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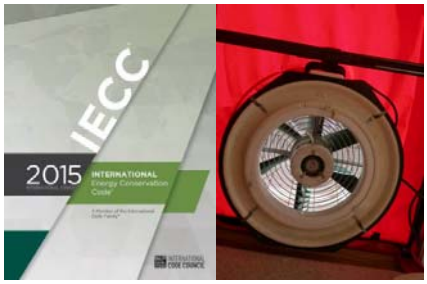
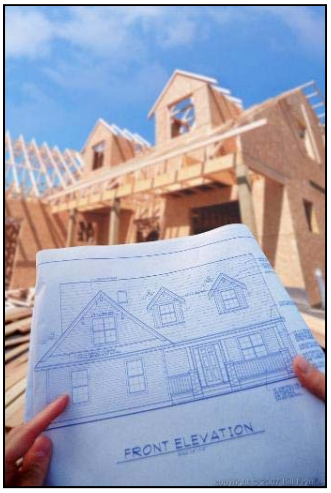



# ERI MORE THAN A HERS RATING

**Presented by Robby Schwarz**

## Agenda

- Setting the stage and the Intent of the IECC
- Look and layout of the 2015 IECC
  - Chapter 1-6 of the IECC
- Pathways through the code
- IRC and IECC need to know them both

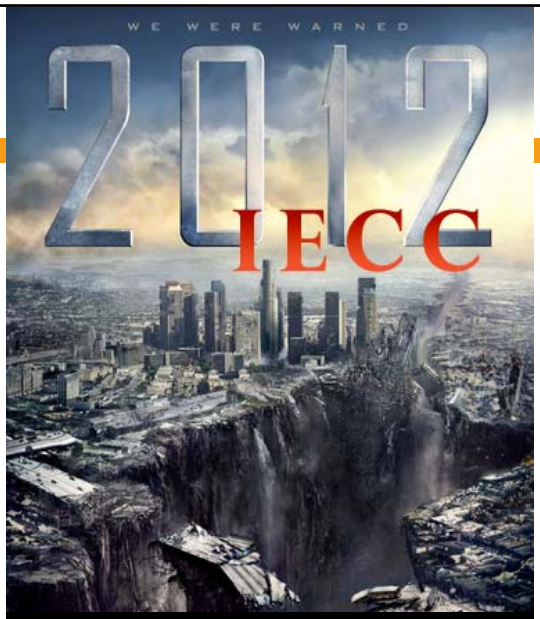



Change is Hard … Change is Good… Change can be Made Easier


- An Energy Ratings inspection is not a code compliance inspection
- The Energy Rating Index path in the code is more than just developing a HERS Index
- Understand what the Jurisdiction is asking of you
- Understand what the Builder is asking of you
- Understand the code
- Understand the liability
- Do you need to be certified

## Expectation


## Look how houses have changed




The Apocalypse is Coming

# The key factor of code development

**Adoption**



**Amendment**

a·mend·ment

- əˈmen(d)mənt/
- *noun*
- a minor change in a document.
- a change or addition to a legal or statutory document.


INTENT & IMPACT DIFFERENCE

in·tent

/inˈtent/

*noun*

1. intention or purpose.
   "with alarm she realized his intent"
   *synonyms:* aim, intention, purpose, objective, object, goal,

## 2015 IECC – Intent

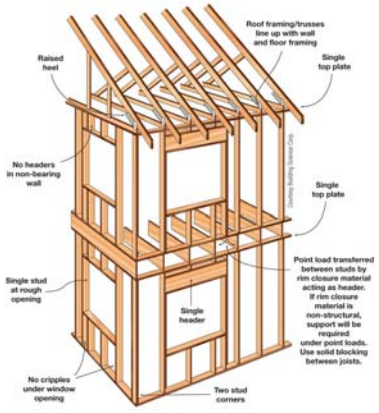
- This code shall regulate the design and construction of buildings for the effective use and conservation of energy **over the useful life of each building**
- Durability

## 2015 IECC – Intent

- This code is intended to **provide flexibility** to permit innovative approaches and techniques to achieve this objective

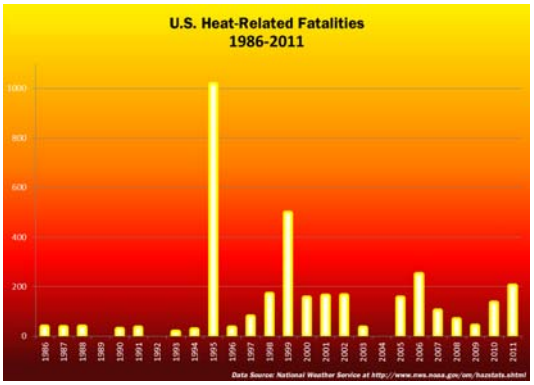
**"Learn the rules so you know how to break them properly"**

Author: Dalai Lama
Date: Feb 25, 2008



# 2012/2015 IECC – Intent

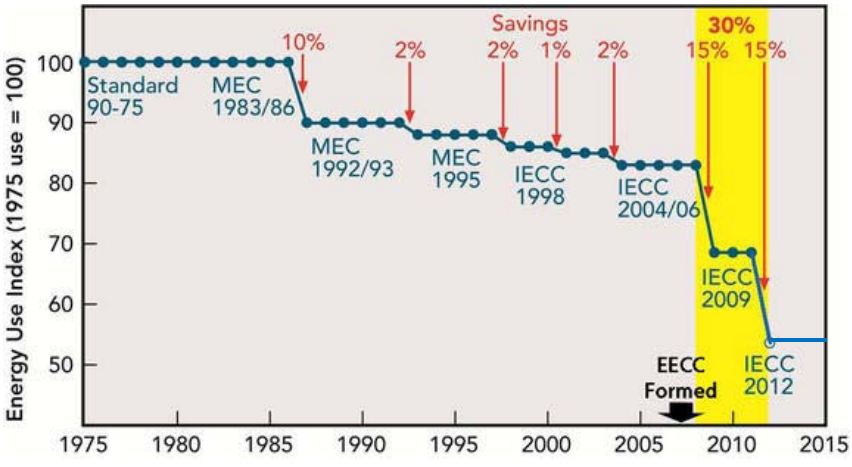
- The code is <u>not intended</u> to **abridge safety, health or environmental requirements** contained in other applicable codes or ordinances




# Energy Code

## Its not your Daddy's code?

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



# The look and layout of the 2015 IECC


**The IECC covers both:**

- **Commercial (CE) chapters 1-6**

**and**

- **Residential (RE) chapters 1-6**

# Residential VS Commercial


Definition of Residential per IECC is different than that found in the IRC and IBC:

RESIDENTIAL BUILDING

- For this code, includes detached one- and two family dwellings and multiple single-family dwellings (townhouses) as well as Group R-2, R-3 and R-4 buildings three stories or less in height above grade plane

COMMERCIAL BUILDING. For this code, all buildings that are not included in the definition of "Residential buildings."

## Who is the code written for?

- Designers
- Contractors
- Building Owners
- Code Officials
- Who else?

- If your building is never inspected do you still have to design it and build it to minimum code requirements?
- Many jurisdictions don't enforce the energy code due to time constraints and man power.
- That doesn't leave the Builder out of having to comply!

## Who is actually using this code?

- Proactive designers
- Market conscience builders
- Building owners who care about their buildings and their costs
- Code Officials who are aware that building owners have expectations

- "When I buy a building I **expect** it to stand through a wind storm. I **expect** my roof to hold the snow load. I **expect** the hot water to be hot and the cold water to be cold. I **expect** the building to be durable and I **expect** my next utility bill will not put me out of my next mortgage payment!"

# Chapter 1: Administration

- Often the Chief Building Official deletes Chapter 1 and inserts their own administrative provisions
- However the IECC has code requirements in Chapter 1 so jurisdictions are more apt to amend this chapter rather than delete it


# New since the 2012

**R101.2 Scope**

- Starting with the 2012 IECC, in addition to the code applying to residential buildings , it now also applies to the **building sites and associated systems and equipment**

## R102.1

- **The Code official <u>shall be permitted</u> to approve an alternative material, design or method of construction** where the code official finds that the proposed design is satisfactory and complies with the intent of the provision of this code and that the material, method or work offered is for the purpose intended, at least the equivalent of that prescribed in this code

## R103.1 General

- Construction documents, technical reports and other supporting data **shall be submitted** in one or more sets **with each application for a permit**.
- The construction documents and technical reports **shall be prepared by a registered design professional** where required by the statutes of the jurisdiction in which the project is to be constructed.
- Where special conditions exist, the *code official* is authorized to require necessary construction documents to be prepared by a registered design professional.

# R103.1

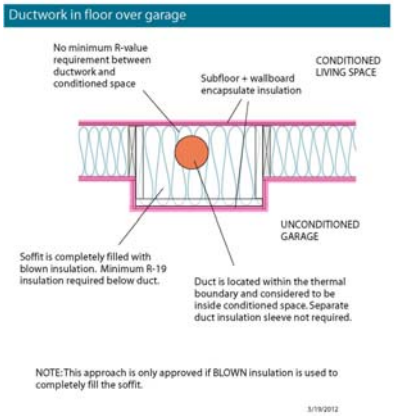
**Construction Documents**

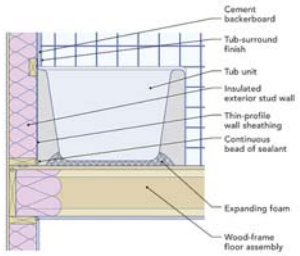
- R103.1 General
  - Construction documents prepared by a design professional
  - I.E. set of plans
  - Different from compliance documents

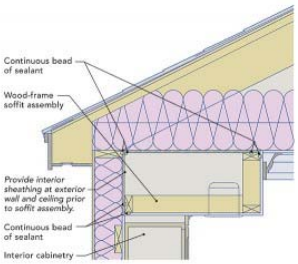
**R103.2 Information on Construction documents**

