

# 2021 IECC Requirements

Presented By Robby Schwarz

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Thinking **ZERO** to 360°

**BUILD***Tank*inc.



# Our Plan Ahead

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R402 Requirements

Table R402.4.1.1 Requirements

Testing Requirements

Other requirements





# R103.2

## 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:
  - [Energy Compliance Path](#)
  - 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](#)





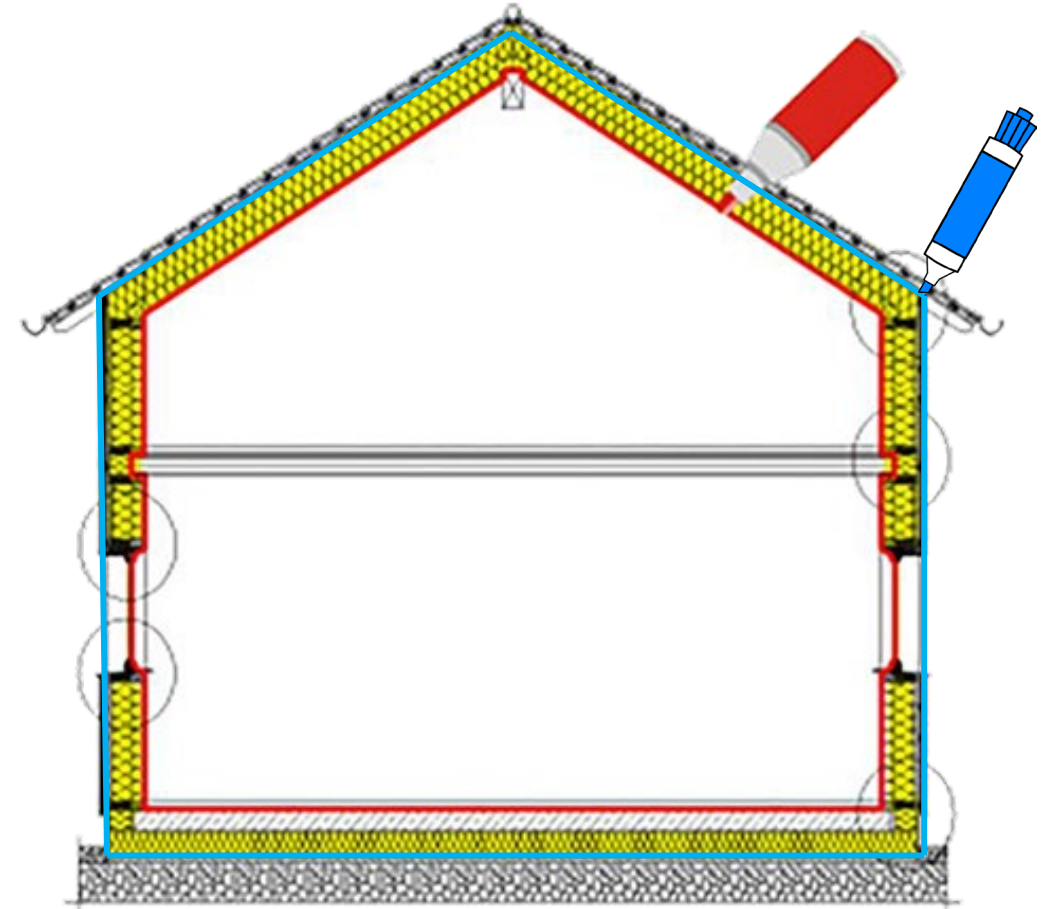
# IECC and the Building Thermal Envelope

## R103.2.1 Building thermal envelope depiction.

- The *building thermal envelope* shall be represented on the construction documents.

## BUILDING THERMAL ENVELOPE.

- The *basement walls, exterior walls, floors, ceiling, roofs and any other building element assemblies that enclose conditioned space* or **provide a boundary between conditioned space and exempt or unconditioned space.**





# R105 Inspections

- Footing and foundation
- Framing and rough-in inspection
- Plumbing rough-in inspection
- Mechanical rough-in inspection
- Final inspection
- Re-inspection
- Construction or work for which a permit is required shall be subject to inspection
- The code official or his/her agent shall inspect....



<https://www.washingtonpost.com/news/where-we-live/wp/2018/06/18/inspecting-the-home-inspectors/>



# Required Inspections

## R105.2.2 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.

## R105.2.4 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

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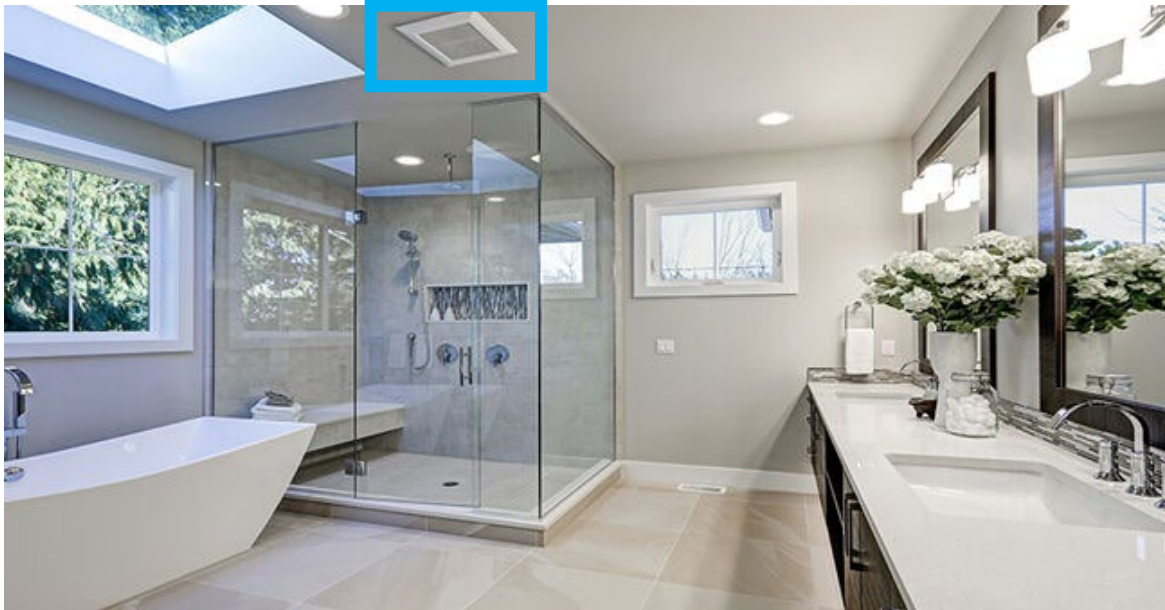
<https://www.calthorpe.com/stapleton>

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# Fundamental Questions

Is It There?



Does It Work?



<https://news.iheart.com/featured/gary-sullivan/content/2018-02-16-special-how-to-dealing-with-bathroom-exhaust-fans/>

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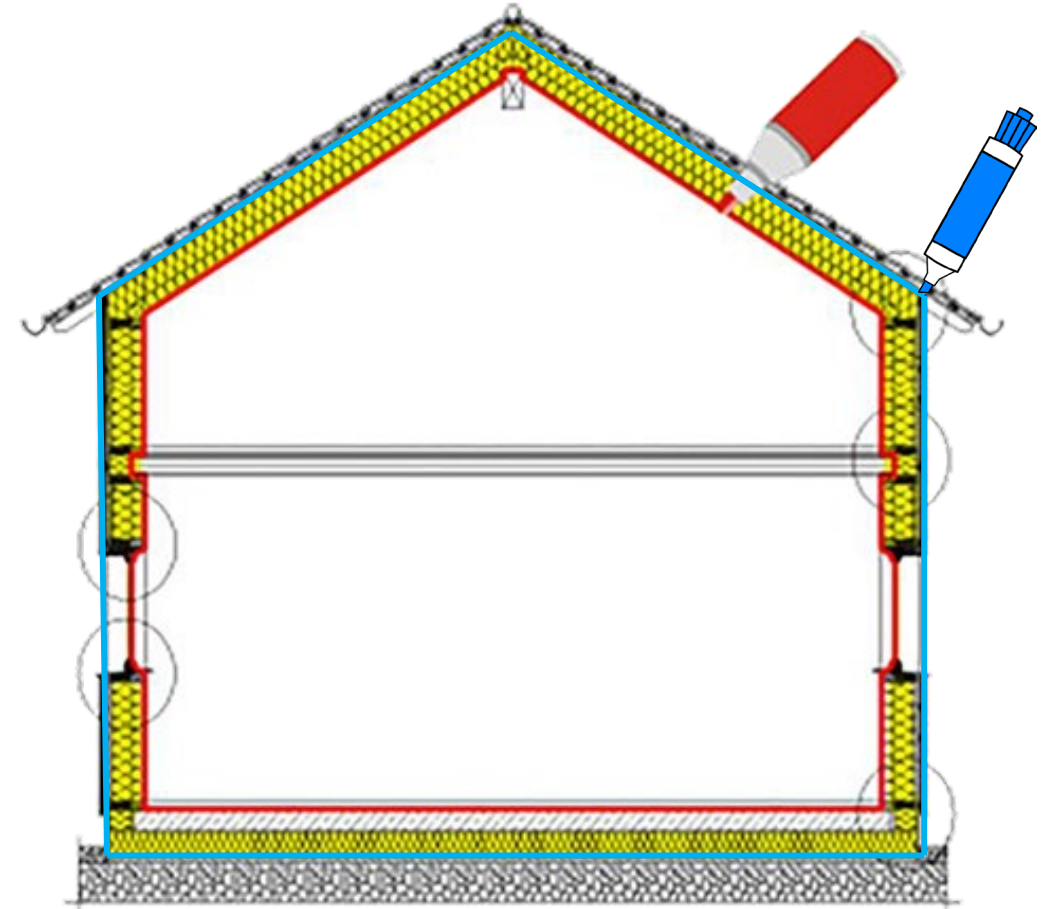
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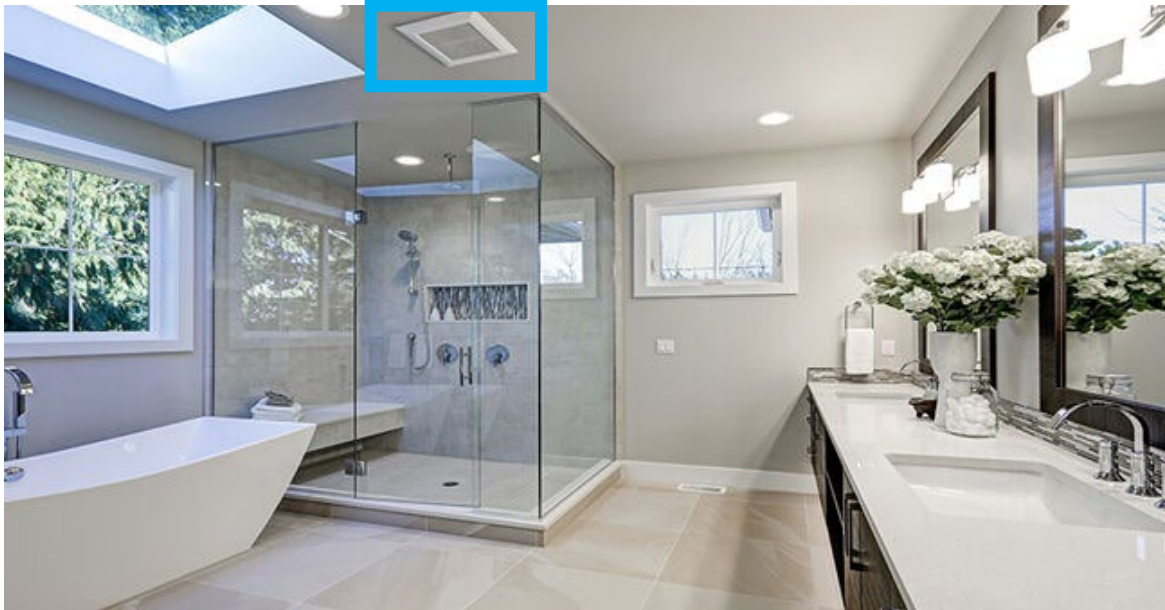
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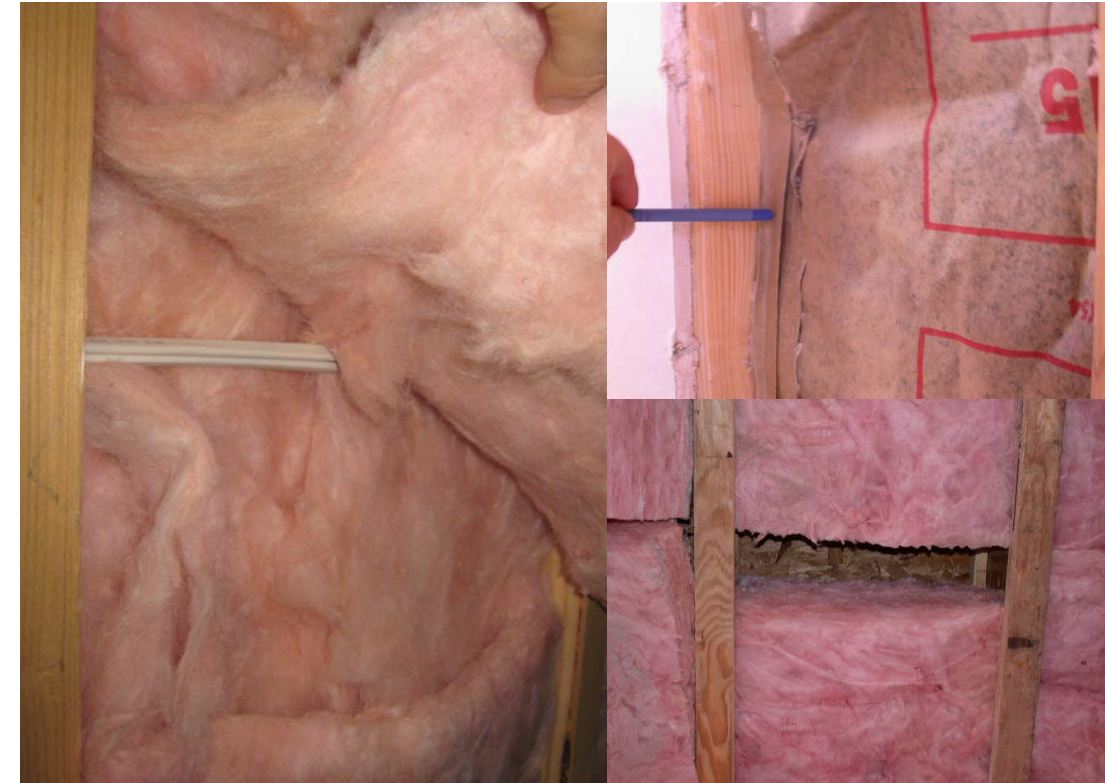
# Chapter 3: Insulation Installation

## R303.1.2 Insulation mark installation.

- Insulating materials **shall be installed such that the manufacturer's R-value mark is readily observable** at inspection
- For insulation materials that are installed without an observable manufacturer's R-value mark, such as blown or draped products, **an insulation certificate complying with Section R303.1.1 shall be left immediately after installation by the installer**, in a conspicuous location within the building, to certify the installed R-value of the insulation material.

