406
  - Vapor Retarders IRC R702.7
  - Flashing / Exterior Coverings IRC R703 R903.2
  - Water Resistive Barriers IRC R703.2
  - Wall Opening Flashing IRC R703.8
  - Roof Drainage IRC R801.3
  - Roofing Coverings IRC R905
  - Mechanical Ventilation IRC M1507.3



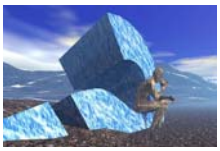
What's Not in the Codes

- Material selection
- Commissioning
  - Testing of air pressure relationships under all operating conditions
  - Combustion safety
    - Carbon monoxide, combustion appliances
  - Airflow and refrigerant charge in HVAC systems
- Mandatory 24 inch center with exceptions
- Site - orientation

What's Not in the Codes

- Indoor Air Quality
  - Duct work under construction
- Pipe and duct location mandates
  - vented crawl spaces, vented attics, and exterior walls
- Details
  - Exterior above grade foundation insulation
  - Above grade exterior finishing materials and connection to foundations
- More emphasis on stack framing and single top plates
- Air tight drywall techniques

Questions



Thank you!

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