- 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

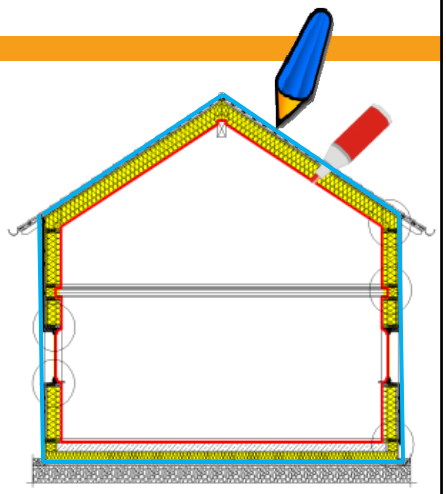


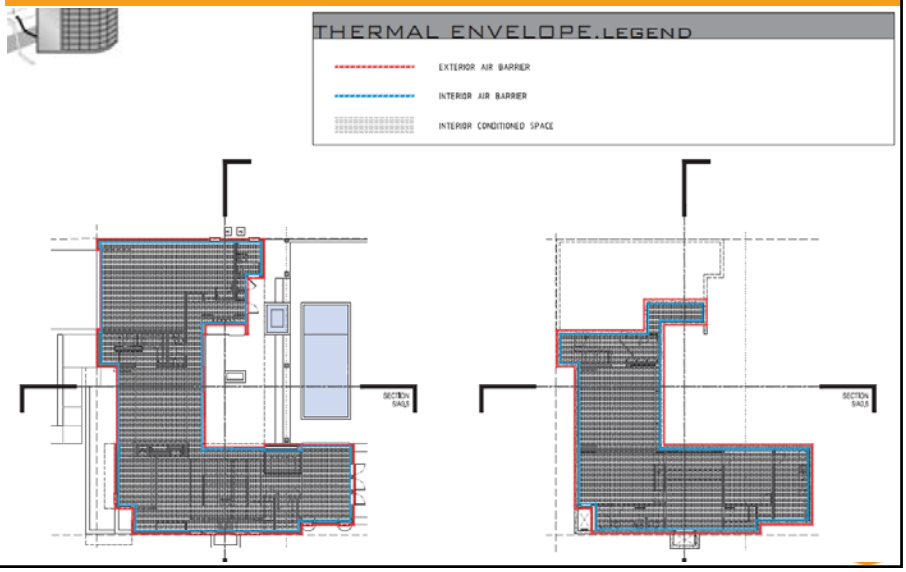



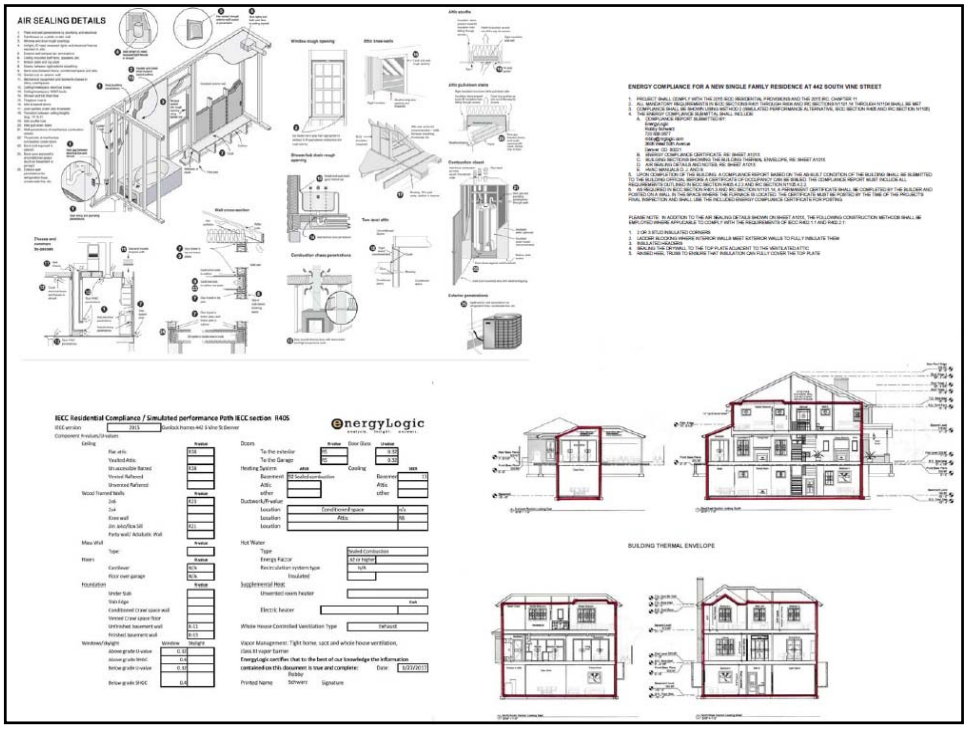
# New in the 2015

- 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



# Building Thermal Envelope Depiction






## R104 Inspections – New in the 2015 IECC

- Construction or work for which a permit is required shall be subject to inspection
- The code official or his/her agent shall inspect….

- Footing and foundation
- Framing and rough-in inspection
- Plumbing rough-in inspection
- Mechanical rough-in inspection
- Final inspection
- Re-inspection

# Required Inspections

**R104.2.2 Framing and rough-in inspection**

- Inspections at framing and rough-in shall be made before application of interior finish and **shall verify** compliance with the code as to types of insulation and corresponding ***R*-values and their correct location and proper installation**; fenestration properties (*U*-factor and SHGC) and proper installation; and **air leakage controls as required by the code** and approved plans and specifications.

**R104.2.4 Mechanical rough-in inspection**

- Inspections at mechanical rough-in shall verify compliance as required by the code and *approved* plans and specifications as to installed HVAC equipment type and size, **required controls, system insulation and corresponding *R*-value, system air leakage control**, programmable thermostats, dampers, **whole-house ventilation**, and minimum fan efficiency.

# Focus on House Performance

# Fundamental Questions

**Is It There?**

**Does It Work?**

# Fundamental Questions

**Is It There?**

**Does It Work?**

# Fundamental Questions

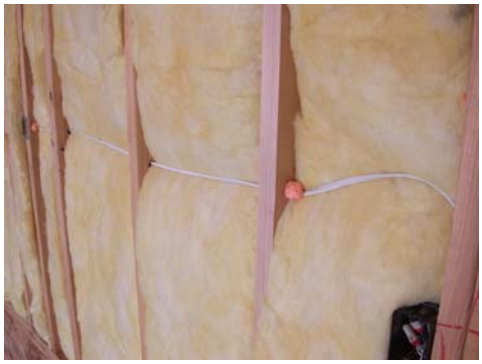
**Is It There?**

**Does It Work?**

# Fundamental Questions

**Is It There?**


**Does It Work?**



## R104.4 Approved Inspection Agency

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

- Becomes important for the Energy Rating Path

## Chapter 2: Definitions

**Sometimes words are defined within IECC Chapter 2**

- **BUILDING THERMAL ENVELOPE**
  - The basement walls, exterior walls, floor, roof and any other building elements that enclose conditioned space or provide a boundary between conditioned space and exempt or unconditioned space.
- **CONTINUOUS AIR BARRIER**
  - A combination of materials and assemblies that restrict or prevent the passage of air through the building thermal envelope.
- **ERI REFERENCE DESIGN**
  - A version of the rated design that meets the minimum requirements of the 2006 *International Energy Conservation Code.*

**Sometimes words are defined in other codes but used in the IECC**

- **JOINT.** The opening in or between adjacent assemblies that is created due to building tolerances, or is designed to allow independent movement of the building in any plane caused by thermal, seismic, wind or any other loading.

# Chapter 3: General

## Chapter 3 discusses

- climate zones
- Design conditions
- General info and requirements that apply to materials, systems, and equipment

**R302.1 Interior design conditions**

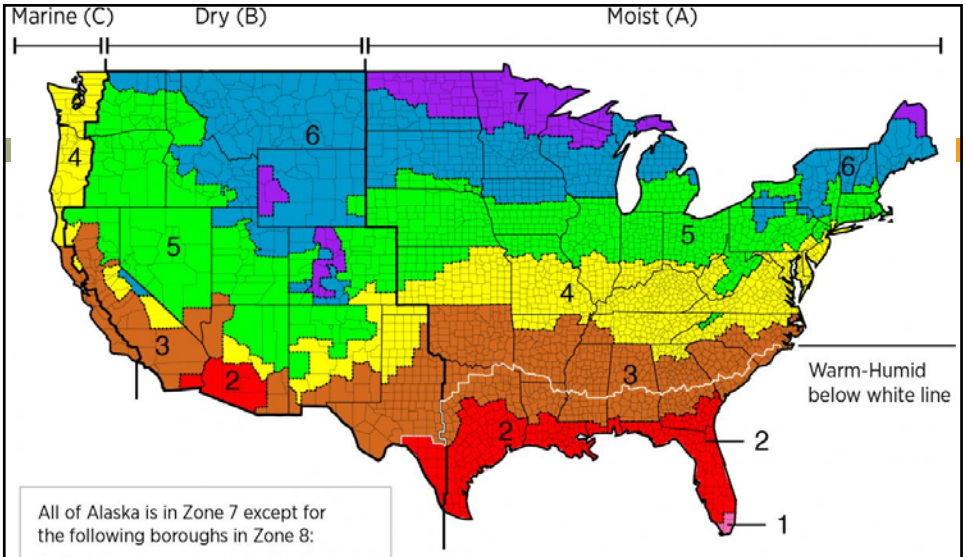
- The interior design temperatures used for heating and cooling load calculations **shall be** a maximum of 72°F (22°C) for heating and minimum of 75°F (24°C) for cooling

**R303.1.1Building 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

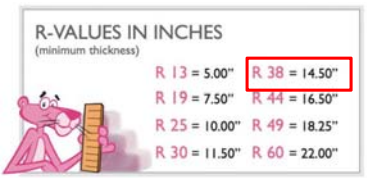
**R303.2 Installation**

- 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



# What is the R-Value?


A core sample or cookie-cutter test involves taking at least three insulation samples and weighing them.



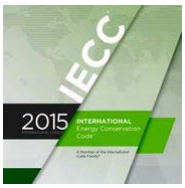

Imperial Coverage Chart

19.08 ft³/Bag R3.59/Inch 25lb./Bag

| Thermal Resistance (R-Value) | Actual Design Thickness (Inches) | Blown-Applied Thickness (Inches) | Weight (lbs/ft²) | Coverage (ft²/bag) | Quick Calculator (bags/1000 ft²) |
|---|---|---|---|---|---|
| R10 | 2.78 | 3.11 | 0.32 | 78.85 | 12.68 |
| R12 | 3.33 | 3.73 | 0.38 | 65.71 | 15.22 |
| R20 | 5.56 | 6.22 | 0.63 | 39.43 | 25.36 |
| R28 | 7.78 | 8.71 | 0.89 | 28.16 | 35.51 |
| R30 | 8.34 | 9.34 | 0.95 | 26.28 | 38.04 |
| R32 | 8.89 | 9.96 | 1.01 | 24.64 | 40.58 |
| R34 | 9.45 | 10.58 | 1.08 | 23.19 | 43.12 |
| R38 | 10.56 | 11.83 | 1.20 | 20.75 | 48.19 |
| R40 | 11.11 | 12.45 | 1.27 | 19.71 | 50.73 |
| R44 | 12.23 | 13.69 | 1.39 | 17.92 | 55.80 |
| R50 | 13.89 | 15.56 | 1.59 | 15.77 | 63.41 |
| R60 | 16.67 | 18.67 | 1.90 | 13.14 | 76.09 |

# 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 _____ | | |

REM/Rate - Residential Energy Analysis and Rating Software v14.6

## Chapter 4: Residential Energy Efficiency

**Specific and technical requirements for the:**

- Building Thermal Envelope
- Mechanical Systems
- Service Hot Water Systems
- Electrical Power and Lighting Systems

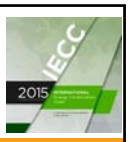
**Pathways through the 2015 IECC**

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


## Terminology

- **Mandatory requirements**
  - Requirements that must be met by every building unless there is a specific exception in the code
- **Prescriptive requirements**
  - Requirements that must be met by every building unless an approved tradeoff is utilized or unless there is a specific exception in the code
- **Performance approach**
  - An overall performance requirement for the building that replaces the individual prescriptive requirements for building systems and components

## SECTION R402 BUILDING THERMAL ENVELOPE
## Prescriptive path ways through code (3 choices)




- **R402.1 General (Prescriptive).**
  - The building thermal envelope shall meet the requirements of Sections R402.1.1 through R402.1.4.
- Sections R402.1.1
  - R-value table specification
- Section R402.1.3
  - U-Value table specification
- Section R402.1.4.
  - Total UA Alternative Approach

- R402.1.2 R-value computation Insulation material used in layers, such as framing cavity insulation and insulating sheathing, shall be summed to compute the component R-value
- The manufacturer's settled R-value shall be used for blown insulation (Attics)
- **Computed R-values shall not include an R-value for other building materials or air films**

## 2015 Prescriptive R-value Table Compliance Specification

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

**Table R402.1.2**
**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.

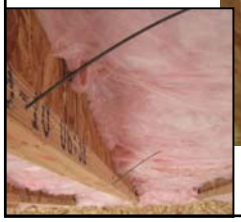
f. Basement wall insulation is not required in warm-humid locations as defined by Figure R301.1 and Table R301.1.