## 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





# R303.1.1 Building thermal envelope insulation.

- An *R*-value identification mark shall be applied by the manufacturer to each piece of *building thermal envelope* insulation that is 12 inches (305 mm) or greater in width. Alternatively, the insulation installers shall provide a certification that indicates the type, manufacturer and *R*-value of insulation installed in each element of the *building thermal envelope*.
- For **blown-in or sprayed fiberglass and cellulose insulation**, the initial installed thickness, settled thickness, settled *R*-value, installed density, coverage area and number of bags installed shall be indicated on the certification.
- For **sprayed polyurethane foam (SPF) insulation**, the installed thickness of the areas covered, and the *R*-value of the installed thickness shall be indicated on the certification.
- For **insulated siding**, the *R*-value shall be on a label on the product's package and shall be indicated on the certification. The insulation installer shall sign, date and post the certification in a conspicuous location on the job site.



# Chapter 3: General

## R303.1.1 Building thermal envelope insulation

- R-value identification mark or
- 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

## R303.1.2 Insulation Mark Installation

- Insulating materials shall be installed such that the manufacturer's *R*-value mark is readily observable at inspection. For insulation materials that are installed without an observable manufacturer's *R*-value mark, such as blown or draped products, **an insulation certificate** complying with Section R303.1.1 **shall be left immediately after installation by the installer**, in a conspicuous location within the building, to certify **the installed *R*-value of the insulation material**.





# R401.3 Certificate (required)

- A permanent certificate **shall be completed and posted** on a wall in the space where the furnace is located, utility room, or an approved location inside the building the builder or approved party
- The certificate shall list....
  - R-values of insulation
  - 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
  - Types and efficiencies of heating, cooling and service water heating equipment.
  - On site PV System array capacity, inverter efficiency, panel tilt, and orientation
  - Code ERI score with and without on-site generation
  - R-values of ducts outside conditioned spaces
  - The code edition under which the structure was permitted, and the compliance path used

<b>IECC 2018 Label</b>
<b>123 Place to Live Dr.</b>
Model: Village N4101
Ekotrope RATER - Version: 3.2.3.2346
<b>Building Envelope Specs</b>
Ceiling: R-50
Above Grade Walls: R-23
Foundation Walls: R-11
Exposed Floor: N/A
Slab: R-0
Infiltration: 2144 CFM50 (2.85 ACH50)
Duct Insulation: R-0
Duct Lkg to Outdoors: 1 CFM @ 25Pa (0.02 / 100 s.f.)
<b>Window &amp; Door Specs</b>
U-Value: 0.31, SHGC: 0.31
Door: R-6
<b>Mechanical Equipment Specs</b>
Heating: Furnace • Natural Gas • 92 AFUE
Cooling: Air Conditioner • Electric • 13 SEER
Hot Water: Water Heater • Natural Gas • 0.62 Energy Factor
<b>Builder or Design Professional</b>
Signature: _____



# R401.3 Certificate

- For prescriptive compliance there is no software to create the report
- You are going to see all kinds of homemade R401.3 Certificates

## 2018 IECC R401 Label/Certificate

Date:

Builder:		RESNET HERS ERI:
Address:		IECC ERI with PV:
Jurisdiction:		IECC ERI w/out PV:
Compliance Path:		

Building Envelope Specifications:		
▪ Ceiling	R -	
▪ Above Grade Walls	R -	
▪ Exposed Floors	R -	
▪ Foundation Walls	R -	
▪ Slab/Slab edge	R -	
▪ Duct in unconditioned space	R -	
▪ Exterior Door R-Value	R -	
▪ Window U-Value / SHGC	U-value:	SHGC:

Mechanical Equipment Specification		
	Type	Efficiency
Heating	Gas Forced Air Furnace	AFUE
Cooling	Central Air Conditioner	SEER
Whole House Ventilation Strategy	Exhaust	CFM Rate:
Water Heating	Electric 50 Gallon	UEF

Building Performance Data	
Envelope Infiltration: Air Changes Per Hour @50 Pascals	ACH50
Duct Leakage compliance target: 4CFM/100sqft of conditioned floor area	3569 Sqft conditioned space: 35.69 X 4 = 143 CFM target
Measured Total Duct Leakage:	CFM25
Measured Duct Leakage to Outside:	CFM25

Photovoltaic systems			
Array Capacity	Inverter Efficiency	Panel Tilt	Panel Orientation

Robby Schwarz

IECC Residential Energy Inspector/Plans Examiner/HERS/ERI Performance Specialist



# IECC Code Compliance Paths

## R401.2 Application



Additional Energy  
Efficiency Requirements

Energy Efficient

<http://www.stouffvilleglass.com/blog/green-friendly-homes-garner-a-price-premium/>



Prescriptive U-Value  
or R-value



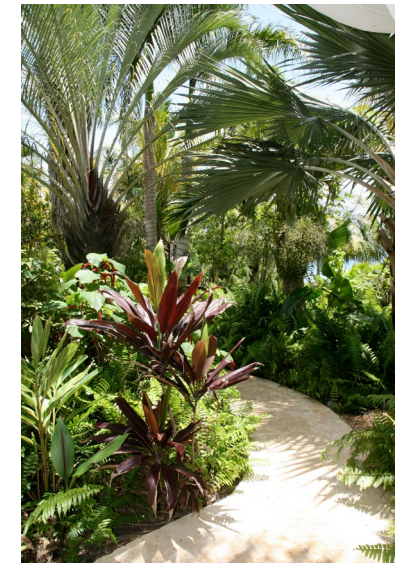
Prescriptive  
UA Compliance



Total Building  
Performance



Energy Rating  
Index Path



Tropical Climate

# International Energy Conservation Code



(Mandatory)

Removed from the language of the code.  
Replaced with table of required items

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Specific and Overarching Requirements  
Dependent on Compliance Path





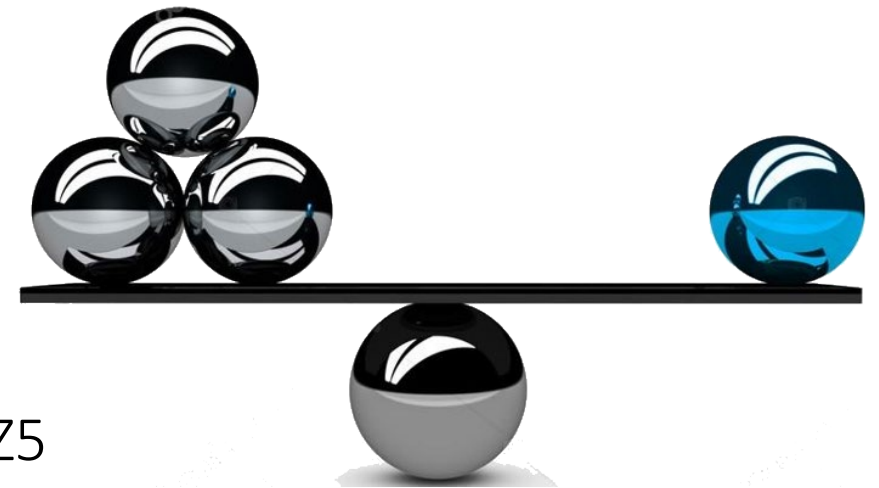
# Terminology

- **Requirements**
  - Mandatory **meant items that could not be traded off**
  - Requirements must be met by every compliance path unless there is a specific exception written in the code. Requirements are found in specific sections or in tables imbedded in the code language
- **Prescriptive Requirements**
  - Requirements that can't be traded **in most cases**, and must be met when using the prescriptive compliance path and met when using other compliance paths if included in a requirement table
- **Performance Approach**
  - **Allows the use of a tradeoffs to meet a specific prescriptive R-value requirement of the code that ensure equal or better performance**
  - A performance approach **does not override** requirements for how to install an efficiency **measure**, such as insulation
  - You can tradeoff R-values, U-values, air tightness, duct leakage, etc. depending on the compliance path you are using



# Tradeoff

- A trade off refers to putting something **more in one** assembly so you can put something **less in another**
- HOWEVER, **in the IECC's case the energy performance scale remains balanced**
- You can tradeoff R-values, U-values, air tightness, duct leakage, etc. depending on the compliance path you are using



- The **blue ball is attic insulation R38**
- The prescriptive R-value path says it must be R60 in CZ5
- The **3 silver balls balanced the energy equation because they represent better windows, air tightness, and reduced duct leakage** than is required by the IECC
- Therefore, I traded off less attic R-value for better windows, air tightness and duct leakage



# R405.2 Compliance Requirements

# R406.2 Compliance Requirements

Compliance with this pathway requires

- Demonstration of compliance with Table R405.2 or R406.2
- The old (Mandatory) items

TABLE R405.2  
REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

SECTION <sup>a</sup>	TITLE
General	
R401.2.5	Additional energy efficiency
R401.3	Certificate
Building Thermal Envelope	
R402.1.1	Vapor retarder
R402.2.3	Eave baffle
R402.2.4.1	Access hatches and doors
R402.2.10.1	Crawl space wall insulation installations
R402.4.1.1	Installation
R402.4.1.2	Testing
R402.5	Maximum fenestration <i>U</i> -factor and SHGC
Mechanical	
R403.1	Controls
R403.3, including R403.3.1, except Sections R403.3.2, R403.3.3 and R403.3.6	Ducts
R403.4	Mechanical system piping insulation
R403.5.1	Heated water circulation and temperature maintenance systems
R403.5.3	Drain water heat recovery units
R403.6	Mechanical ventilation
R403.7	Equipment sizing and efficiency rating
R403.8	Systems serving multiple dwelling units
R403.9	Snow melt and ice systems
R403.10	Energy consumption of pools and spas
R403.11	Portable spas
R403.12	Residential pools and permanent residential spas
Electrical Power and Lighting Systems	
R404.1	Lighting equipment
404.2	Interior lighting controls

TABLE R406.2  
REQUIREMENTS FOR ENERGY RATING INDEX

SECTION <sup>a</sup>	TITLE
General	
R401.2.5	Additional efficiency packages
R401.3	Certificate
Building Thermal Envelope	
R402.1.1	Vapor retarder
R402.2.3	Eave baffle
R402.2.4.1	Access hatches and doors
R402.2.10.1	Crawl space wall insulation installation
R402.4.1.1	Installation
R402.4.1.2	Testing
Mechanical	
R403.1	Controls
R403.3 except Sections R403.3.2, R403.3.3 and R403.3.6	Ducts
R403.4	Mechanical system piping insulation
R403.5.1	Heated water circulation and temperature maintenance systems
R403.5.3	Drain water heat recovery units
R403.6	Mechanical ventilation
R403.7	Equipment sizing and efficiency rating
R403.8	Systems serving multiple dwelling units
R403.9	Snow melt and ice systems
R403.10	Energy consumption of pools and spas
R403.11	Portable spas
R403.12	Residential pools and permanent residential spas
Electrical Power and Lighting Systems	
R404.1	Lighting equipment
404.2	Interior lighting controls
R406.3	Building thermal envelope

a. Reference to a code section includes all of the relative subsections except as indicated in the table.

# R401.2.5 Additional Energy Efficiency

This section established additional requirements **applicable to all compliance approaches** to achieve additional efficiency.

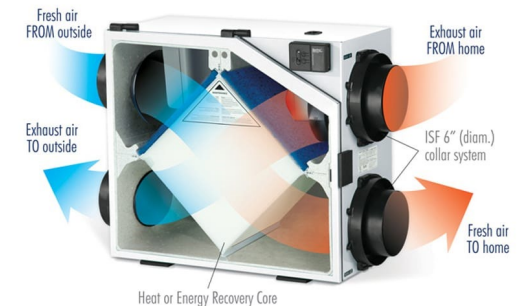
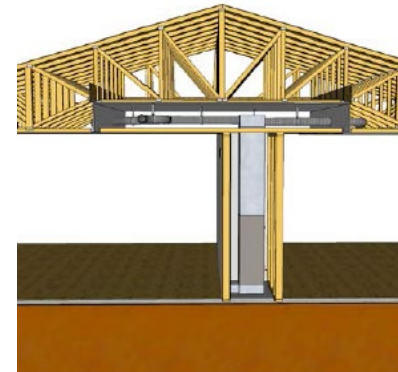
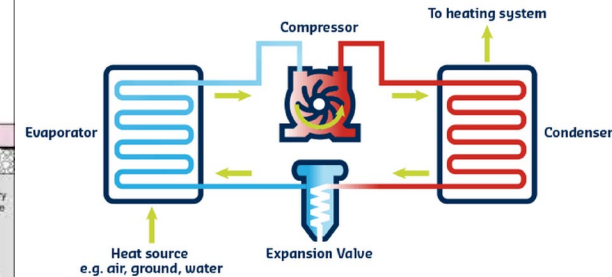
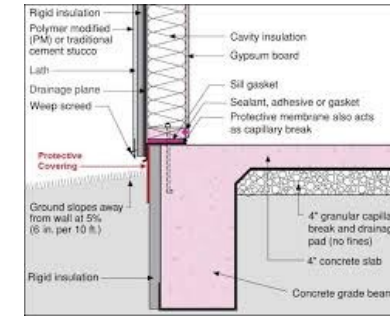
- Prescriptive compliance
  - **Choose one** of the efficiency packages laid out in Section R408.2
- Total Building Performance compliance
  - **Choose one** of the efficiency packages laid out in Section R408.2 **DO NOT model the additional efficiency** (???) OR
    - The **cost compliance shall be 5% or better than** the reference design
- Energy Rating Index compliance
  - The **ERI score shall be 5% better than** that required by the IECC.