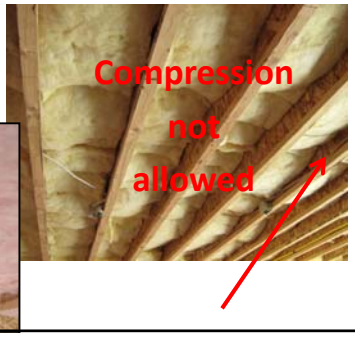
g. Or insulation sufficient to fill the framing cavity, R-19 minimum.

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.

# Floor Systems




- Best Practices
  - Insulation must be in contact with the surface it is intended to insulate
  - Insulation completely fills the cavity

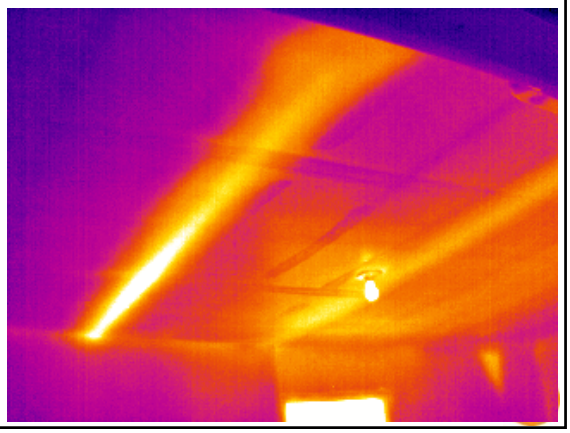
2012 IECC

- **R402.2.7 Floors.**
- Floor insulation shall be installed to maintain permanent contact with the underside of the subfloor decking.
- **R-30 climate zone 5**

# Ducts in Garage Ceiling

**Old Installation methods**

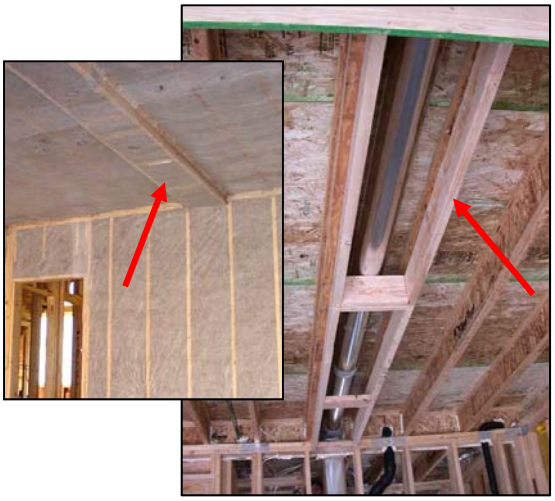
**What about obstructions in the floor system**



# Ducts in Garage Ceiling

**Code requirements**

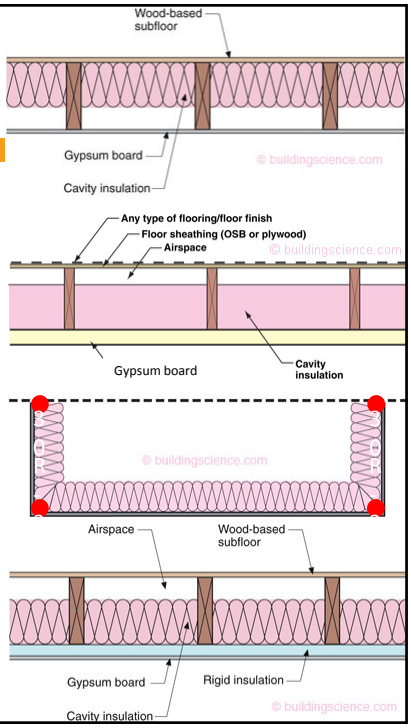
- Insulation in complete contact with subfloor
- Insulation encapsulates duct
- IECC Table 402.1.2 footnote G
- **Minimum R-19 below duct**



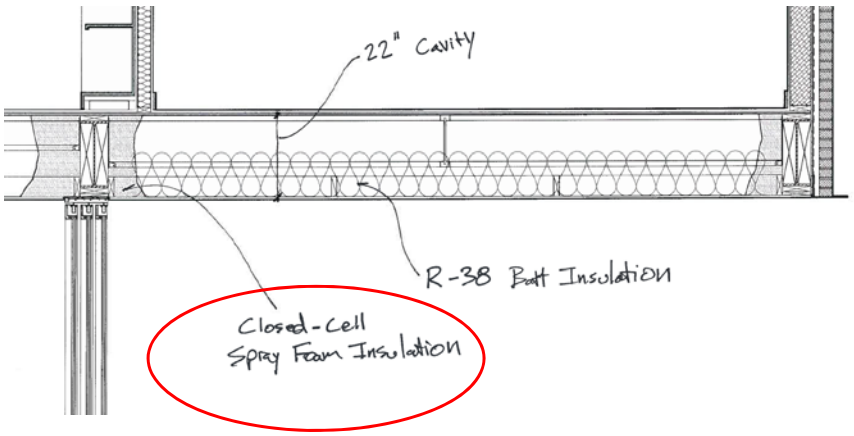
# R402.2.8 Exception

Joseph Lstiburek Exception and details

1. Complete & tight air barrier system, **and**
2. R-30 Insulation on the bottom sheathing of the assembly, **or**
3. Continuous R-20 bathtub insulation Including floor rim joist insulation, **or**
4. Continuous insulation below framing with cavity insulation ≥ R-20

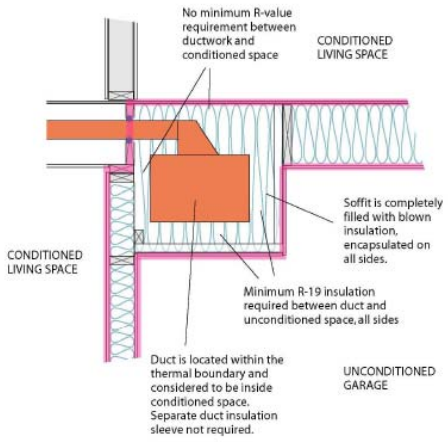


# Floor over Garage



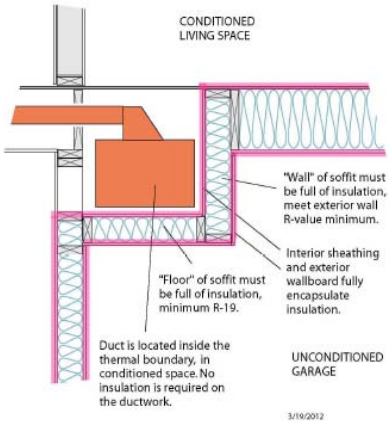

# Ducts in Garage Soffits

Ductwork in garage soffit, adjoining conditioned space, living space above - Solution 1




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

Ductwork in garage soffit, adjoining conditioned space, living space above - Solution 2



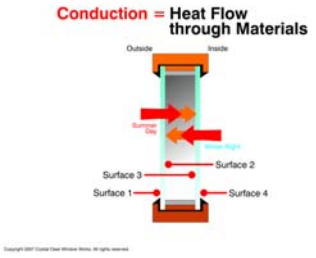
# R402.1.4 U-factor Alternative

| CLIMATE ZONE | FENESTRATION U-FACTOR | SKYLIGHT U-FACTOR | CEILING U-FACTOR | FRAME WALL U-FACTOR | MASS WALL U- FACTORb | FLOOR U-FACTOR | BASEMENT WALL U-FACTOR | CRAWL SPACE WALL U- FACTOR |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.50 | 0.75 | 0.035 | 0.084 | 0.197 | 0.064 | 0.360 | 0.477 |
| 2 | 0.40 | 0.65 | 0.030 | 0.084 | 0.165 | 0.064 | 0.360 | 0.477 |
| 3 | 0.35 | 0.55 | 0.030 | 0.060 | 0.098 | 0.047 | 0.091c | 0.136 |
| 4 except Marine | 0.35 | 0.55 | 0.026 | 0.060 | 0.098 | 0.047 | 0.059 | 0.065 |
| 5 and Marine 4 | 0.32 | 0.55 | 0.026 | 0.060 | 0.082 | 0.033 | 0.050 | 0.055 |
| 6 | 0.32 | 0.55 | 0.026 | 0.045 | 0.060 | 0.033 | 0.050 | 0.055 |
| 7 and 8 | 0.32 | 0.55 | 0.026 | 0.045 | 0.057 | 0.028 | 0.050 | 0.055 |

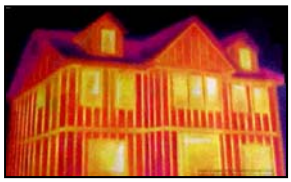
- **An assembly** with a U-factor equal to or less than that specified in Table R402.1.4 shall be permitted as an alternative to the R-value in Table R402.1.2
- Example: Climate zone 5 framed wall
  - U- .060 = R-16.67
  - R-value table requires cavity insulation at R20 or 13+5
  - 1/20 = U.05 Plus sheathing, air film, etc. = U.06

# R402.1.5 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 UA 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 Code uses to show compliance with the UA Trade Off (ResCheck) and the Simulated Performance Path

**The Actual built homes performance will be less than or equal to the performance of the code standard reference design**

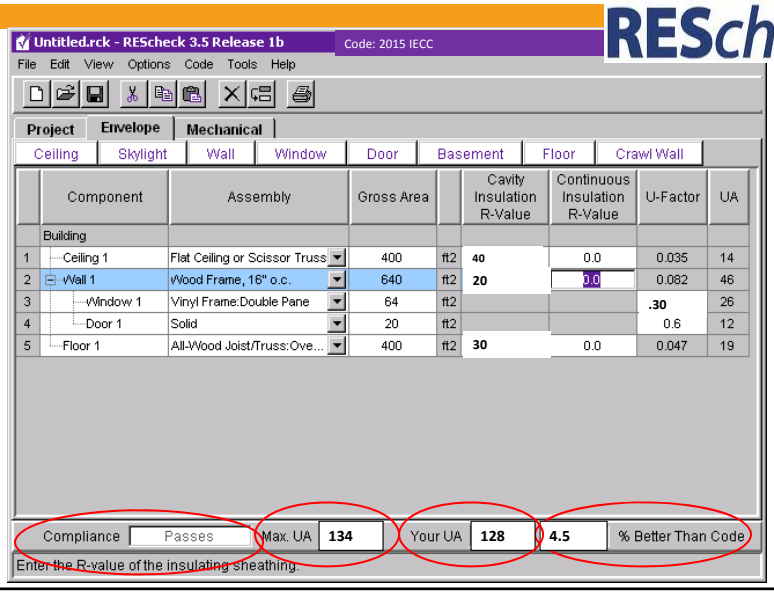
**The Standard reference design for code is the prescriptive path of compliance built in Table 405.5.2 (1)**

# Twin Houses

| 2015 IECC reference design house | vs. | Builder's desired house |
|---|---|---|
| ▪ Geometric Twin<br>▪ 2015 IECC prescriptive envelope U-values in (Table 402.1.4) | | ▪ Geometric Twin<br>▪ 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

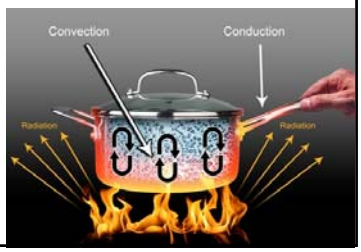
# Example




# R405 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

**2015 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 2015 IECC Prescriptive path

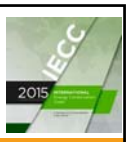
- The home you are building and evaluating, compared to the "Reference" home in order to quantify performance and demonstrate compliance with the Energy code.

## Energy Costs?

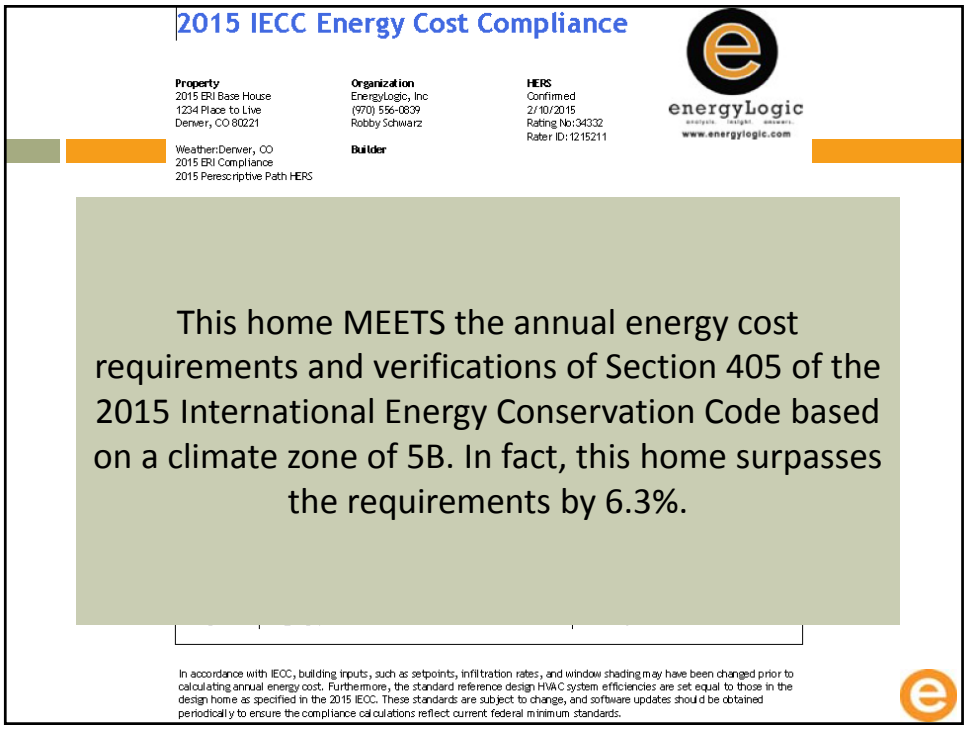
- **405.3 Performance-based compliance.** Compliance based on simulated energy performance requires that a proposed residence (proposed design) be shown to have an **annual energy cost** that is less than or equal to the annual energy cost of the standard reference design.

# SECTION R405

## SIMULATED PERFORMANCE ALTERNATIVE (PERFORMANCE)




- **R405.3 Performance-based compliance.**
  - Energy prices shall be taken from a source *approved* by the *code official,* such as the Department of Energy, Energy Information Administration's *State Energy Price and Expenditure Report*
- **R405.4.2 Compliance report**
  - Batch sampling of buildings to determine energy code compliance for all buildings in the batch shall be prohibited.



2015 IECC Energy Cost Compliance

**Property**
2015 ERI Base House
1234 Place to Live
Denver, CO 80221

Weather:Denver, CO
2015 ERI Compliance
2015 Perescriptive Path HERS

**Organization**
EnergyLogic, Inc
(970) 556-0839
Robby Schwarz

**Builder**

**HERS**
Confirmed
2/10/2015
Rating No:34332
Rater ID:1215211

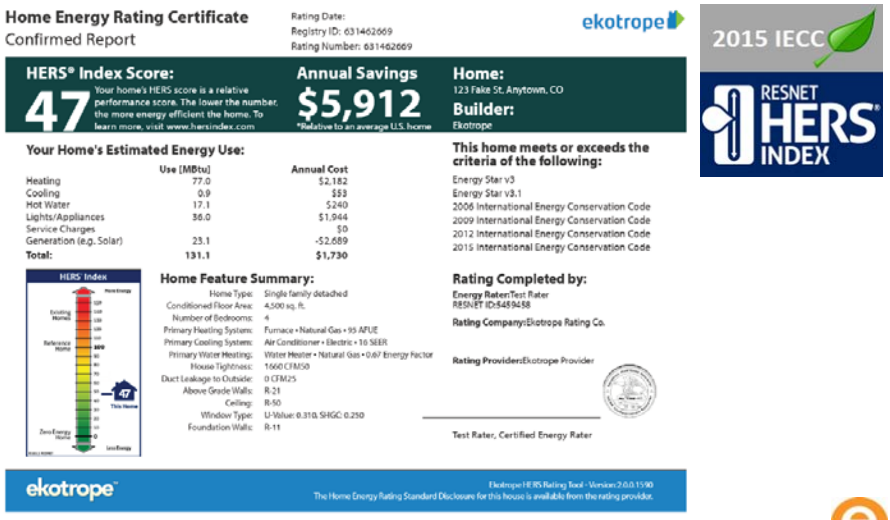
energyLogic
www.energylogic.com

This home MEETS the annual energy cost requirements and verifications of Section 405 of the 2015 International Energy Conservation Code based on a climate zone of 5B. In fact, this home surpasses the requirements by 6.3%.

In accordance with IECC, building inputs, such as setpoints, infiltration rates, and window shading may have been changed prior to calculating annual energy cost. Furthermore, the standard reference design HVAC system efficiencies are set equal to those in the design home as specified in the 2015 IECC. These standards are subject to change, and software updates should be obtained periodically to ensure the compliance calculations reflect current federal minimum standards.

# Section R406 of the2015 IECC

## Energy Rating Index Compliance Alternative



**Home Energy Rating Certificate**
Confirmed Report

Rating Date:
Registry ID: 631462669
Rating Number: 631462669

ekotrope

2015 IECC

RESNET HERS INDEX

**HERS® Index Score:** 47
Your home's HERS score is a relative performance score. The lower the number, the more energy efficient the home. To learn more, visit www.hersindex.com

**Annual Savings** $5,912
*Relative to an average U.S. home

**Home:**
123 Fake St, Anytown, CO
**Builder:**
Ekotrope

**Your Home's Estimated Energy Use:**

| | Use [MBtu] | Annual Cost |
|---|---|---|
| Heating | 77.0 | $2,182 |
| Cooling | 0.9 | $83 |
| Hot Water | 17.1 | $240 |
| Lights/Appliances | 36.0 | $1,944 |
| Service Charges | | $0 |
| Generation (e.g. Solar) | 23.1 | -$2,689 |
| **Total:** | **131.1** | **$1,730** |

**This home meets or exceeds the criteria of the following:**
Energy Star v3
Energy Star v3.1
2006 International Energy Conservation Code
2009 International Energy Conservation Code
2012 International Energy Conservation Code
2015 International Energy Conservation Code

HERS Index

**Home Feature Summary:**

| | |
|---|---|
| Home Type: | Single family detached |
| Conditioned Floor Area: | 4,500 sq. ft. |
| Number of Bedrooms: | 4 |
| Primary Heating System: | Furnace • Natural Gas • 95 AFUE |
| Primary Cooling System: | Air Conditioner • Electric • 16 SEER |
| Primary Water Heating: | Water Heater • Natural Gas • 0.67 Energy Factor |
| House Tightness: | 1660 CFM50 |
| Duct Leakage to Outside: | 0 CFM25 |
| Above Grade Walls: | R-21 |
| Ceiling: | R-50 |
| Window Type: | U-Value: 0.310, SHGC: 0.250 |
| Foundation Walls: | R-11 |

**Rating Completed by:**
Energy Rater:Test Rater
RESNET ID:5459458
Rating Company:Ekotrope Rating Co.
Rating Provider:Ekotrope Provider

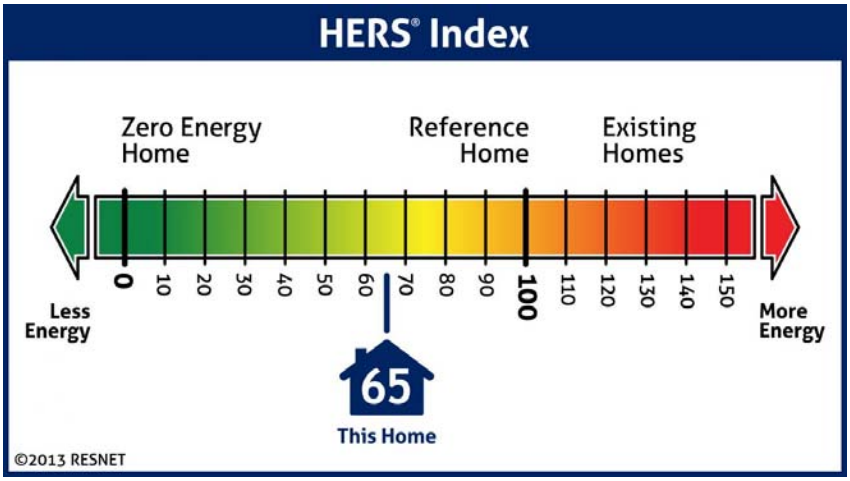
Test Rater, Certified Energy Rater

ekotrope
Ekotrope HERS Rating Tool - Version 7.0.0.1590
The Home Energy Rating Standard Disclosure for this house is available from the rating provider.

# Quantifying Energy Use

## ERI vs. HERS

- ERI Index Score = HERS Index Score



## Code Book misprint and the Errata

er·ra·tum

iˈrätəm,-ˈrā-,-ˈrat-/ *noun*

plural noun: **errata**

An error in printing or writing.

A list of corrected errors appended to a book or published in a subsequent issue of a journal.

- **R406.2 Mandatory requirements.** Compliance with this section requires that the ~~mandatory~~ provisions identified in Sections ~~R401.2~~ R401 through R404 labeled as 'mandatory" and Section R403.5.3 be met. The building thermal envelope shall be greater than or equal to levels of efficiency and Solar Heat Gain Coefficient in Table 402.1.2 or 402.1.4 of the 2009 *International Energy Conservation Code*.