# R408 Additional Efficiency Package Options

- **R408.2.1 Enhanced envelope performance**
  - Envelope and area weighted SHGC are 5% better than prescriptive U-value Table R402.1.2
- **R408.2.2 More efficient HVAC equipment**
  - $\geq 95$  AFUR furnace and 16 SEER AC
  - $\geq 10$  HPSF /16 SEER air source heat pump
  - $\geq 3.5$  COP ground source heat pump
- **R408.2.3 More efficient water heating**
  - $\geq 82$  EF gas water heater
  - $\geq 2.0$  EF electric water heater
  - $\geq 0.4$  solar fraction water heater
- **R408.2.4 More efficient HVAC delivery**
  - 100% of duct, ductless, or hydronic distribution inside Building Thermal Envelope
- **R408.2.5 Improved air sealing and ventilation**
  - $\leq 3.0$  ACH50 plus ERV or HRV with 75% SRE and 50% LRMT



# R402.2 Specific insulation requirements.

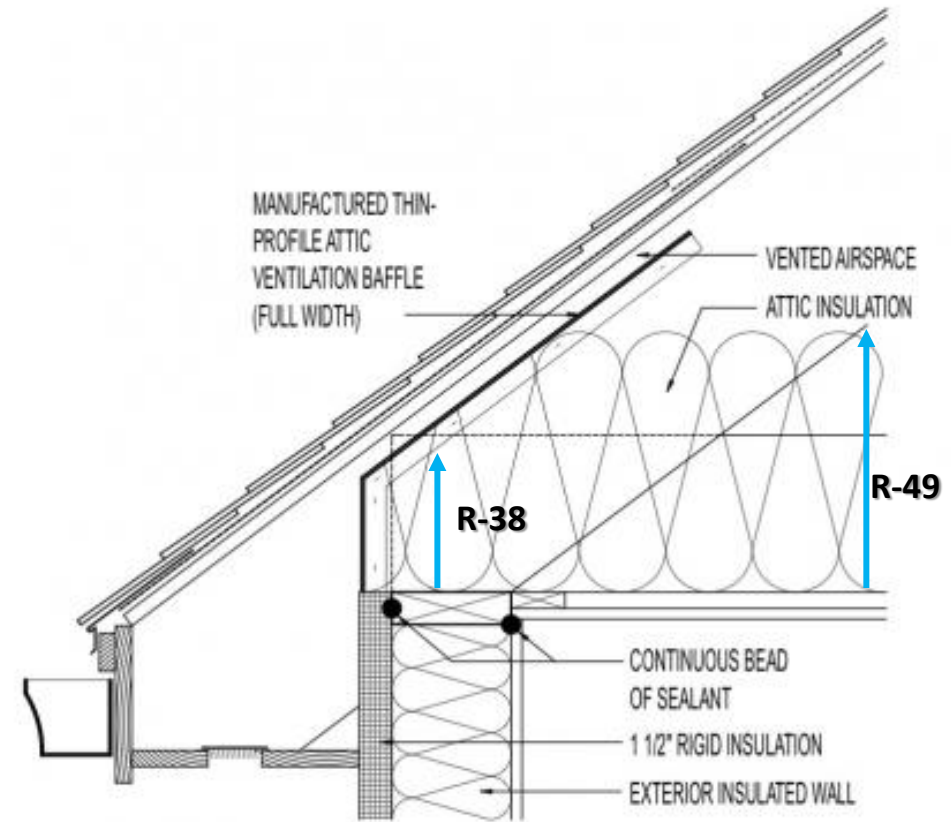
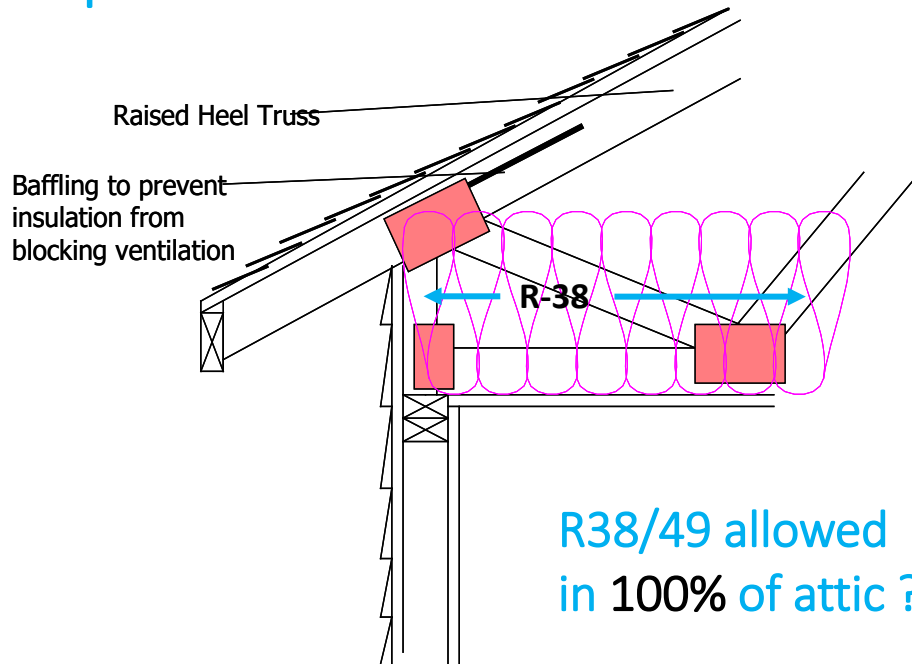
- In addition to the requirements of Section R402.1, **insulation shall meet the specific requirements** of Sections R402.2.1 through R402.2.12
- Mandatory (old) vs. requirements (new)
  - Installation requirements that can't be traded off
    - Ceilings
    - Eave baffles
    - Foundations
    - Attic hatches
    - Mass wall
    - Steel framing
    - Floor systems
    - Etc.



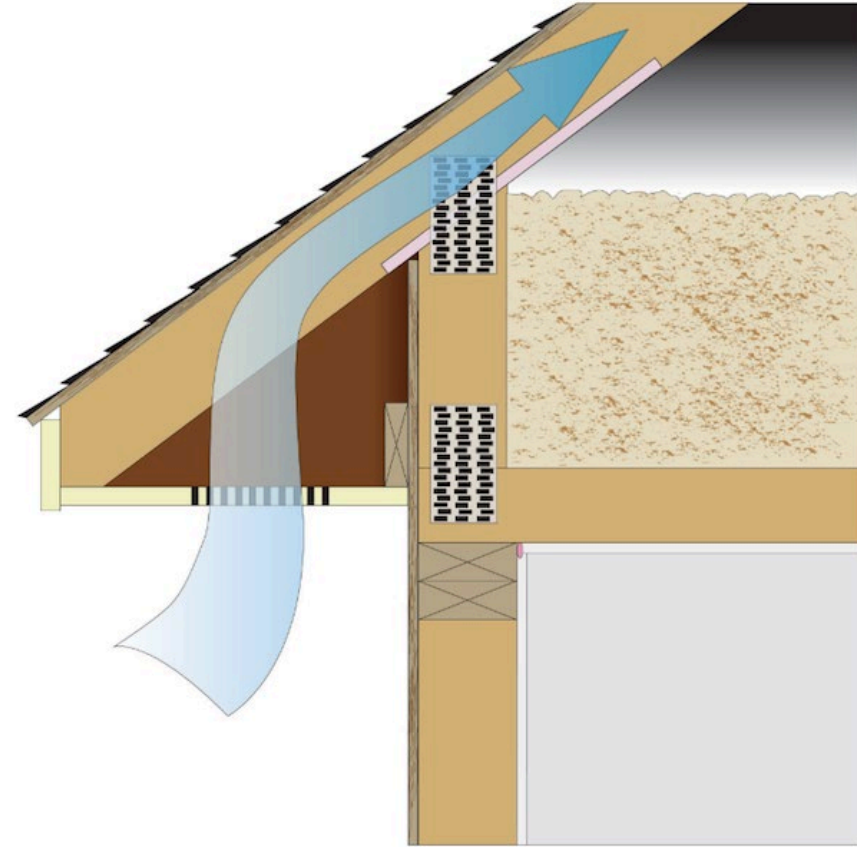


# R402.2.1 Ceilings with attics

- R38/R49 shall be deemed to satisfy the requirement for R49/R60 **wherever the full height of uncompressed R-38 insulation extends over the wall top plate at the eaves**



## R402.2.1 Ceilings with attic spaces

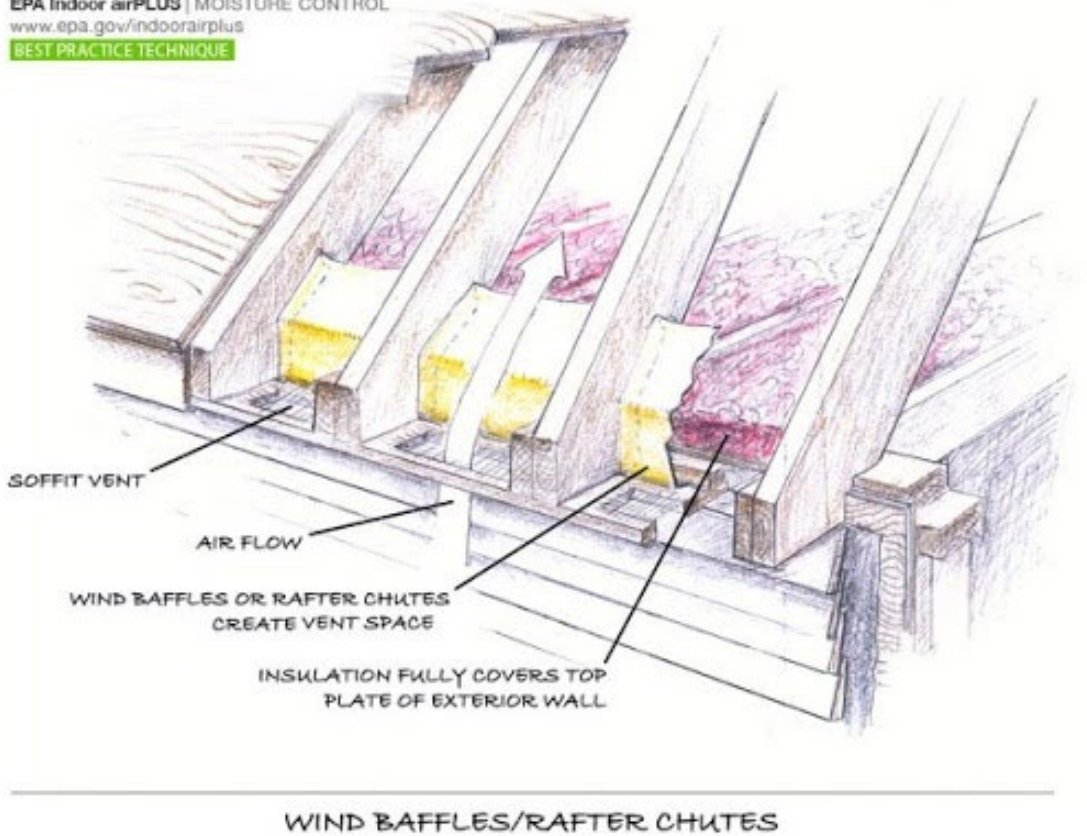


<https://www.probuilder.com/advanced-framing-techniques-help-boost-home-performance>



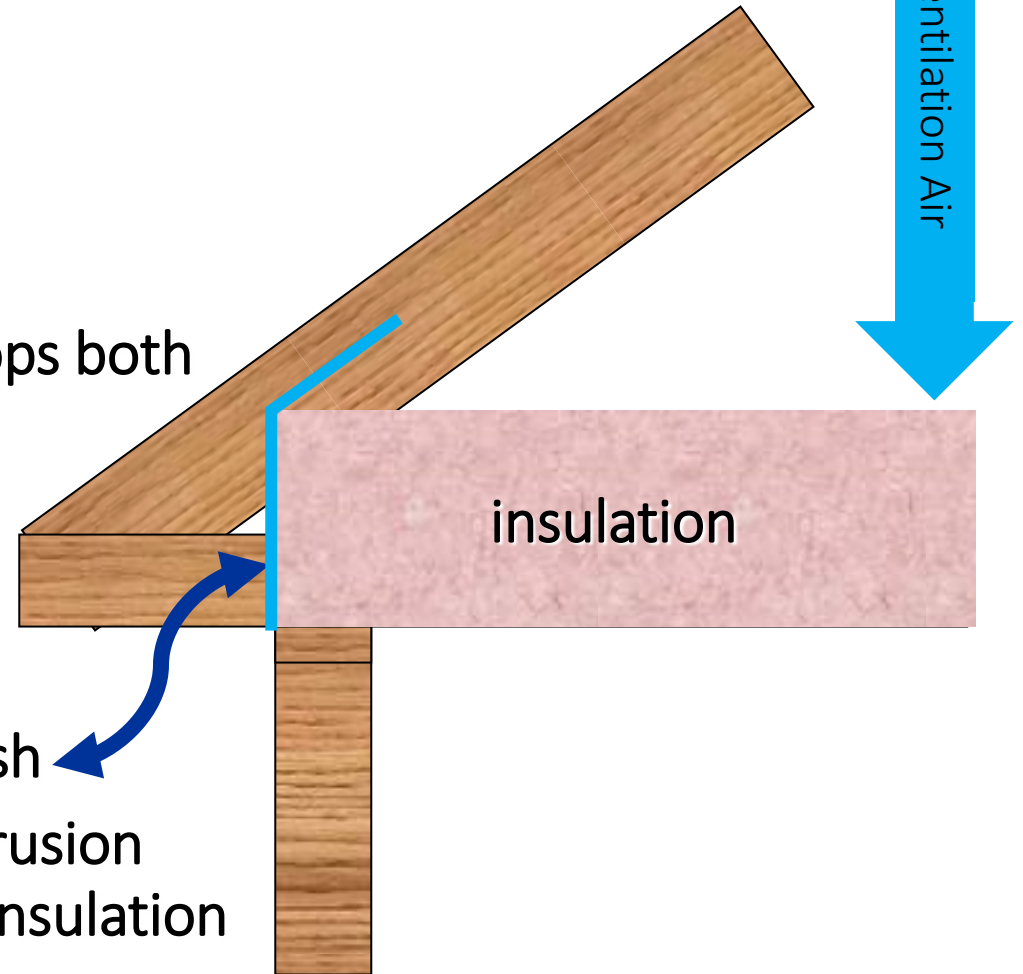
# Theory of Ventilated Attic Insulation

EPA Indoor airPLUS | MOISTURE CONTROL  
www.epa.gov/indoorairplus  
BEST PRACTICE TECHNIQUE



Baffle stops both

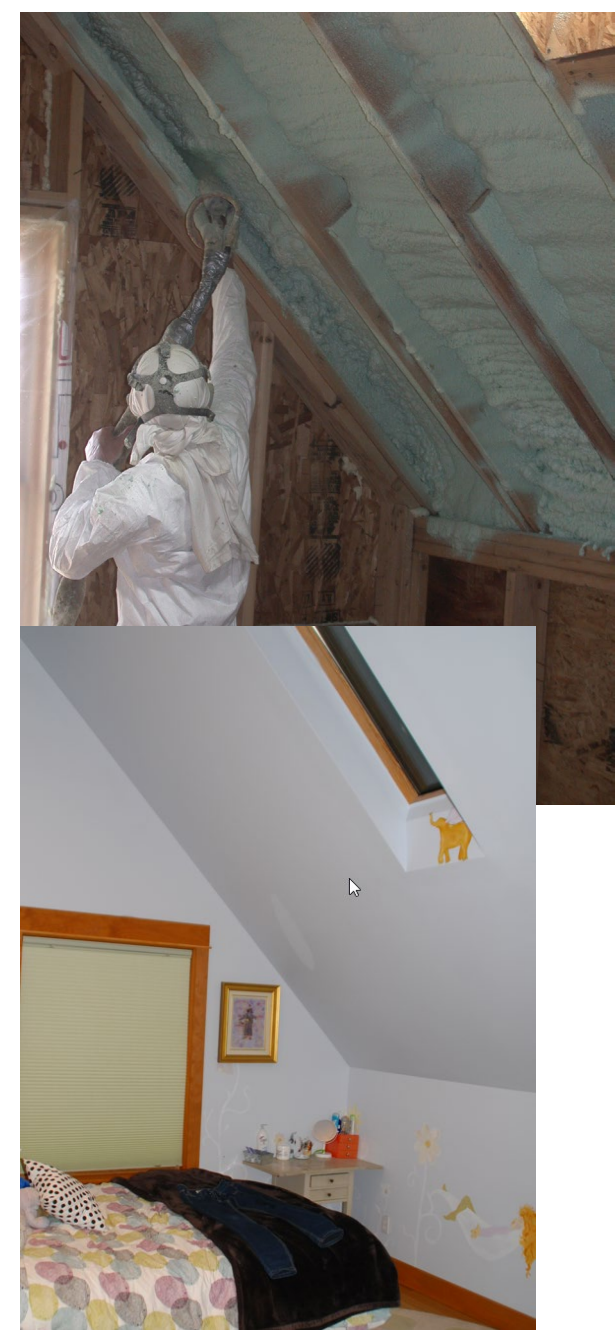
wind-wash  
Wind intrusion  
into the insulation





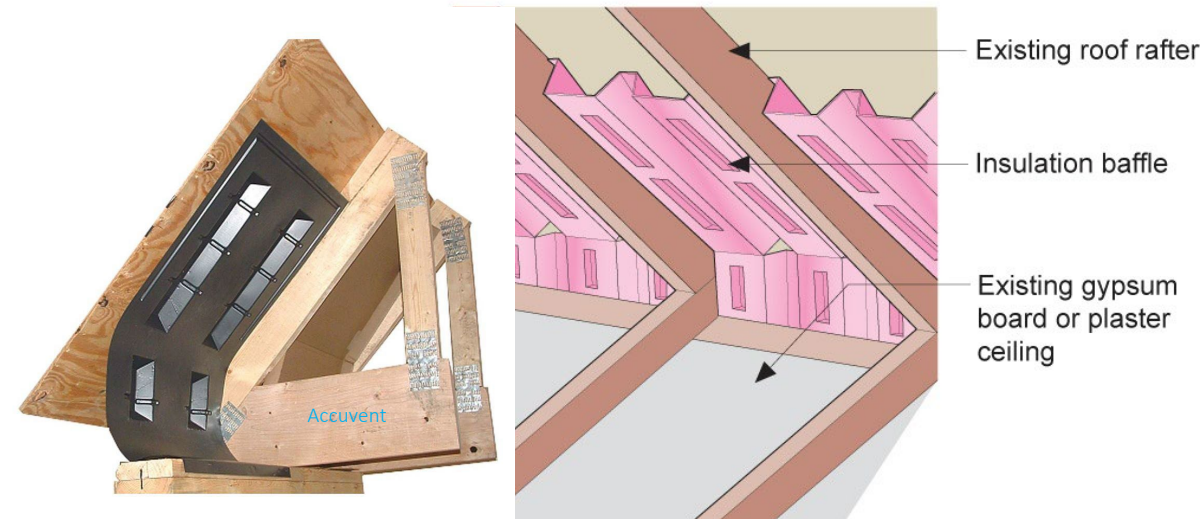
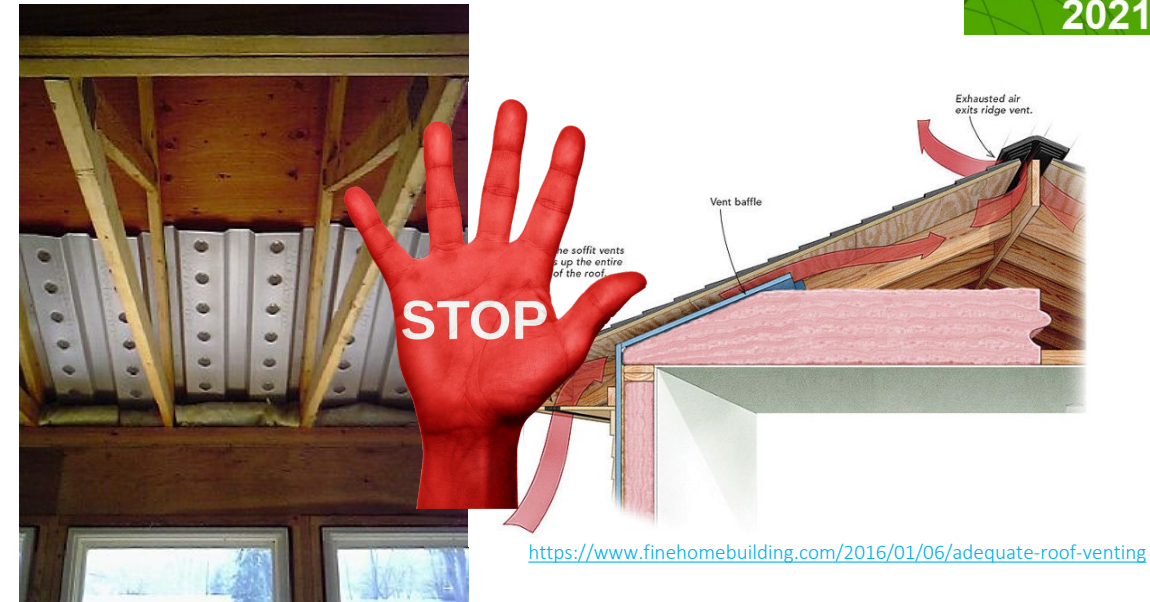
# R402.2.2 Ceilings without attics

- Where Section R402.1.3 requires insulation  $R$ -values greater than  $R$ -30 in the interstitial space above a ceiling and below the structural roof deck, and the design of **the roof/ceiling assembly does not allow sufficient space for the required insulation**, the minimum required insulation  $R$ -value for such roof/ceiling assemblies **shall be  $R$ -30**.
- **Insulation shall extend over the top of the wall plate to the outer edge of such plate and shall not be compressed.**
- This reduction of insulation from the requirements of Section R402.1.3 **shall be limited to 500 square feet (46 m<sup>2</sup>) or 20 percent of the total insulated ceiling area, whichever is less.**
- This reduction **shall not apply to the Total UA alternative** in Section R402.1.5.



## R402.2.3 Eave baffle

- For air permeable insulations in vented attics, a **baffle shall be installed** adjacent to soffit and eave vents
- Baffles **shall maintain an opening** equal or greater than the size of the vent
- The baffle **shall extend over the top of the attic insulation**
- The baffle **shall be installed to the outer edge of the exterior wall top plate**
- Baffles **shall be installed continuously** to prevent ventilation air in the eave soffit from bypassing the baffle system

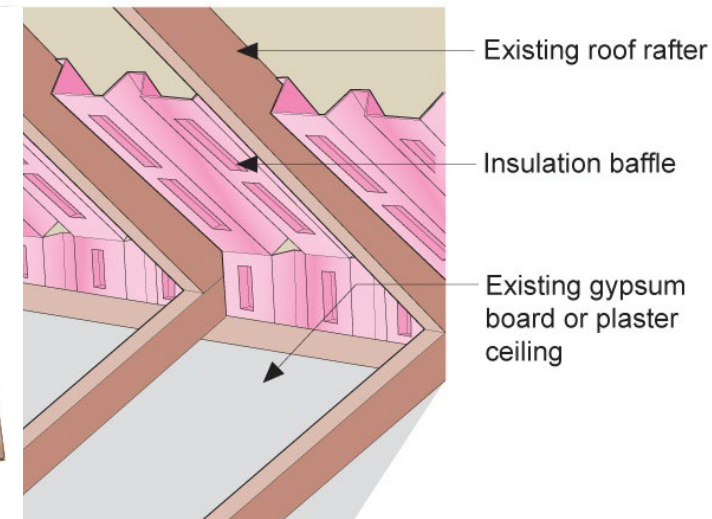
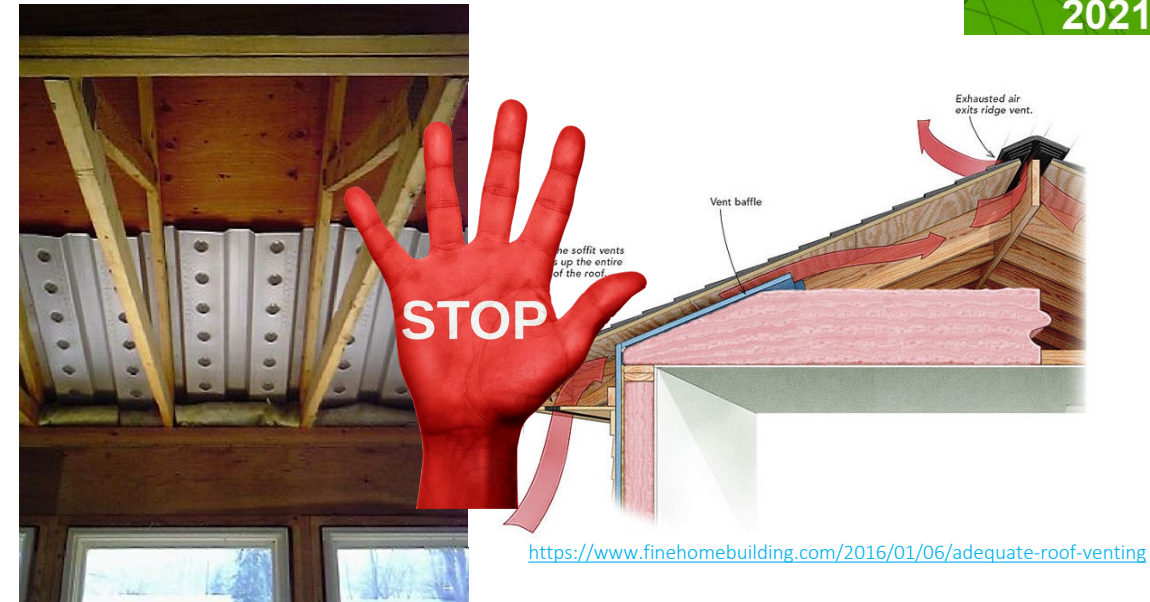


<https://basc.pnnl.gov/images/clean-attic-floor-debris-prior-installing-new-attic-insulation-use-baffles-provide-path>



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# R402.2.4 Access Hatches and Doors

- Shall be insulated to the **same R-value required for the wall or ceiling** in which they are installed

## Table R402.4.1.1

- Access openings, drop downstairs or knee wall doors **shall be sealed**



## R402.2.4.1 Access Hatched and Door Insulation Installation and Retention

- Shall be **weather stripped**
- Access to all mechanical equipment **can't damage insulation**
- Attic **insulation dame** to keep insulation in place
  - Attic hatch
  - Higher to lower sections of attic
- Insulation dam shall provide **permanent means to maintain installed R-value**

IECC  
2021





# R402.2.5 Mass walls.

Mass walls, where used as a component of the *building thermal envelope* shall be one of the following:

1. Above-ground walls of concrete block, concrete, insulated concrete form, masonry cavity, brick but not brick veneer, adobe, compressed earth block, rammed earth, solid timber, mass timber or solid logs.
2. Any wall having a heat capacity greater than or equal to  $6 \text{ Btu/ft}^2 \times ^\circ\text{F}$  ( $123 \text{ kJ/m}^2 \times \text{K}$ ).



<https://www.loghome.com/articles/3-colorado-log-home-companies-to-check-out>



# R402.2.6 Steel-frame ceilings, walls and floors

- Steel frame ceilings, walls, and floors shall comply with the insulation requirements of Table R402.2.6 or the  $U$ -factor requirements of Table R402.1.2.
- The calculation of the  $U$ -factor for a steel-frame envelope assembly shall use a series-parallel path calculation method.