## Mandatory sections of the 2015 IECC

- R402.4 Air leakage (Mandatory)
  - Table R402.4.1.1
  - R402.4.1.2 Testing
    - Air leakage rate not exceeding 5 air changes per hour in Climate Zones 1 and 2, and 3 air changes per hour in Climate Zones 3 through 8

# R406.1 Mandatory Requirements

- The building thermal envelope shall be **greater than or equal** to levels of efficiency and Solar Heat Gain Coefficient in Table 402.1.1 or 402.1.3 of the **2009 *International Energy Conservation Code***.

2018 IECC

- If Solar is installed on a home using the ERI path, builders **must** also meet the minimum prescriptive envelope efficiency measures in the 2015 IECC
- If there is no solar on the home then the builders **must** also meet the minimum prescriptive envelope efficiency measures in the 2009 IECC

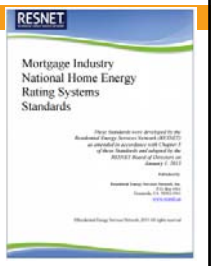
# 2009 IECC vs. 2015 IECC Prescriptive Table

| Climate Zone | Window U-Factor | Window SHGC | Ceiling R-Value | Wood Framed Wall R-Value | Mass Wall R-Value | Floor R-Value | Basement Wall R-Value | Slab R-Value and Depth | Crawl Space Wall R-Value |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.2<br>NR | 0.30<br>0.25 | R-30 | R-13 | R-3/4 | R-13 | 0 | 0 | 0 |
| 2 | 0.65<br>0.40 | 0.30<br>0.25 | R- 30<br>38 | R-13 | R-4/6 | R-13 | 0 | 0 | 0 |
| 3 | 0.35<br>0.35 | 0.30<br>0.25 | R-30<br>38 | R-13<br>20 or 13+5 | R-5/8<br>8/13 | R-19 | R-5/13 | 0 | R-5/13 |
| 4 except Marine | 0.35<br>0.35 | NR<br>0.40 | R-38<br>49 | R-13<br>20 or 13+5 | R-5/10<br>8/13 | R-19 | R-10/13 | R-10, 2ft | R-10/13 |
| 5 and Marine 4 | 0.35<br>0.32 | NR | R-38<br>49 | R-20 or 13+5 | R-13/17 | R-30 | R-10/13<br>15/19 | R-10, 2ft | R-10/13<br>15/19 |
| Climate Zone 6 | 0.35<br>0.32 | NR | R-49 | R-20 or 13+5<br>20+5 or 13+10 | R-15/20 | R-30 | R-15/19 | R-10, 4ft | R-10/13<br>15/19 |
| Climate Zone 7 & 8 | 0.35<br>0.32 | NR | R-49 | R-21<br>20+5 or 13+10 | R-19/21 | R-38 | R-15/19 | R-10, 4ft | R-10/13<br>15/19 |

# R406.3.1 ERI reference design

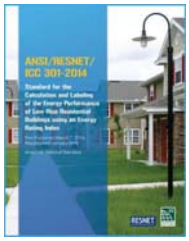
2015 IECC

- The *ERI* ***reference design*** shall be configured such that is it meets the minimum requirements of the 2006 *International Energy Conservation Code* prescriptive requirement



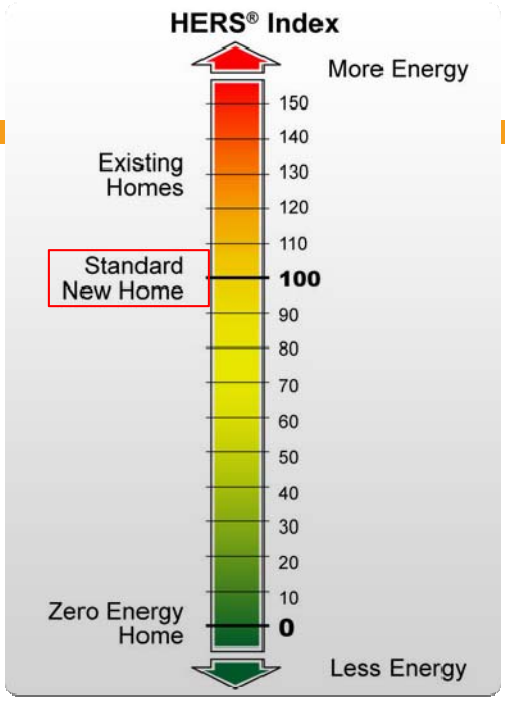

2018 IECC

- The Energy Rating Index will be develop in accordance with ANSI/RESNET/ICC 301-2014




- The proposed residential building shall be shown to have an annual total normalized Modified Loads that are less than or equal to the annual total Loads of the *ERI reference design*

- 100 meets the minimum requirements of the 2006 International Energy Conservation Code prescriptive requirements



# Twin Houses

| ERI reference design house | vs. | Builder's desired house |
|---|---|---|
| ▪ Geometric Twin<br>▪ 2006 IECC prescriptive requirements | | ▪ Geometric Twin<br>▪ Mandatory 2009 IECC Envelope R-Values<br>▪ 2015 IECC Mandatory Requirements |

The Builder's house must have the Energy Rating Index Required by code, or lower, to meet the intent of code

# Table R406.4 Maximum Energy Rating Index

| Climate Zone | 2015 IECC Energy Rating Index |
|---|---|
| 1 | 52 |
| 2 | 52 |
| 3 | 51 |
| 4 | 54 |
| 5 | 55 |
| 6 | 54 |
| 7 | 53 |
| 8 | 53 |

| Climate Zone | 2018 IECC Energy Rating Index |
|---|---|
| 1 | 57 |
| 2 | 57 |
| 3 | 57 |
| 4 | **62** |
| 5 | **61** |
| 6 | **61** |
| 7 | 58 |
| 8 | 58 |

- Compliance based on an ERI analysis requires that the *rated design* be shown to have an ERI less than or equal to the appropriate value listed in Table R406.3, when compared to the *ERI reference design*

# Features that Impact the ERI

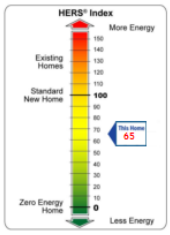
**(Lower the score)**

- Mechanical equipment
  - High efficiency furnace
  - High efficiency AC
  - High efficiency water heater
- More R-value than required by the 2009 IECC
- House orientation with the ERI
- House tightness below 3 ACH50
- Duct leakage to the outside
- Duct location
- Whole house fan
- CFL or LED Lighting above 75%
- High efficiency appliances
- Solar


## 2015 IECC ENERGY RATING INDEX REPORT

energyLogic
www.energylogic.com

| Property | Organization | HERS |
|---|---|---|
| 2015 ERI Base House<br>1234 Place to Live<br>Denver, CO 80221 | EnergyLogic, Inc<br>(970) 556-0839<br>Robby Schwarz | Confirmed<br>2/10/2015<br>Rating No:34332<br>Rater ID:1215211 |




**Annual Energy Consumption**

| | HERS Reference Home (MBTU) | Rated Home nMUEL (MBTU) | Rated Home Cost ($/yr) |
|---|---|---|---|
| Heating | 56.1 | 32.4 | 595 |
| Cooling | 19.1 | 7.5 | 87 |
| Water Heating | 12.8 | 11.1 | 186 |
| Lights & Appliances | 31.6 | 26.5 | 811 |
| Photovoltaics | 0 | -0.0 | -0 |
| Total | 119.6 | 77.5 | 1679 |

**Annual Estimates**

| | | | |
|---|---|---|---|
| Electric(kWh): | 8056 | CO2 Emissions(Tons): | 12 |
| Natural gas(Therms): | 780 | Energy Savings ($)**: | 1386 |

*Based on standard operating conditions
**Based on U.S. DOE designation of a HERS Index of 130 as the Typical Existing Home

TARGET INDEX: 55 HERS INDEX: 65 FAIL

This home DOES NOT meet the RESNET Home Energy Rating Index requirements of Sections 406.3 and 406.4 of the 2015 International energy Conservation Code based on a climate zone of 5B.

| | | | |
|---|---|---|---|
| Name | Robby Schwarz | Signature | |
| Organization | EnergyLogic, Inc | Date | 26 May 2015 |

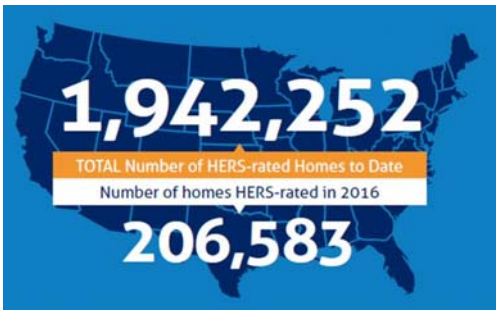
**Mandatory Requirements**

| | | | |
|---|---|---|---|
| HERS Target | FAIL | Duct Insulation (Ducts outside R-6, Inside is R-0) | PASS |
| 2009 IECC UA | PASS | Maximum Fenestration U-factor (2012) | PASS |
| Duct Sealing (2012) | PASS | Maximum Fenestration SHGC (2012) | PASS |
| Mechanical Ventilation | PASS | Air Leakage (5 ACH50 for CZ 1-2, 3 ACH50 for CZ3-8) | PASS |
| Mechanical Ventilation Efficacy | PASS | | |

| Emissions Data | | Provider Data and Seal |
|---|---|---|
| Pollution Prevented | | Home Energy Rating Provider |
| Carbon Dioxide (CO2) - tons/year | 4.7 | EnergyLogic |
| Sulfur Dioxide (SO2) - lbs/year | 5.5 | PO Box N |
| Nitrogen Oxides (NOx) - lbs/year | 12.7 | Berthoud CO, 80513 |
| | | Phone: 1-800-315-0459 |
| | | www.nrglogic.com |

REM/Rate - Residential Energy Analysis and Rating Software v 14.6.1
This information does not constitute any warranty of energy cost or savings.