<https://www.homerreference.net/steel-vs-wood-framing/>

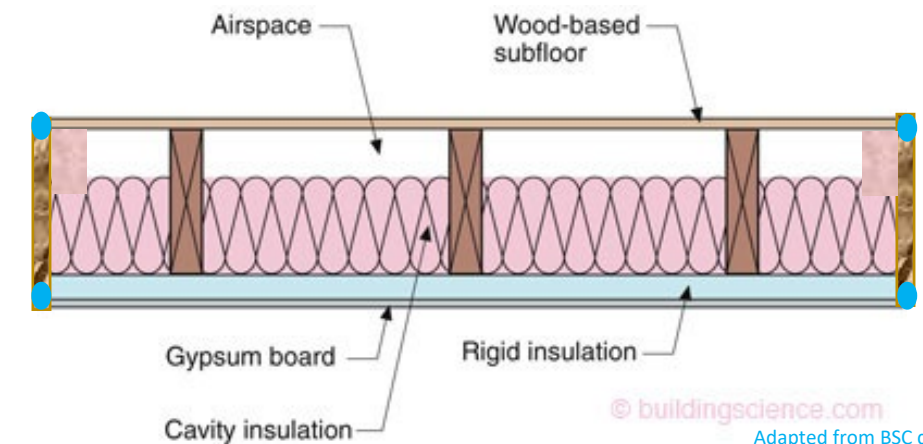
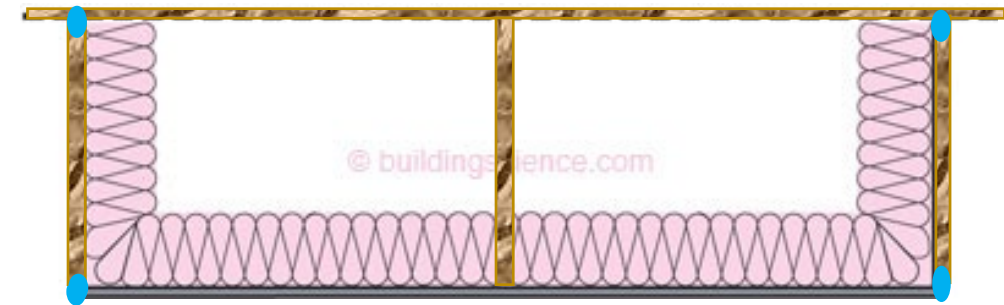
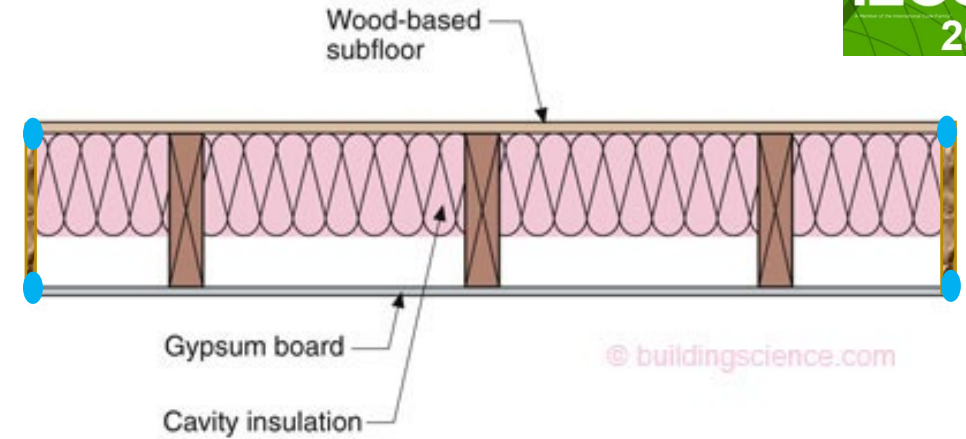
TABLE R402.2.6  
STEEL-FRAME CEILING, WALL AND  
FLOOR INSULATION R-VALUES

WOOD FRAME R-VALUE REQUIREMENT	COLD-FORMED STEEL-FRAME EQUIVALENT R-VALUE <sup>a</sup>
Steel Truss Ceilings <sup>b</sup>	
R-30	R-38 or R-30 + 3 or R-26 + 5
R-38	R-49 or R-38 + 3
R-49	R-38 + 5
Steel Joist Ceilings <sup>b</sup>	
R-30	R-38 in 2 × 4 or 2 × 6 or 2 × 8 R-49 in any framing
R-38	R-49 in 2 × 4 or 2 × 6 or 2 × 8 or 2 × 10
Steel-frame Wall, 16 inches on center	
R-13	R-13 + 4.2 or R-21 + 2.8 or R-0 + 9.3 or R-15 + 3.8 or R-21 + 3.1
R-13 + 5	R-0 + 15 or R-13 + 9 or R-15 + 8.5 or R-19 + 8 or R-21 + 7
R-13 + 10	R-0 + 20 or R-13 + 15 or R-15 + 14 or R-19 + 13 or R-21 + 13
R-20	R-0 + 14.0 or R-13 + 8.9 or R-15 + 8.5 or R-19 + 7.8 or R-21 + 7.5
R-20 + 5	R-13 + 12.7 or R-15 + 12.3 or R-19 + 11.6 or R-21 + 11.3 or R-25 + 10.9
R-21	R-0 + 14.6 or R-13 + 9.5 or R-15 + 9.1 or R-19 + 8.4 or R-21 + 8.1 or R-25 + 7.7
Steel-frame Wall, 24 inches on center	
R-13	R-0 + 9.3 or R-13 + 3.0 or R-15 + 2.4
R-13 + 5	R-0 + 15 or R-13 + 7.5 or R-15 + 7 or R-19 + 6 or R-21 + 6
R-13 + 10	R-0 + 20 or R-13 + 13 or R-15 + 12 or R-19 + 11 or R-21 + 11
R-20	R-0 + 14.0 or R-13 + 7.7 or R-15 + 7.1 or R-19 + 6.3 or R-21 + 5.9
R-20 + 5	R-13 + 11.5 or R-15 + 10.9 or R-19 + 10.1 or R-21 + 9.7 or R-25 + 9.1
R-21	R-0 + 14.6 or R-13 + 8.3 or R-15 + 7.7 or R-19 + 6.9 or R-21 + 6.5 or R-25 + 5.9
Steel Joist Floor	
R-13	R-19 in 2 × 6, or R-19 + 6 in 2 × 8 or 2 × 10
R-19	R-19 + 6 in 2 × 6, or R-19 + 12 in 2 × 8 or 2 × 10

# R402.2.7 Floors

Choose one of three choices

1. Installed insulation to **maintain permanent contact with underside of subfloor decking**
2. Install insulation **on top side of sheathing separating cavity from unconditioned space below**
  - Insulation shall extend from the bottom to the top of all perimeter floor framing members and the framing shall be air sealed
3. Combination of cavity and continuous insulation to equal required R-value
  - Cavity insulation on sheathing separating cavity from unconditioned space
  - Continuous insulation below sheathing
  - Air sealing requirements above





# R402.2.8 Basement walls



- Defines conditioned and unconditioned basements
  - Floor separating basement and conditioned space, stairs, and walls are insulated
  - Airtight door between basement and conditioned space
  - Defined building thermal envelope separated basement from conditioned space
  - No uninsulated duct or pipes
  - No HVAC supply or return registers
- **R402.2.8.1 Basement wall insulation installation**
  - Conditioned basements **insulate from the top of the basement wall down 10' below grade or to the basement floor whichever is less**





# R402.2.9.1 Slab on Grade Floor Insulation

- Insulation shall extend downward from the top of the slab on the outside or inside of the foundation wall
- Insulation located below grade shall be extended 2'- 4' per Table R402.1.2 and CZ
  - Allowed installation
    - vertical insulation
    - insulation extending under slab
    - insulation extending out from the building shall be protected
- When installed on the inside between stem wall and slab
  - Top edge of the insulation maybe cut at a 45-degree angle



<https://www.youtube.com/watch?app=desktop&v=RVNU1m9apf4>

# R402.2.9 Slab-on-grade floors

- Slab-on-grade floors with a floor surface less than 12 inches (305 mm) below grade **shall be insulated in accordance with Table R402.1.3.**
  - **Exception:** Slab-edge insulation is not required in jurisdictions designated by the code official as having a very heavy termite infestation.

## Table R402.1.3 footnote d

- R-5 insulation shall be provided under the full slab area of a heated slab in addition to the **required slab edge insulation R-value for slabs as indicated in the table.**
- The slab-edge insulation for heated slabs shall not be required to extend below the slab.





# R402.2.10 Crawl Space Walls

- Crawl space walls shall be insulated in accordance with Table R402.1.3.
- **Exception:** Crawl space walls associated with a crawl space that is vented to the outdoors and the floor overhead **is insulated in accordance with Table R402.1.3 and Section R402.2.7.**

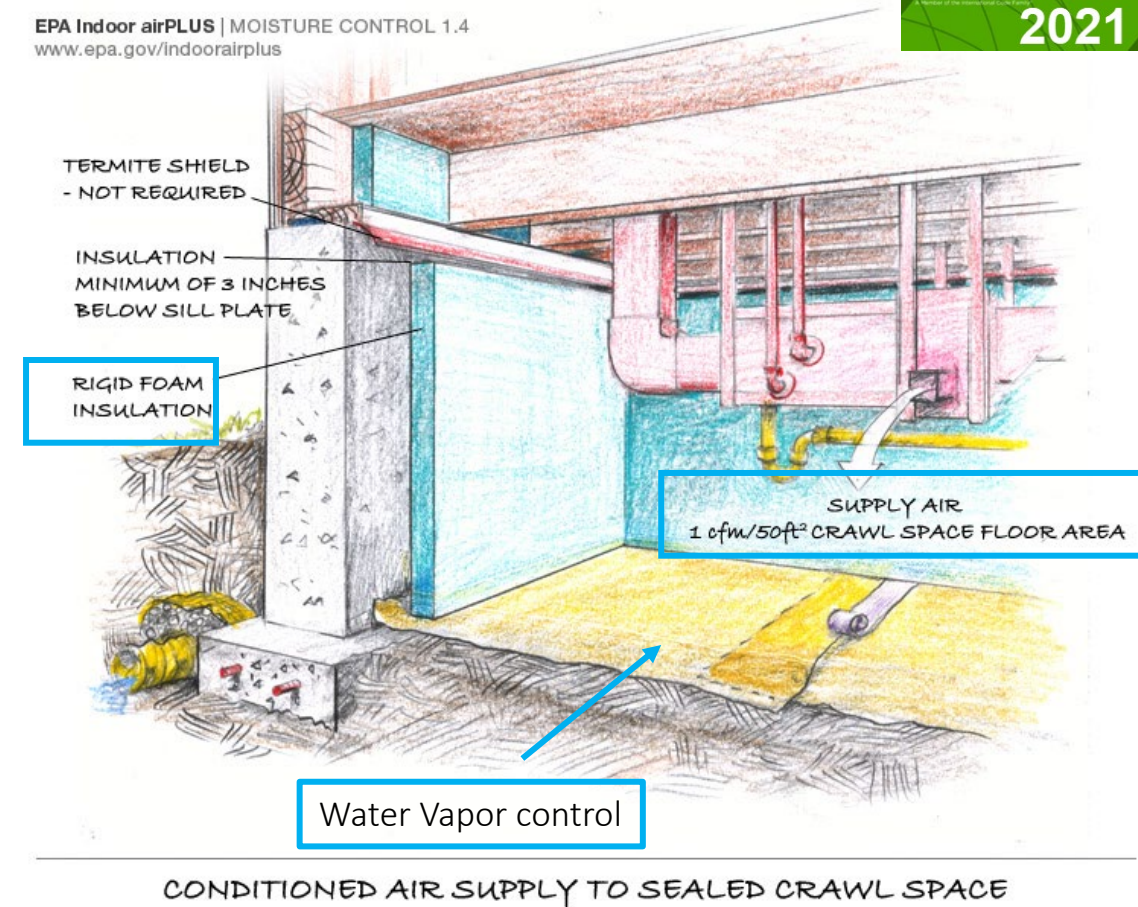




# R402.2.10.1 Crawl space wall insulation installations

- Where crawl space wall insulation is installed, it shall be permanently fastened to the wall and shall extend downward from the floor to the finished grade elevation and then vertically or horizontally for not less than an additional 24 inches (610 mm).
- Exposed earth in unvented crawl space foundations shall be covered with a continuous Class I vapor retarder in accordance with the *International Building Code* or *International Residential Code*, as applicable.
- Joints of the vapor retarder shall overlap by 6 inches (153 mm) and be sealed or taped.
- The edges of the vapor retarder shall extend not less than 6 inches (153 mm) up stem walls and shall be attached to the stem walls.

EPA Indoor airPLUS | MOISTURE CONTROL 1.4  
www.epa.gov/indoorairplus





# R402.2.12 Sunroom and Heated Garage Insulation

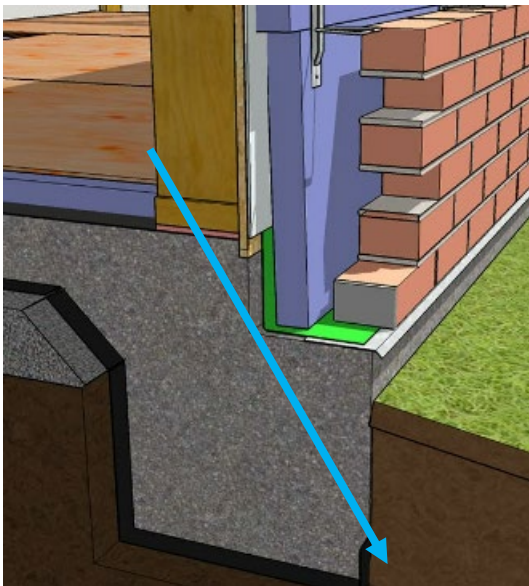
- Sunrooms enclosing conditioned space and heated garages shall meet the insulation requirements of this code.