# Will the ERI path be used?




- In 2015
  - 190,180 homes were rated
  - Average HERS Index 62
- In 2016
  - 206,583 homes were rated
  - Average HERS Index 61

# Code Compliance Paths

**Prescriptive Path**

**UA Compliance Path**

**Simulated Performance Path**

**Energy Rating Index Path**

# End Goal

Prescriptive Path



UA Compliance Path



Simulated Performance Path

Energy Rating Index Path

# Base Case Compliance

## 2015 Compliance Reality

- 2 story
- 2800 Square Feet
- Single Family Detached
- Conditioned basement

- UA Alternative
  - Pass by 6.3%
- Simulate Performance
  - Pass by 1.8%
- Corresponding HERS Index
  - HERS 72

## House Specs

- Foundation R-15
- Slab R-0
- Floor over garage R-30
- Rim R-19
- Walls blown R-20
- Windows U-32/SHGC.32
- Doors R-5/ R-2.2
- Attic R-49 flat R-38 edge
- Furnace 80 AFUE w/ 150 CFM LTO & 10% in attic R-8
- Water Heater 62 EF
- AC 13 Seer
- 3 ACH50 & Exhaust Ventilation
- Default appliances 75% CFL

# Typical Code House in Colorado

## 2015 Compliance Reality

- 2 story
- 2800 Square Feet
- Single Family Detached
- Conditioned basement

- UA Alternative
  - Pass by 3%
- Simulate Performance
  - Pass by 6.9%
- Corresponding HERS Index
  - HERS 61

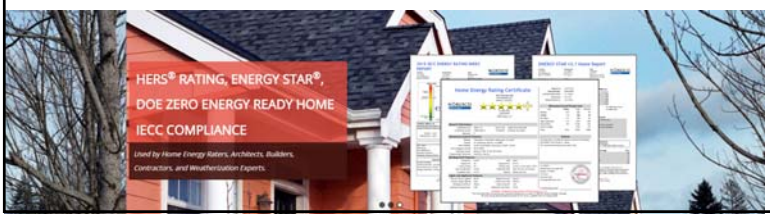
## House Specs

- Foundation R-11
- Slab R-0
- Floor over garage R-50
- Rim R-19
- Walls blown R-23
- Windows U-34/SHGC.32
- Doors R-5/ R-2.2
- Attic R-38 flat R-30 edge
- Furnace 92.5 AFUE w/ 50 CFM LTO & 10% in attic R-8
- Water Heater 62 EF
- AC 13 Seer
- 2.5 ACH50 & Exhaust Ventilation
- Default appliances 100% CFL

# Lets look at the software

ekotrope

REM/Rate™

# Starting Base Case Scenario

**2006 IECC compliant**

- 2 story
- 2800 Square Feet
- Single Family Detached
- Conditioned basement

- HERS Index
  - HERS 98

**House Specs**

- Foundation R-10
- Slab R-0
- Floor over garage R-30 **Grade 3**
- Rim R-19 **Grade 3**
- Walls blown R-19 **Grade 3**
- Windows U-.35/SHGC -.35
- Doors R-5/ R-2.2
- Attic R-38 flat R-30 edge
- Furnace 80 AFUE w/ 200 CFM LTO & 20% return in attic R-6 /20% supply in garage ceiling
- Water Heater .54 EF
- AC 12 Seer
- 7 ACH50 & Exhaust Ventilation
- Default appliances 10% CFL

# Starting Base Case Scenario

**2009 IECC compliant**

- 2 story
- 2800 Square Feet
- Single Family Detached
- Conditioned basement

- HERS Index
  - HERS 95
  - 6.4K PV system = 55

**House Specs**

- Foundation R-10
- Slab R-0
- **Floor over garage R-30 Grade 1**
- **Rim R-19 Grade 1**
- **Walls blown R-19 Grade 1**
- Windows U-.35/SHGC -.35
- Doors R-5/ R-2.2
- Attic R-38 flat R-30 edge
- Furnace 80 AFUE w/ 200 CFM LTO & 20% return in attic R-6 /20% supply in garage ceiling
- Water Heater .54 EF
- AC 12 Seer
- 7 ACH50 & Exhaust Ventilation
- Default appliances 10% CFL

# Integrated within Chapter 4

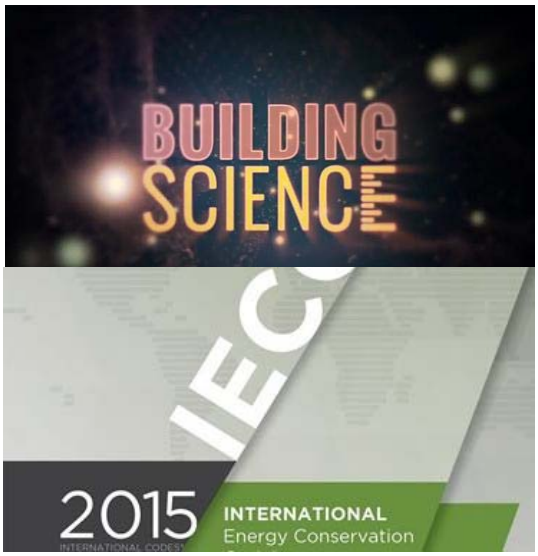
**Systems Thinking**

**Applied Building Science**

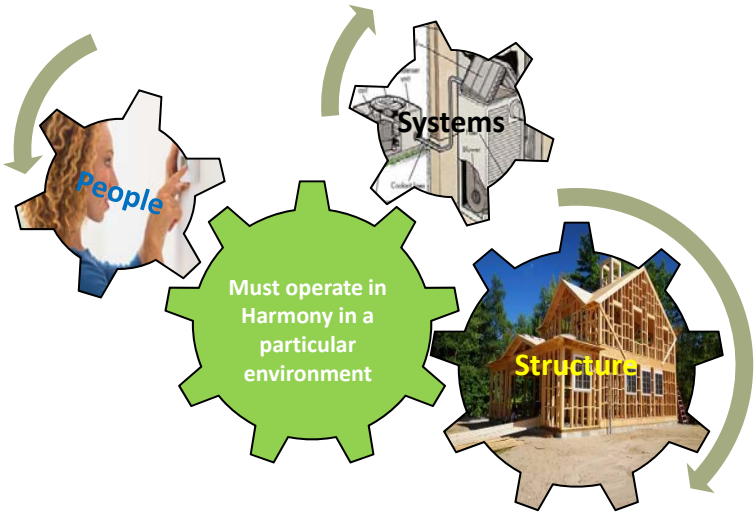
**Air Flow**

**Thermal Flow**

**Moisture Flow**




# House as a System and Applied Building Science

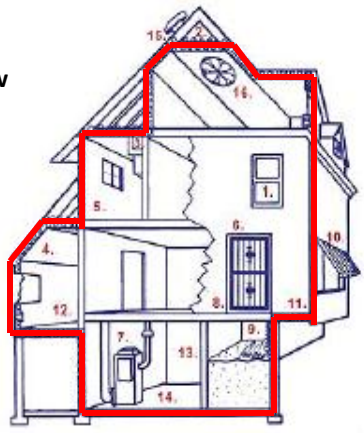


## R402.4.4
## Rooms containing fuel-burning appliances

- In Climate Zones 3 through 8, where open combustion air ducts provide combustion air to open combustion fuel-burning appliances, **the appliances and combustion air opening shall be located outside the building thermal envelope or enclosed in a room, isolated from inside the thermal envelope.**
- **Such rooms shall be sealed** and insulated in accordance with the envelope requirements of Table N1102.1.2, where the walls, floors and ceilings shall meet a minimum of the basement wall *R*-value requirement.
- The **door into the room shall be fully gasketed** and any water lines and ducts in the room insulated in accordance with Section N1103.
- The combustion air duct shall be insulated where it passes through conditioned space to a minimum of R-8.
- Exceptions:
  - Sealed combustion directly vented appliances
  - Fire places complying with section R402.4.2 and IRC section R1006

## What / Where is the Thermal Envelope?

- Control
  - **Air Flow**
  - **Moisture Flow**
  - **Thermal Flow**
  - **HVAC Design**



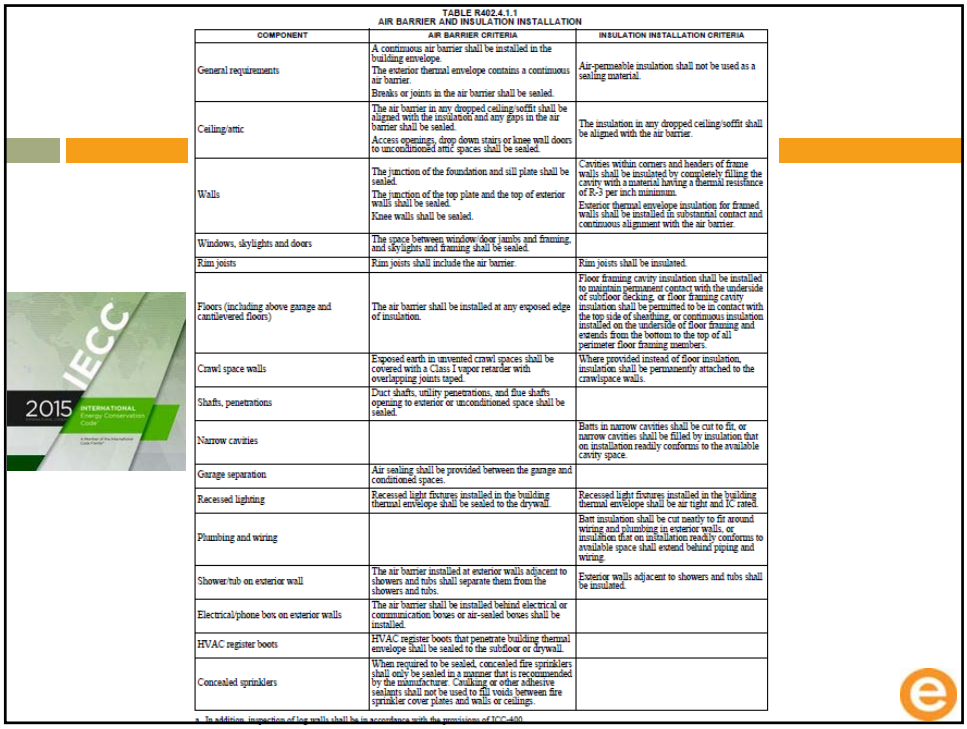


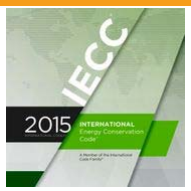
TABLE R402.4.1.1
AIR BARRIER AND INSULATION INSTALLATION

| COMPONENT | AIR BARRIER CRITERIA | INSULATION INSTALLATION CRITERIA |
|---|---|---|
| General requirements | A continuous air barrier shall be installed in the building envelope.<br>The exterior thermal envelope contains a continuous air barrier.<br>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 shall be sealed.<br>Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed. | The insulation in any dropped ceiling/soffit shall be aligned with the air barrier. |
| Walls | The junction of the foundation and sill plate shall be sealed.<br>The junction of the top plate and the top of exterior walls shall be sealed.<br>Knee walls shall be sealed. | Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance of R-3 per inch minimum.<br>Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier. |
| Windows, skylights and doors | The space between window/door jambs and framing, and skylights and framing shall be sealed. | |
| Rim joists | Rim joists shall include the air barrier. | Rim joists shall be insulated. |
| Floors (including above garage and cantilevered floors) | The air barrier shall be installed at any exposed edge of insulation. | Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of subfloor decking, or floor framing cavity insulation shall be permitted to be in contact with the top side of sheathing, or continuous insulation installed on the underside of floor framing and extends from the bottom to the top of all perimeter floor framing members. |
| Crawl space walls | Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped. | Where provided instead of floor insulation, insulation shall be permanently attached to the crawlspace walls. |
| 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 sealed to the drywall. | Recessed light fixtures installed in the building thermal envelope shall be air tight and IC rated. |
| 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 | The air barrier installed at exterior walls adjacent to showers and tubs shall separate them from the showers and tubs. | Exterior walls adjacent to showers and tubs shall be insulated. |
| Electrical/phone 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 subfloor or drywall. | |
| Concealed sprinklers | 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. | |

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

## 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

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 (Mandatory)

## 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


# 5 key Air Barriers Attributes

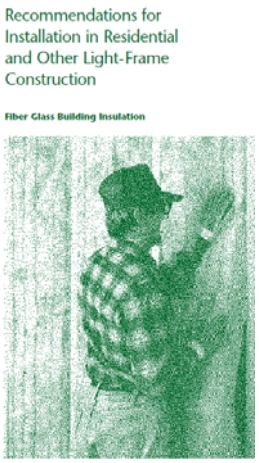
- **Continuity**: The most important element in 3D structures with so many different components
- **Impermeability**: The ABS must be impermeable to Air
- **Strength**: The ABS must be designed to transfer the full designed wind load and continue to be impermeable
- **Durability**: The ABS must continue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

# 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

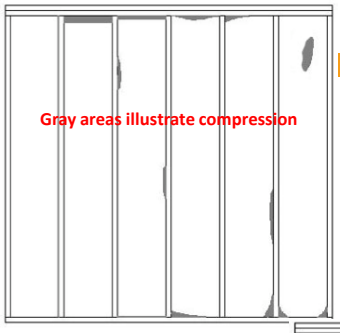
- When insulating walls, place the insulation in the cavity and check to be sure **it completely fills the cavity**, top to bottom.
- Gently press the insulation at the sides into the framing cavity, usually about 3/4 inch, until the outside edge of **the flange is flush with the face of the framing.**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

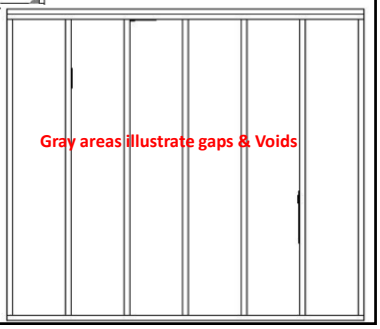
## RESNET Standards Grade 1 Insulation Installation

- 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".

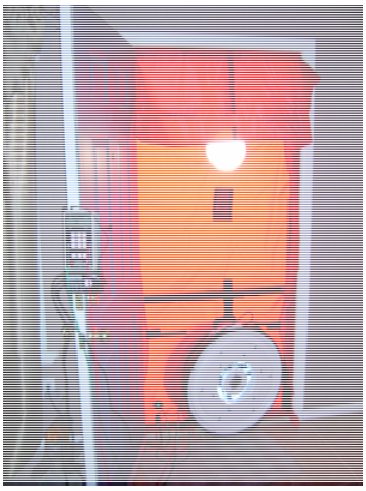
## RESNET Standards – Grade I Insulation



# R402.4.1.2 Testing (Mandatory)

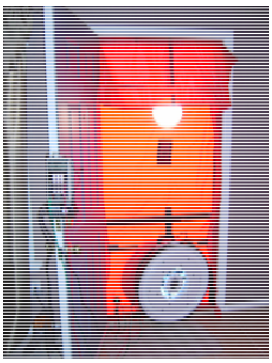
- The building or dwelling unit **shall be tested** and verified as having an air leakage rate not exceeding:
  - 5 ACH@50 in Climate Zones 1 and 2
  - **3 ACH@50 in Climate Zones 3 through 8**
- Testing shall be conducted by an approved third party
- Reporting



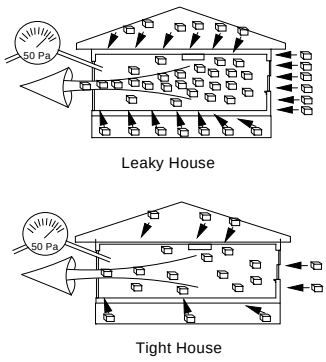
# Air leakage Testing

Air out = Air in

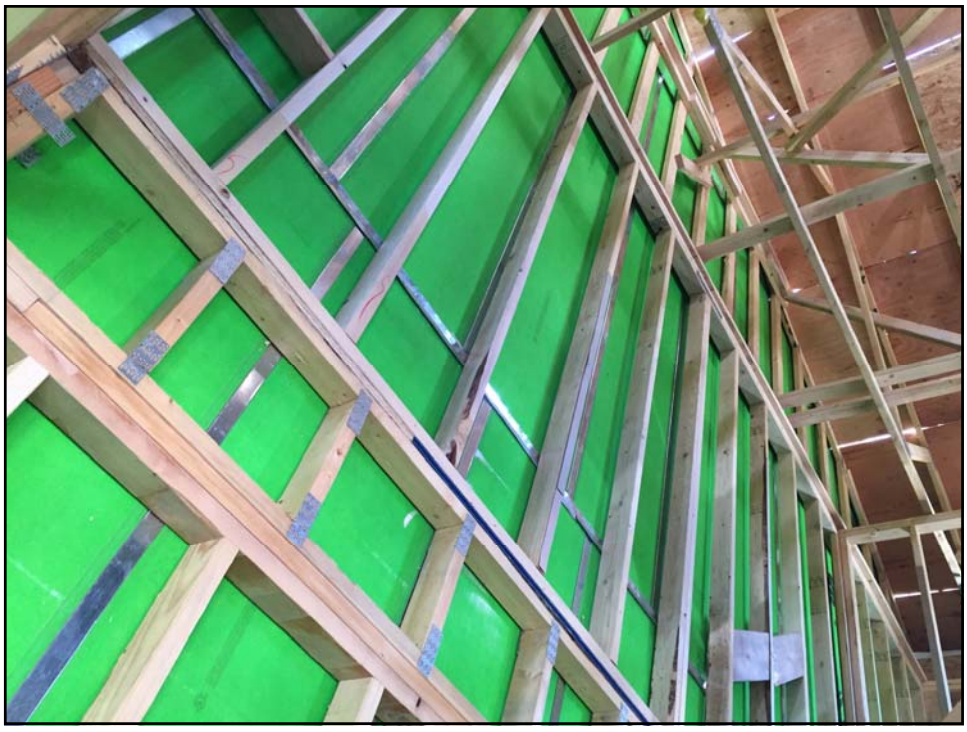
The principle behind the blower door



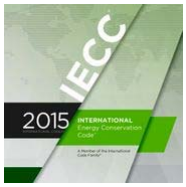
Blower Door Depressurizing House
To 50 Pascals



## Single Family vs. Attached Housing



# Items listed in this table are mandatory and sometimes not clear




## Definitions

**Building Thermal Envelope:** The basement walls, exterior walls, floor, roof, and any other building element that enclose the conditioned space. This boundary also includes the boundary between conditioned space and any exempt or unconditioned space.


TABLE R402.4.1.1
AIR BARRIER AND INSULATION INSTALLATION

| COMPONENT | AIR BARRIER CRITERIA | INSULATION INSTALLATION CRITERIA |
|---|---|---|
| General requirements | A continuous air barrier shall be installed in the building envelope.<br>The exterior thermal envelope contains a continuous air barrier.<br>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 shall be sealed.<br>Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed. | The insulation in any dropped ceiling/soffit shall be aligned with the air barrier. |
| Walls | The junction of the foundation and sill plate shall be sealed.<br>The junction of the top plate and the top of exterior walls shall be sealed.<br>Knee walls shall be sealed. | Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance of R-3 per inch minimum.<br>Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier |
| Windows, skylights and doors | The space between window/door jambs and framing, and skylights and framing shall be sealed. | |
| Rim joists | Rim joists shall include the air barrier. | Rim joists shall be insulated. |
| Floors (including above garage and cantilevered floors) | The air barrier shall be installed at any exposed edge of insulation. | Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of subfloor decking, or floor framing cavity insulation shall be permitted to be in contact with the top side of sheathing, or continuous insulation installed on the underside of floor framing and extends from the bottom to the top of all perimeter floor framing members. |
| Crawl space walls | Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped. | Where provided instead of floor insulation, insulation shall be permanently attached to the crawlspace walls. |
| 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 sealed to the drywall. | Recessed light fixtures installed in the building thermal envelope shall be air tight and IC rated. |
| 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 | The air barrier installed at exterior walls adjacent to showers and tubs shall separate them from the showers and tubs. | Exterior walls adjacent to showers and tubs shall be insulated. |
| Electrical/phone 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 subfloor or drywall. | |
| Concealed sprinklers | 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 sealers shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings. | |

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

# Table 402.4.1.1
## Component – Walls

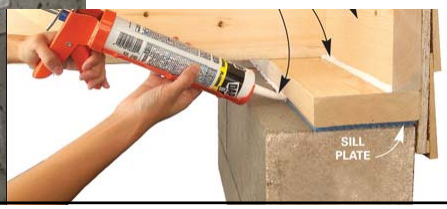

### Air Barrier Criteria

- 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

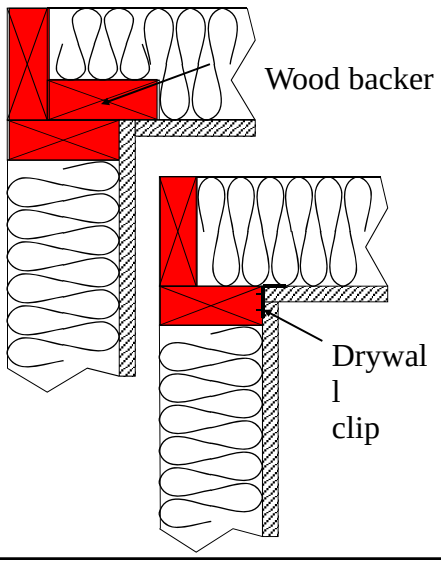




## The junction of the top plate and top of exterior walls shall be sealed

## Doing it Right

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


## Corners and Headers shall be Insulated




# Interior wall meets exterior wall

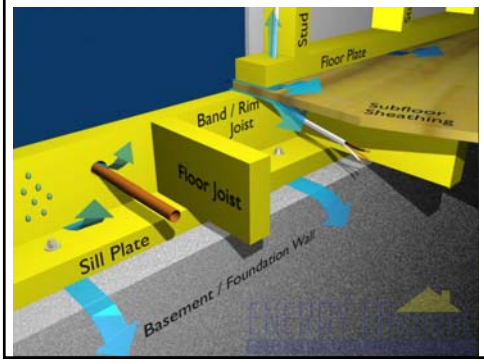
**Ladder Blocking**

**Continuous 2x6 behind 2x4**

# Table 402.4.1.1
## Component – Rim Joists


**Air Barrier Criteria**

- Rim joists shall include the air barrier



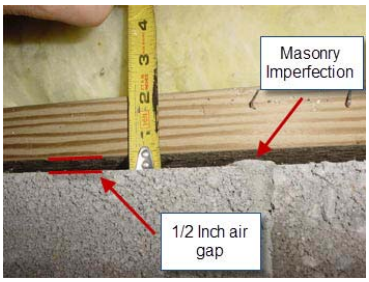

**Insulation Installation Criteria**

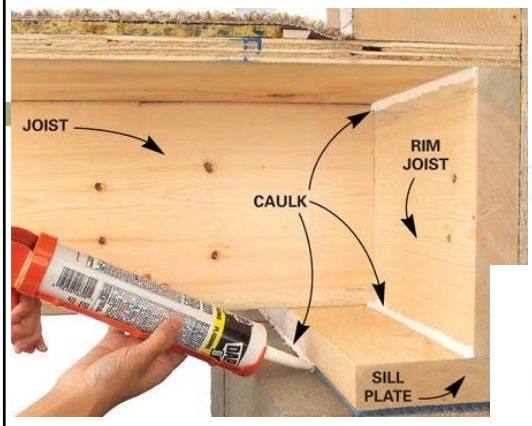
- Rim joists shall be insulated

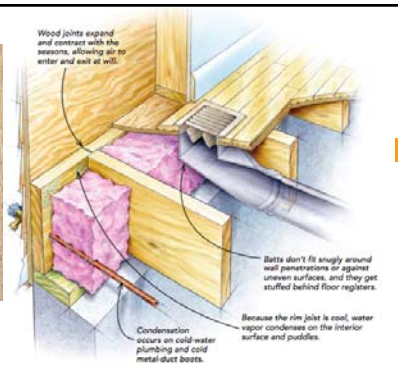
**Rim Joist**

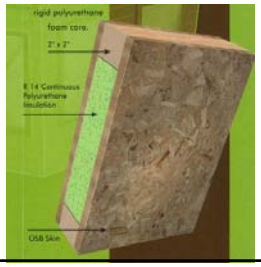
**Box Sill**

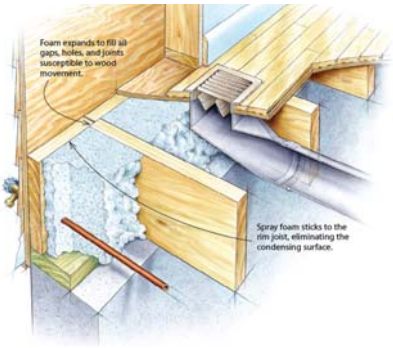
# What Does Air Barrier Mean?