# R402.2.11 Masonry veneer

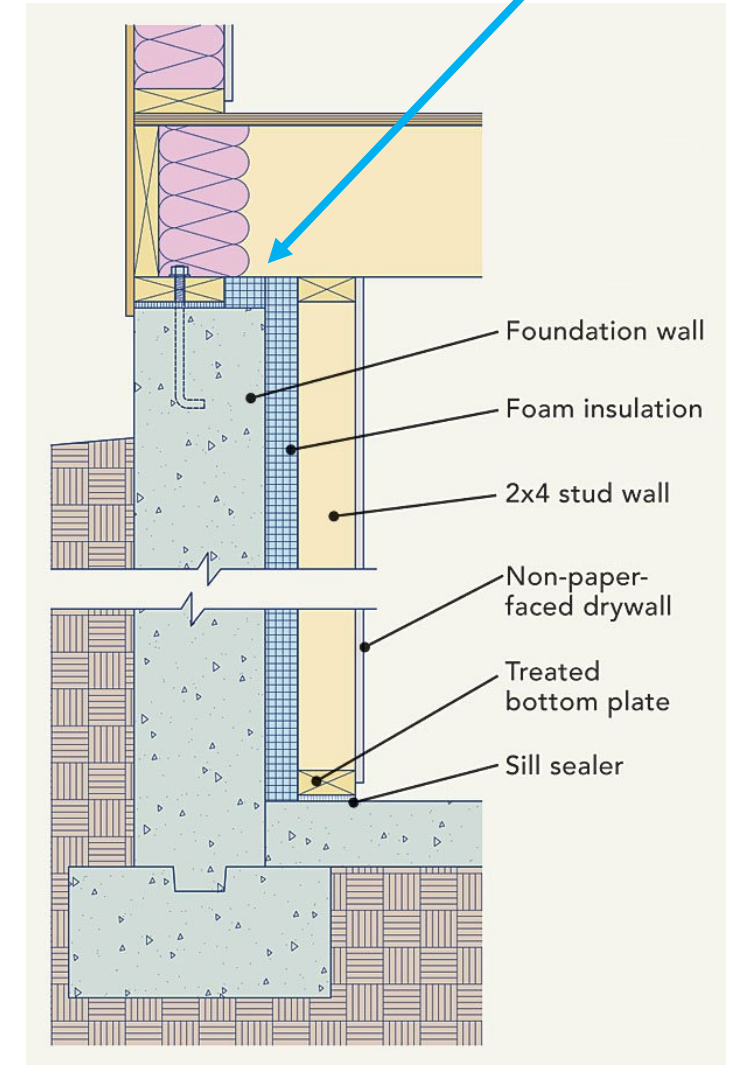
- Insulation shall not be required on the horizontal portion of a foundation that supports a masonry veneer.



<https://www.protradecraft.com/detail/insulated-monolithic-slab-brick-ledge>



<https://theconstructor.org/practical-guide/brick-ledge/28007/>



<https://www.finehomebuilding.com/2013/05/16/retrofitting-basement-insulation>

# 2021 IECC Table R402.4.1.1

## Air Barrier, Air Sealing, and Insulation Installation

- New language in Component Sections:
  - Rim Joist
  - Basement, crawls space and slab foundations
  - Shaft Penetrations
  - Narrow cavities
  - Garage separation
  - Recessed lighting
  - Plumbing wiring or other obstructions
  - Footnote b
    - Air barrier and insulation full enclosure is not required in unconditioned/ventilated attic spaces and at the rim joist

TABLE R402.4.1.1  
AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION<sup>a</sup>

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
General requirements	A continuous air barrier shall be installed in the building envelope. Breaks or joints in the air barrier shall be sealed.	Air-permeable insulation shall not be used as a sealing material.
Ceiling/attic	The air barrier in any dropped ceiling or soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed. Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.	The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.
Walls	The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the top of exterior walls shall be sealed. Knee walls shall be sealed.	Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance, <i>R</i> -value, of not less than <i>R</i> -3 per inch. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.



# Section R202 General definitions

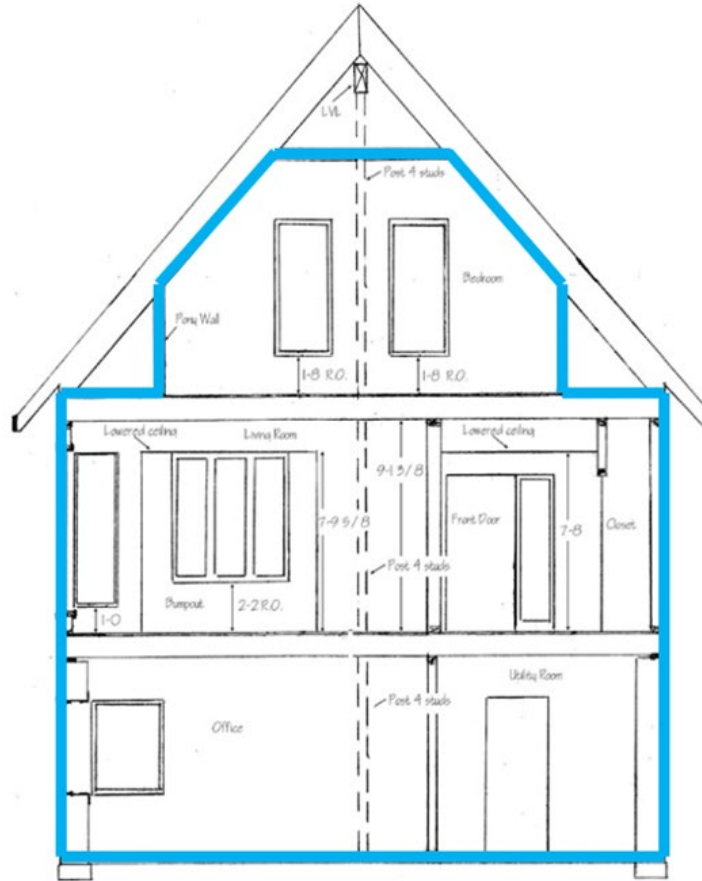
- Air Barrier
  - Material(s) **assembled and joined together** to provide a barrier to air leakage through the building envelope.
  - **An air barrier may be a single material or a combination of materials**
- Continuous Air Barrier
  - A **combination of materials and assemblies** that restrict or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



# Code Perspective on Air barriers

## Belts and Suspenders

- **Primary Interior Air Barrier**
  - Drywall
- **Primary Exterior Air Barrier**
  - Exterior Sheathing
- **Continuity of both**
- Where there is not continuity add a supplemental Air barrier



# 5 key Air Barriers Attributes

- **Continuity**: The most important element in 3D structures with so many different components
- **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
- **Impermeability**: The ABS must be impermeable to Air

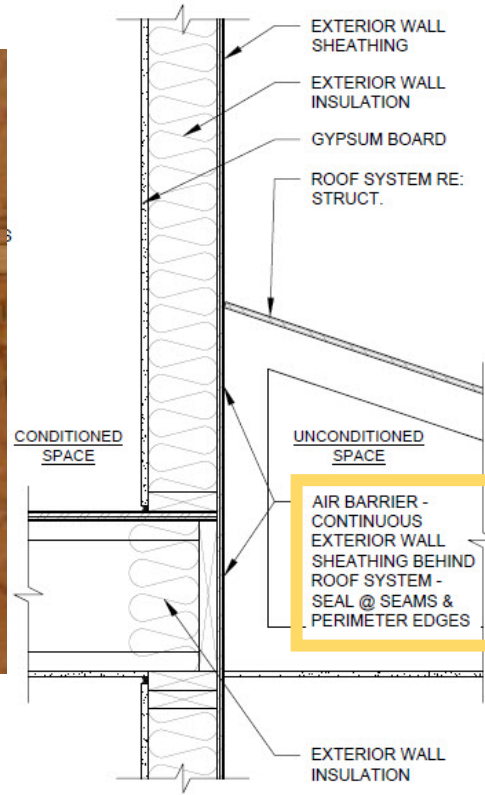
<https://www.buildingscience.com/>



## Air Barrier Example: Wall Adjoining Porch Roof



No air barrier between porch attic and conditioned space



Air barrier is installed prior to porch attic framing.



# Continuous Air Barrier at Stair





# Table 402.4.1.1

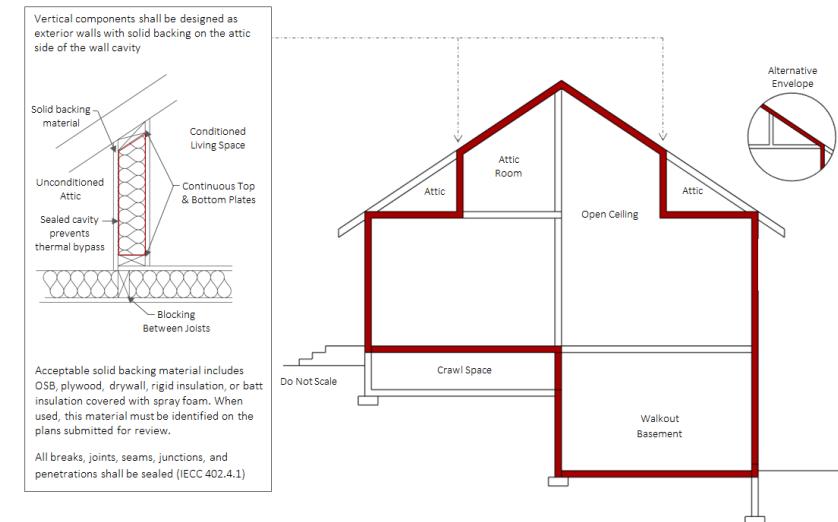
## Component – General Air barrier/Thermal barrier

### Air Barrier Criteria

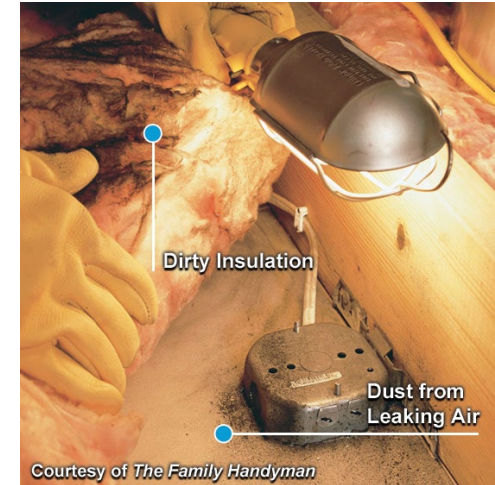
- A **continuous air barrier** shall be installed in the building envelope
- ~~Exterior thermal envelope contains a~~ **continuous air barrier**
- Breaks or joints in the air barrier shall be sealed

### Insulation Installation Criteria

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



# Air-permeable insulation not used as a sealing material





# Do we Understand?



# Table 402.4.1.1

## Component – Ceiling / Attic

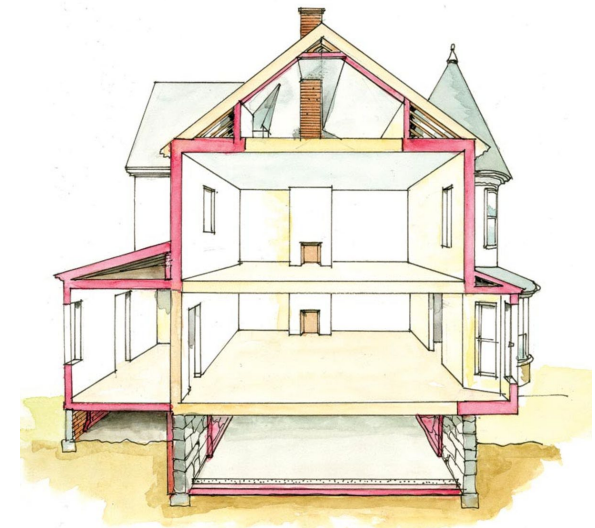


### Air Barrier Criteria

- The air barrier in any **dropped ceiling/soffit** shall be aligned with the insulation and any gaps in the air barrier sealed
- **Access openings**, drop down stair or knee wall doors to unconditioned attic spaces shall be sealed