# Shafts / Penetrations

**Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed**

# 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

# 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

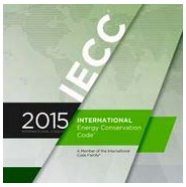
**Insulation Installation Criteria**

# Table 402.4.1.1
## Component – Garage Separation

**Air Barrier Criteria**

- Air sealing shall be provided between the garage and conditioned spaces

**Insulation Installation Criteria**



## Garage Separation

- What does this mean?

## 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

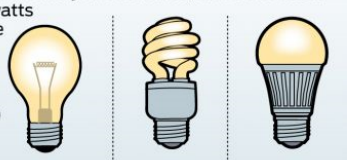
**Insulation Installation Criteria**

# Other Mandatory Items

- HVAC Controls
- Building cavities Shall not be used as ducts or plenums
- Hot water circulation and pipe insulation
- CFL or LED Lighting

**Shedding light on bulbs**

Federal law taking effect Jan. 1 bans the manufacture of incandescent light blubs of 40 watts or more, although sale of existing inventory will continue, and bulbs rated just under 40 watts probably will be available.



| A comparison of a 40-watt bulb and alternatives that produce the same amount of light: | Incandescent bulb | Compact fluorescent lamp (CFL) | Light-emitting diode (LED) |
|---|---|---|---|
| Energy used | 40 watts | 11 watts | 7 watts |
| Lifespan* | 1 year | 9 years | 22 years |
| Price per bulb | $1-2 | $4-6 | $10-25 |
| Annual cost to operate* | $4.82 | $1.32 | $0.84 |

* Based on three hours use a day at 11 cents per kilowatt hour.

Source: Batteries Plus Bulbs; U.S. Department of Energy

Chronicle

# Chapter 5

**R501 Existing Buildings**

- Except as specified in this chapter, this code shall not be used to require the removal, *alteration* or abandonment of, nor prevent the continued use and maintenance of, an existing building or building system lawfully in existence at the time of adoption of this code.

**R501.6 Historical Buildings**

- No provision of this code relating to the construction, *repair, alteration,* restoration and movement of structures, and *change of occupancy* shall be mandatory for *historic buildings* provided a report has been submitted … that (demonstrates that such) provision would threaten, degrade or destroy the historic form, fabric or function of the *building*.

**R502 Additions**

- An extension or increase in the conditioned space floor area or height of a building structure
- Additions to an existing building, building system or portion thereof shall conform to the provisions of this code as those provisions relate to new construction without requiring the unaltered portion of the existing building or building system to comply with this code.

**R 503 Alterations**

- Any construction, retrofit or renovation to an existing structure other than repair or addition that requires a permit
- *Alterations* shall be such that the existing building or structure is no less conforming to the provisions of this code than the existing building or structure was prior to the *alteration*.

**R504 Repairs**

- The reconstruction or renewal of any part of an existing building for the purpose of its maintenance or to correct damage.
- Work on nondamaged components necessary for the required *repair* of damaged components shall be considered part of the *repair* and shall not be subject to the requirements for *alterations* in this chapter

**R505 Change of Occupancy or Use**

- Spaces undergoing a change in occupancy that would result in an increase in demand for either fossil fuel or electrical energy shall comply with this code.

# Chapter 6: Referenced Standards

**ACCA**

- Manual J Residential Load Calculation Eighth Edition, Referenced in R403.6
- Manual S: Residential Equipment Selection, Referenced in R403.6

**ASHRAE**

- Handbook of Fundamentals, Referenced in 402.1.4, Table R405.5.2(1)
- 62.2-10 Home Ventilation Standard???

**NFRC**

- Procedure for Determining Fenestration Products U-Factors, Second Edition, Referenced in R303.1.3

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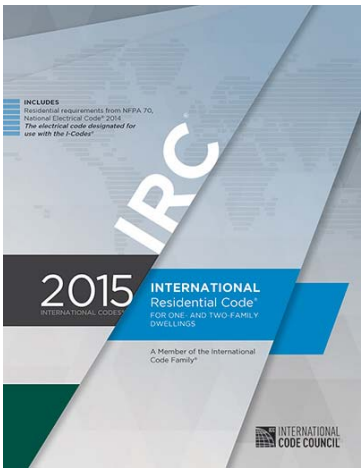
# 2015 International Residential Code

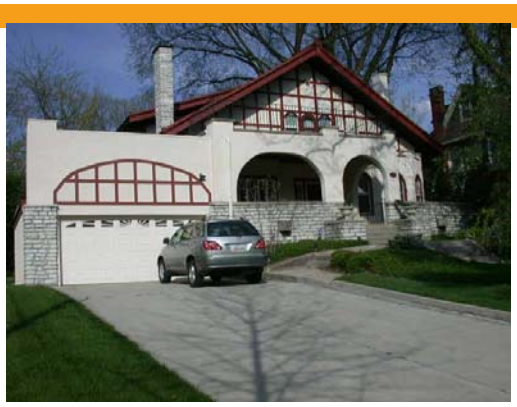
**Connection to the IECC**



# R102.1

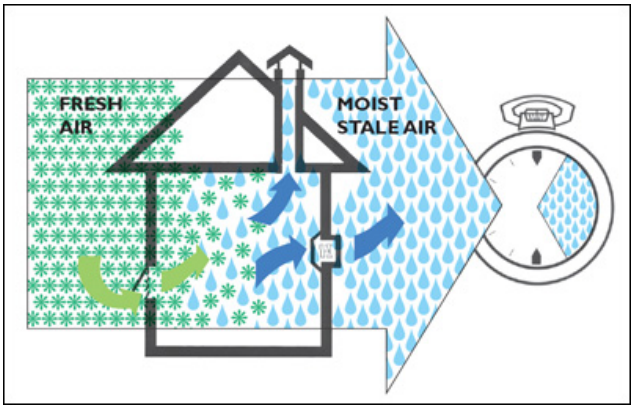
- **The Code official <u>shall be permitted</u> to approve an alternative material, design or method of construction** where the code official finds that the proposed design is satisfactory and complies with the intent of the provision of this code and that the material, method or work offered is for the purpose intended, at least the equivalent of that prescribed in this code


# How to stop Diffusion



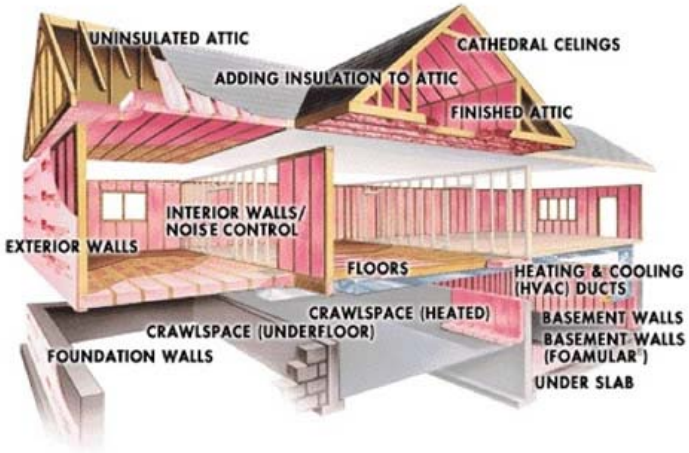
**STOP BUILDING HOUSE**

# Ventilation & HVAC Design




# Thermal Envelope vs. HVAC

- Is it there and does it work?



# 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

# 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 |

- Ventilation can't be greater than what is calculated by formula
- Simulated Performance and ASHRAE 62.2 Formula

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

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

(0.01 X 1510) + (7.5 times 5)
Formula Result: 52.5 CFM
Chart Result: 75 CFM

## *Local Exhaust Ventilation* Sometimes referred to as "Spot Ventilation" Removes pollutants, Moisture, to the odors at the 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




## *Local Exhaust Ventilation* Sometimes referred to as "Spot Ventilation" Removes pollutants, Moisture, to the odors at the source

**TABLE M1507.4**

- **Kitchens:**
  - **100 CFM intermittent**
  - **25 CFM continuous**
  - **Ducted to outside**
- **Baths:**
  - **50 CFM intermittent**
  - **20 CFM continuous**



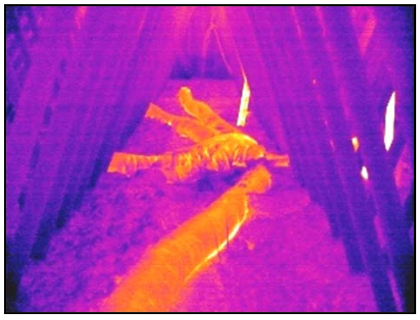

## HVAC Design

- The HVAC design process has three major steps:
  - Step 1: Calculate the heating and cooling loads (Manual J).
  - Step 2: Select equipment with capacity to meet those loads (Manual S).
  - Step 3: Design a duct system that can get air from the equipment to the rooms and back (Manual D).


# R403.3.3 Duct testing (Mandatory).

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

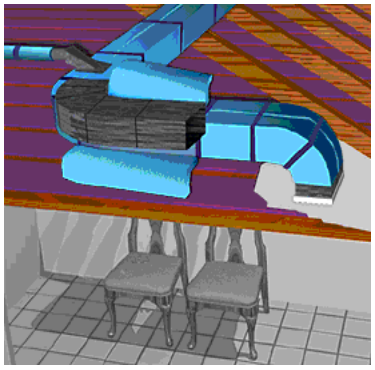
- Attic
- Unconditioned crawl space
- Isolated mechanical room with natural draft appliance
- Floor over garage?
- Exterior wall?



# Duct Leakage to Outside

## Not included in the 2012 or 2015 IECC / Kinda??

**Must be tested when using the performance path of code**



https://thecraftsmanblog.com/how-to-tell-if-you-have-a-balloon-frame-house/

# Conclusion

- Code compliance 3rd party inspection is a huge opportunity
- Huge responsibility
- Need to study the code like you would a program
- Building Science is embedded in Code
  - Air Flow
  - Thermal Flow
  - Moisture Flow


Thank you!

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