### Insulation Installation Criteria

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

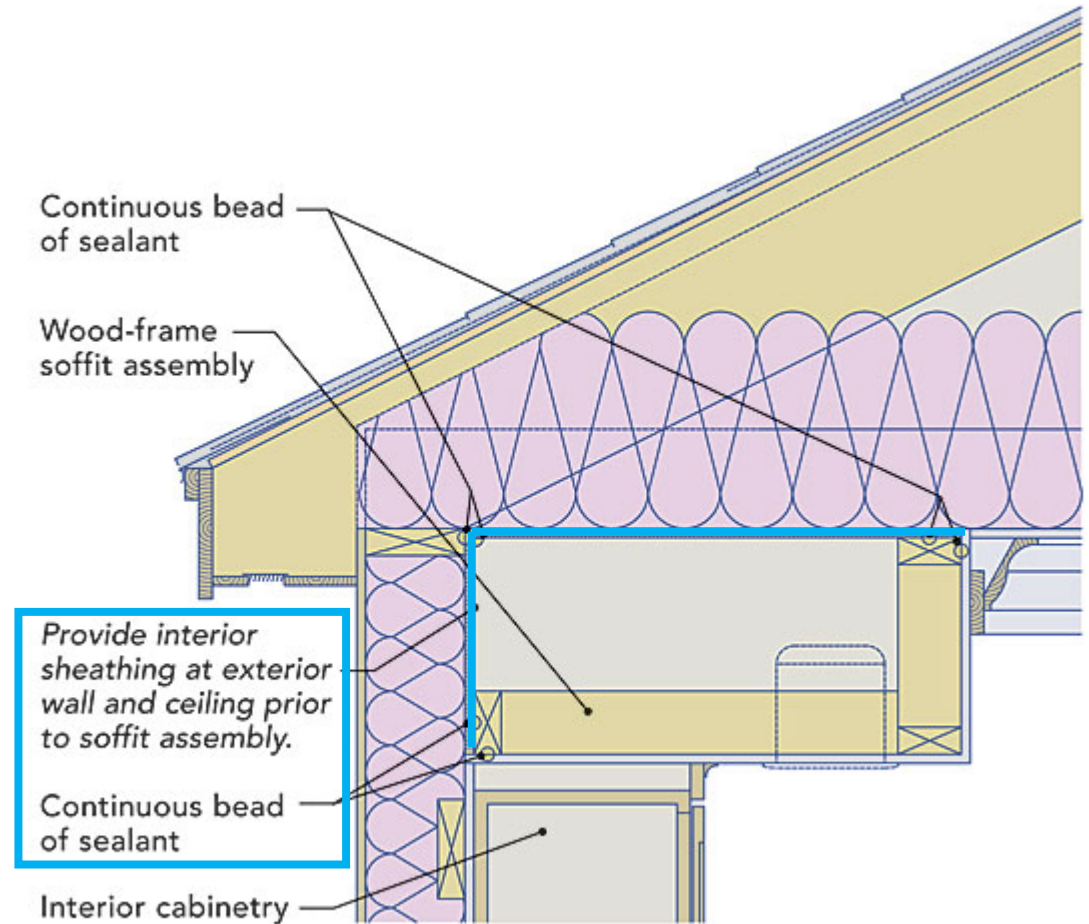


<https://www.oldhouseonline.com/repairs-and-how-to/7-insulation-tips>



# Dropped Ceiling / Soffit

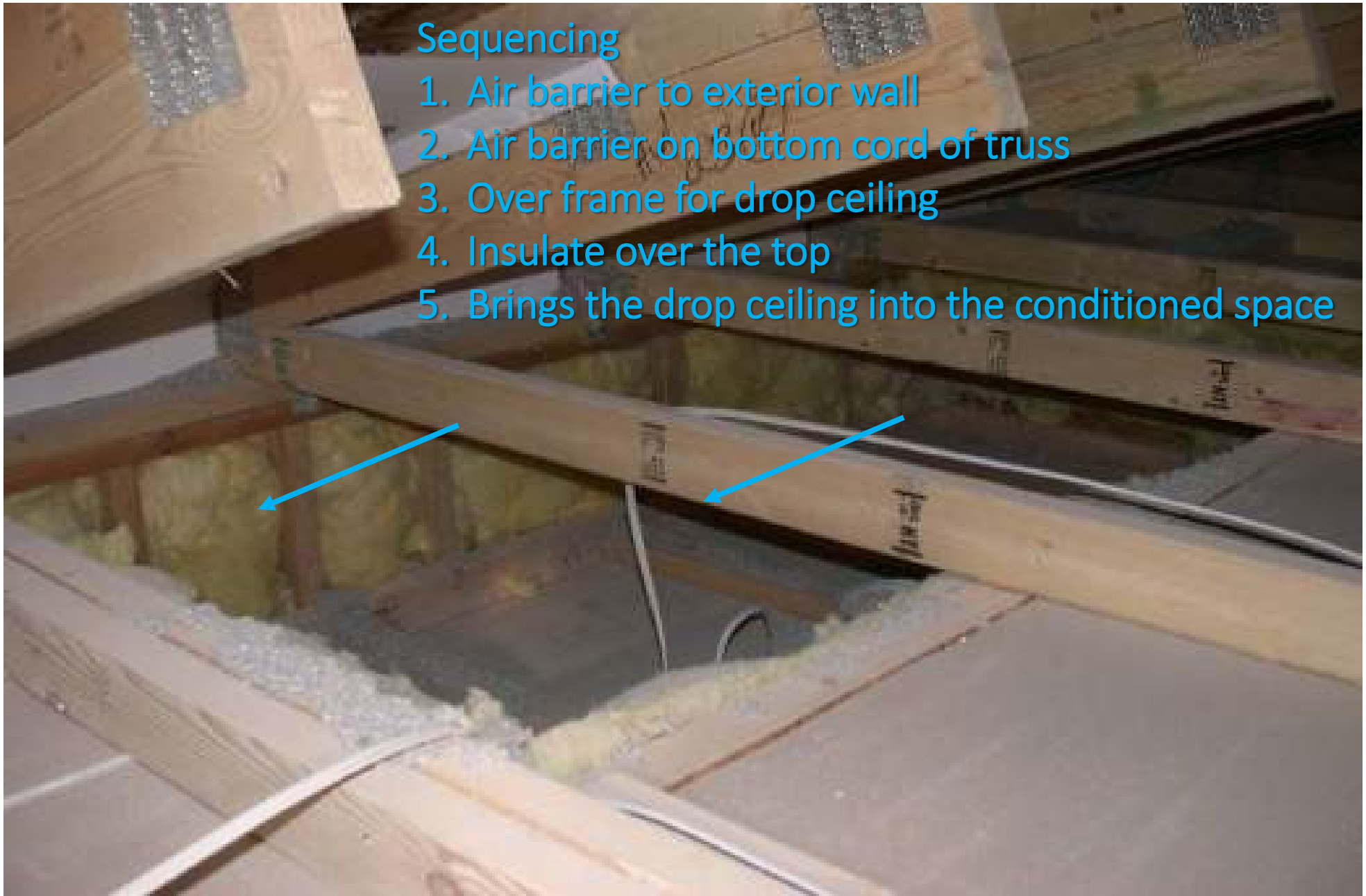
## Full Air Barrier Aligned with Insulation



Building America Solution Center <https://basc.pnnl.gov/>  
<http://www.betzwood.com/2011/09/05/howtoseal/>

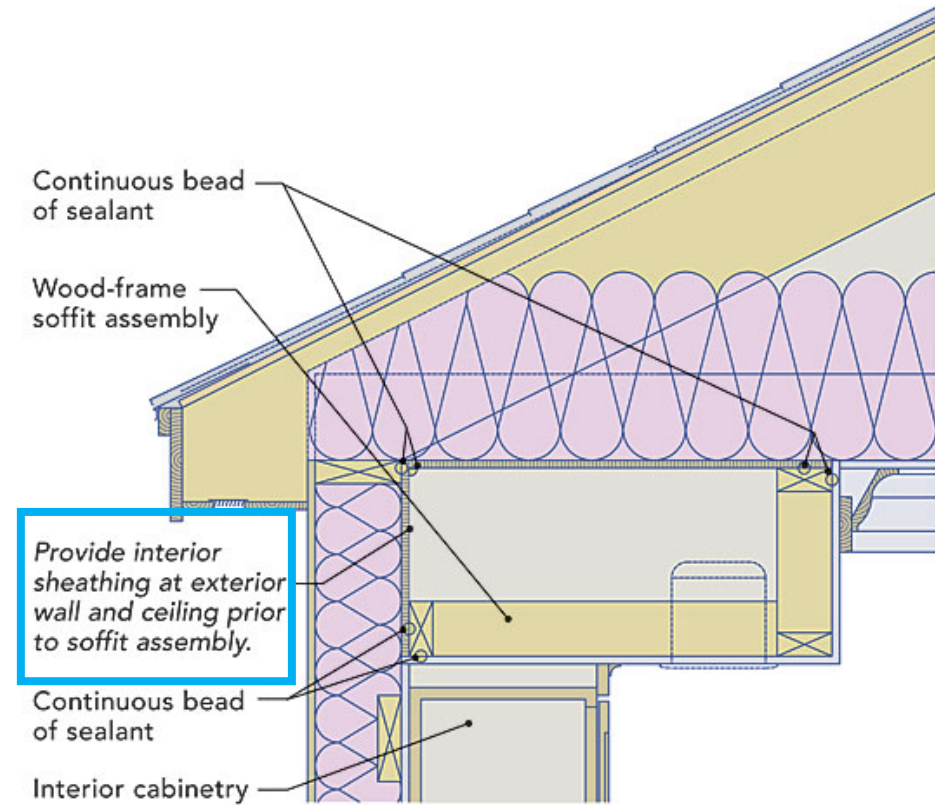
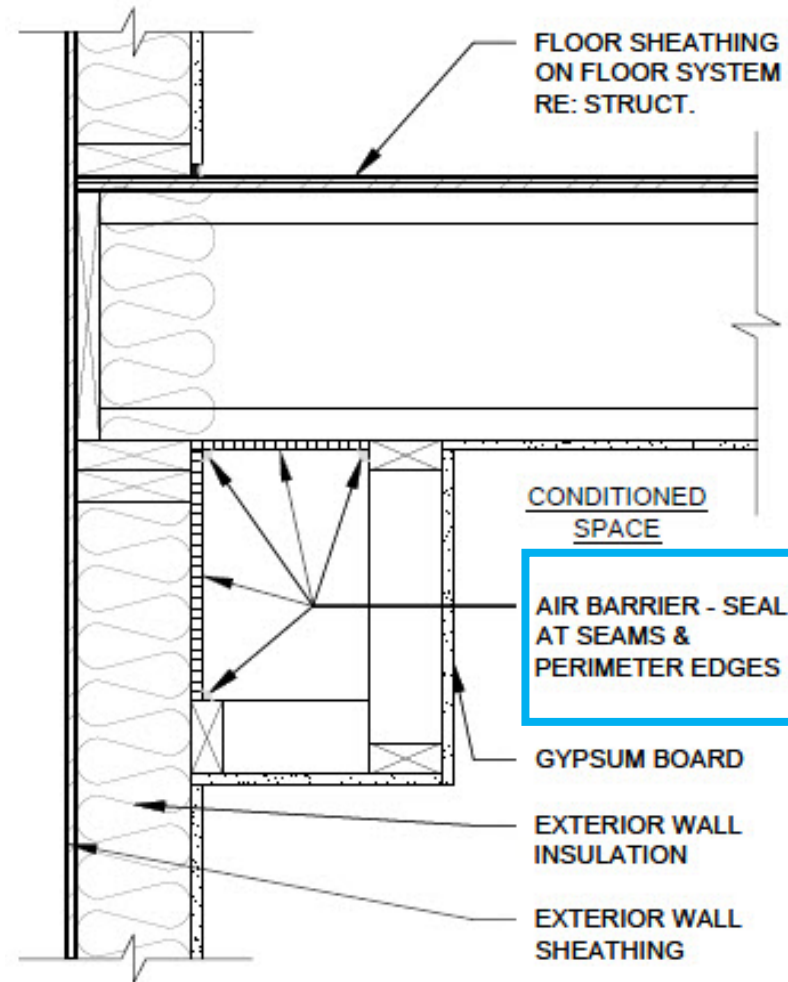
## Sequencing

1. Air barrier to exterior wall
2. Air barrier on bottom cord of truss
3. Over frame for drop ceiling
4. Insulate over the top
5. Brings the drop ceiling into the conditioned space





# Example Details

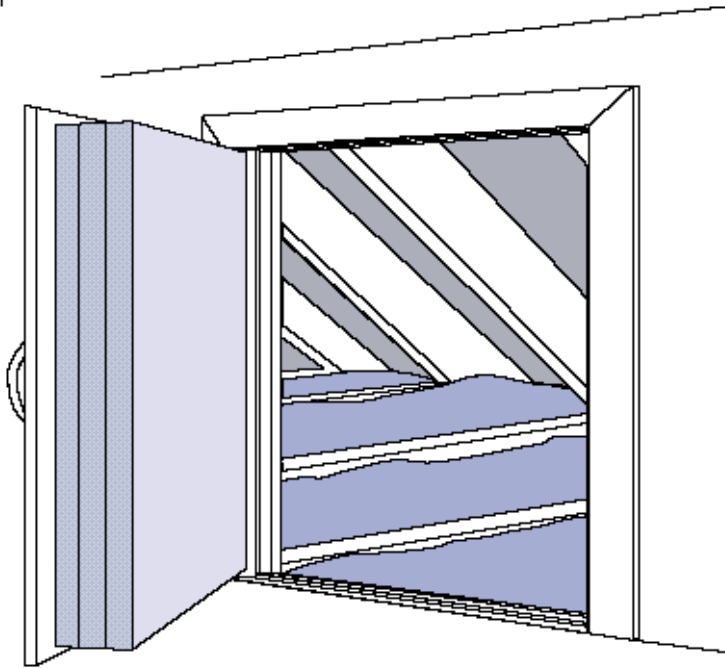


<http://www.betzwood.com/2011/09/05/howtoseal/>  
Building America Solution Center <https://basc.pnnl.gov/>

**BUILD**Tank<sup>inc.</sup>

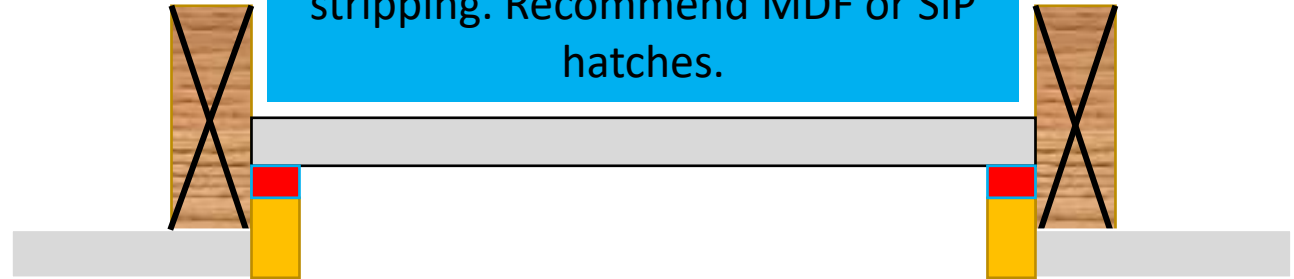
# Ceiling Access Openings

KNEE-WALL DOOR



R-Value to match wall  
door is penetrating

Insulated Hatch must be heavy enough to create a seal on weather stripping. Recommend MDF or SIP hatches.



<https://www.pinterest.com/pin/265008759297853383/?lp=true>

Building America Solution Center <https://basc.pnnl.gov/>

**BUILD**Tank<sup>inc.</sup>



# 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**

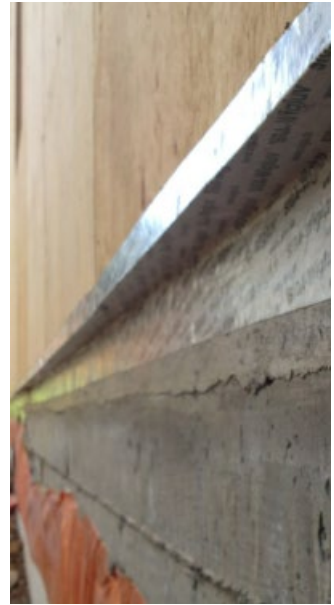


# Junction of foundation and sill plate is sealed





# Best Installation Practice





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

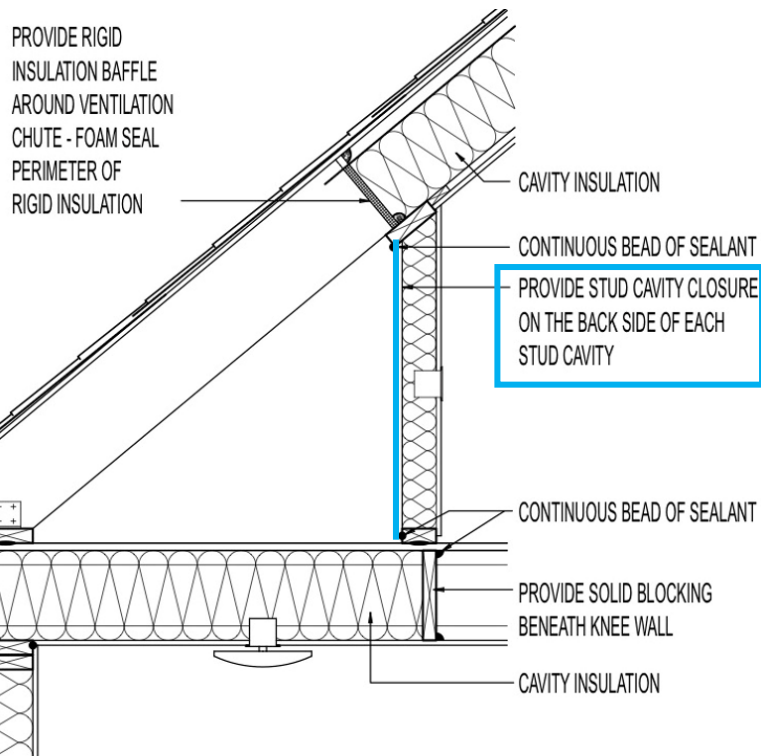








# Doing it Right — knee wall air barrier installation



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





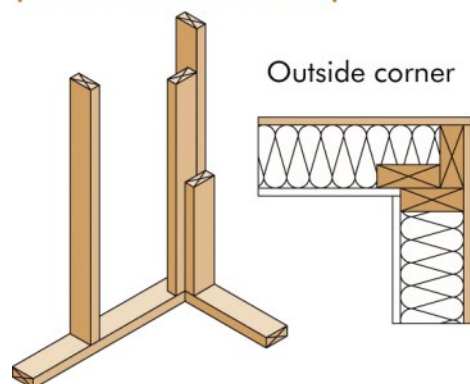




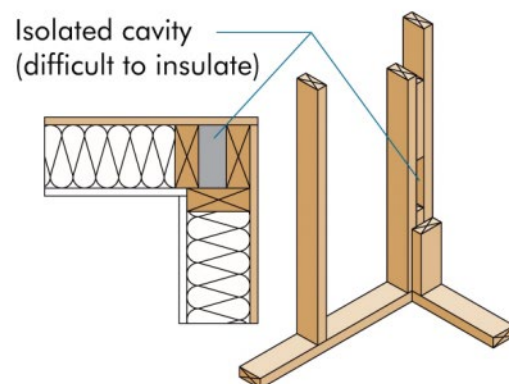
# Insulated Headers and Corners

## THREE-STUD CORNERS

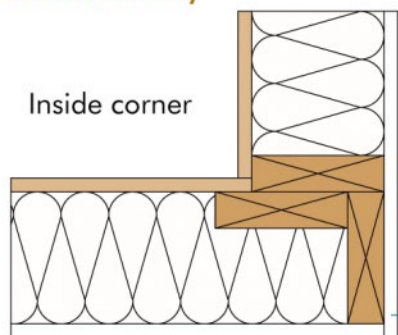
### INSULATED THREE-STUD CORNER (CALIFORNIA CORNER)



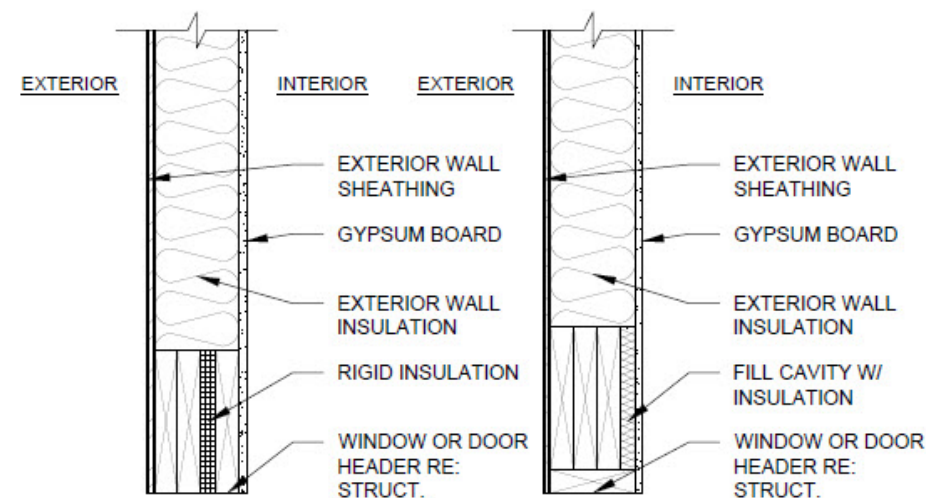
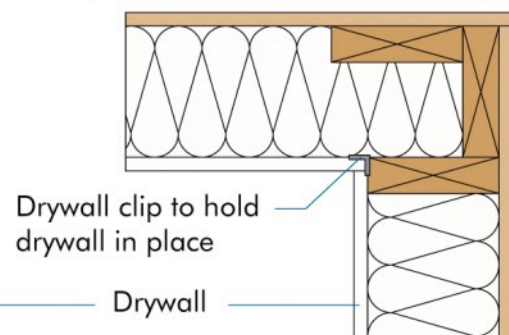
### CONVENTIONAL CORNER



### INSULATED THREE-STUD CORNER (INSIDE CORNER)



### ALTERNATE INSULATED THREE-STUD CORNER (WITH DRYWALL CLIPS)



<https://www.bdcnetwork.com/blog/boost-efficiency-advanced-framing>



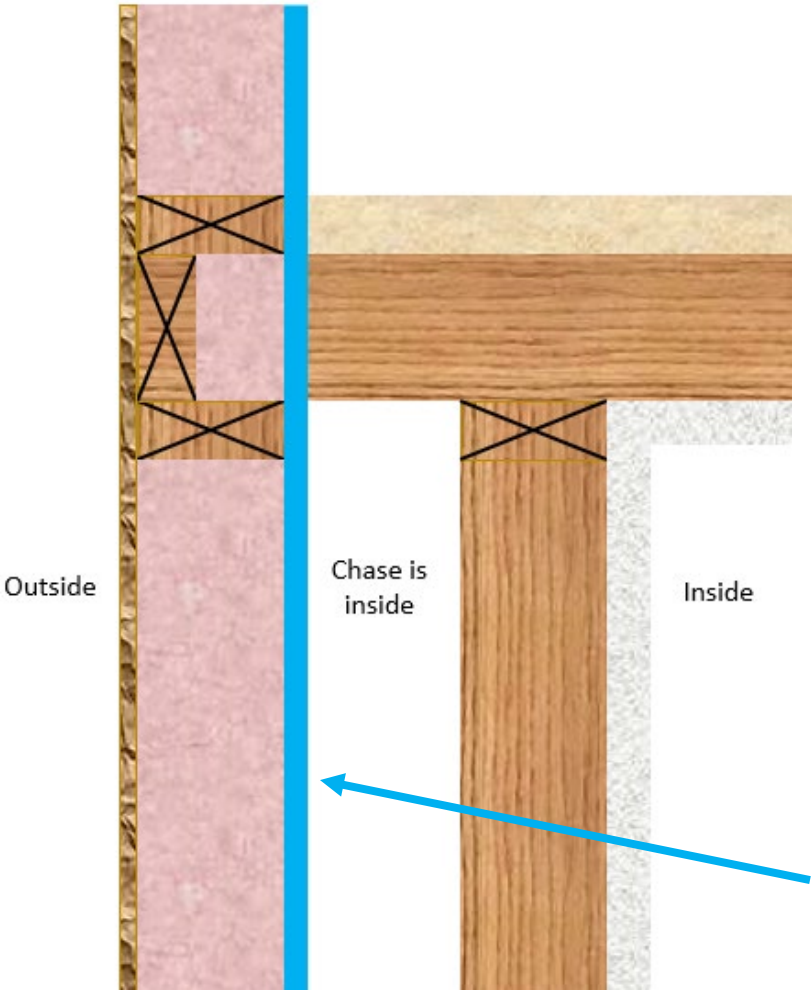
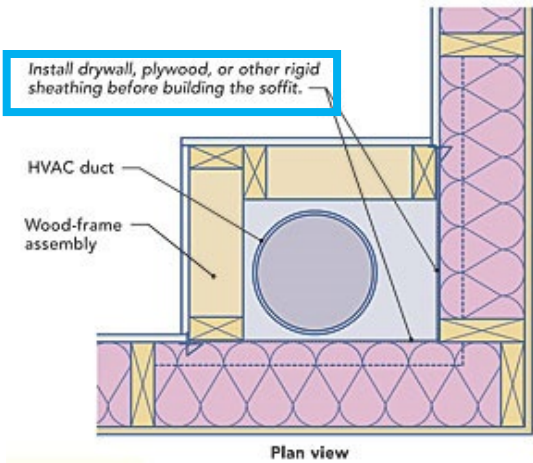
Define where the  
thermal barrier is

Make a choice,  
then execute





# Chase or dead space: Where is the thermal Envelope?



<https://www.finehomebuilding.com/2013/01/10/hiding-ducts-in-conditioned-space>



# Table 402.4.1.1

## Component – Windows, Skylights, and Doors

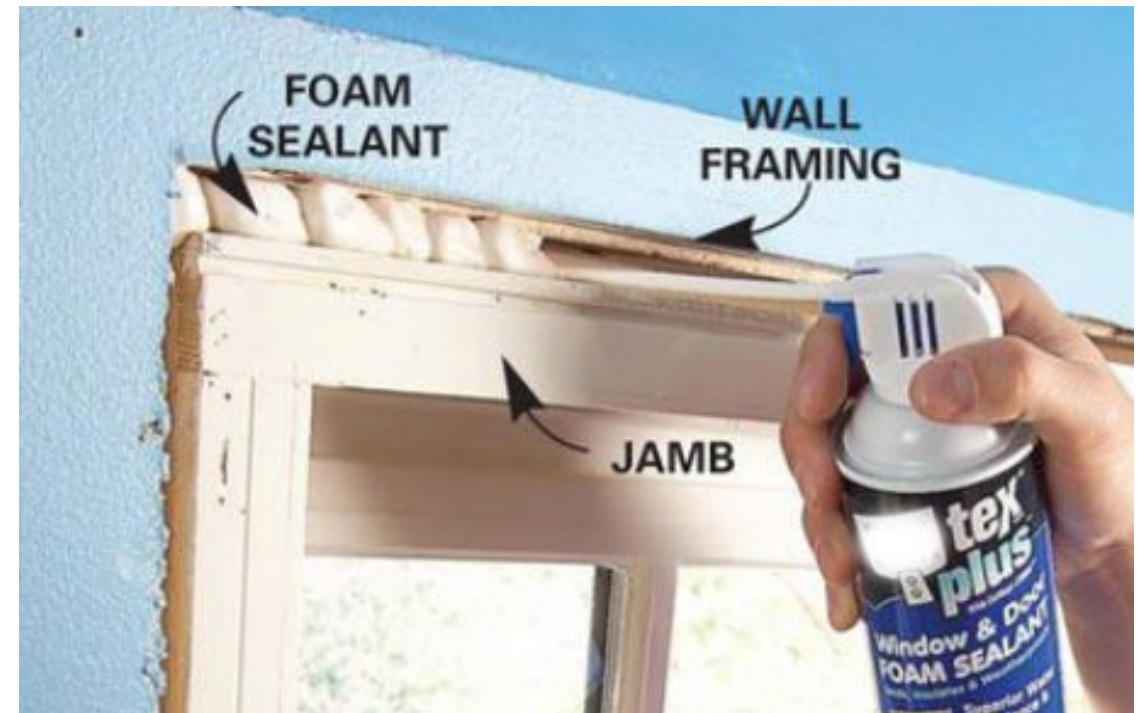


### Air Barrier Criteria

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



### Insulation Installation Criteria



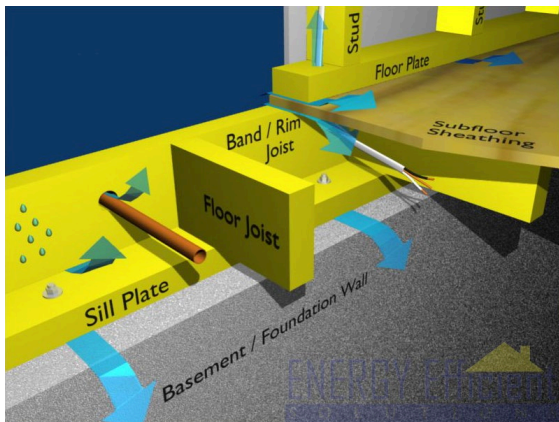
<https://www.familyhandyman.com/>

**BUILD**Tank<sup>inc.</sup>

# Table 402.4.1.1 Component – Rim Joists

## Air Barrier Criteria

- Rim joists shall include an exterior air barrier
- The junction of the rim board and the sill plate and the rim board and the subfloor shall be air sealed



## Insulation Installation Criteria

- Rim joists shall be insulated so that the insulation maintains permanent contact with the exterior rim board

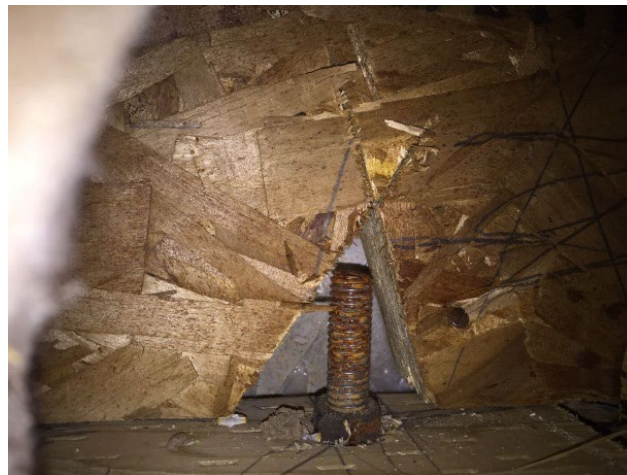
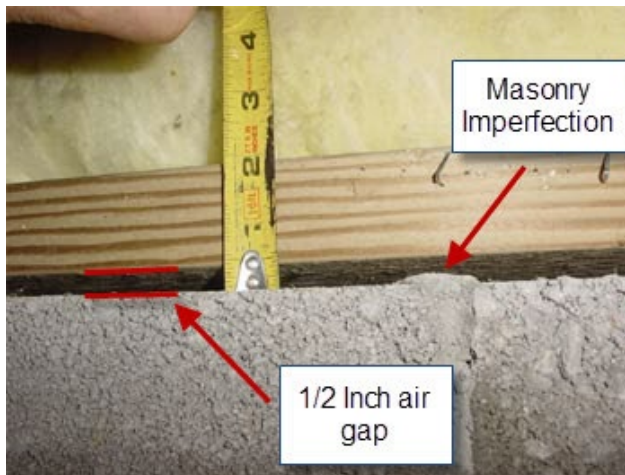


<https://www.energyefficientsolutions.com/seal-and-insulate-rim-joist.asp>

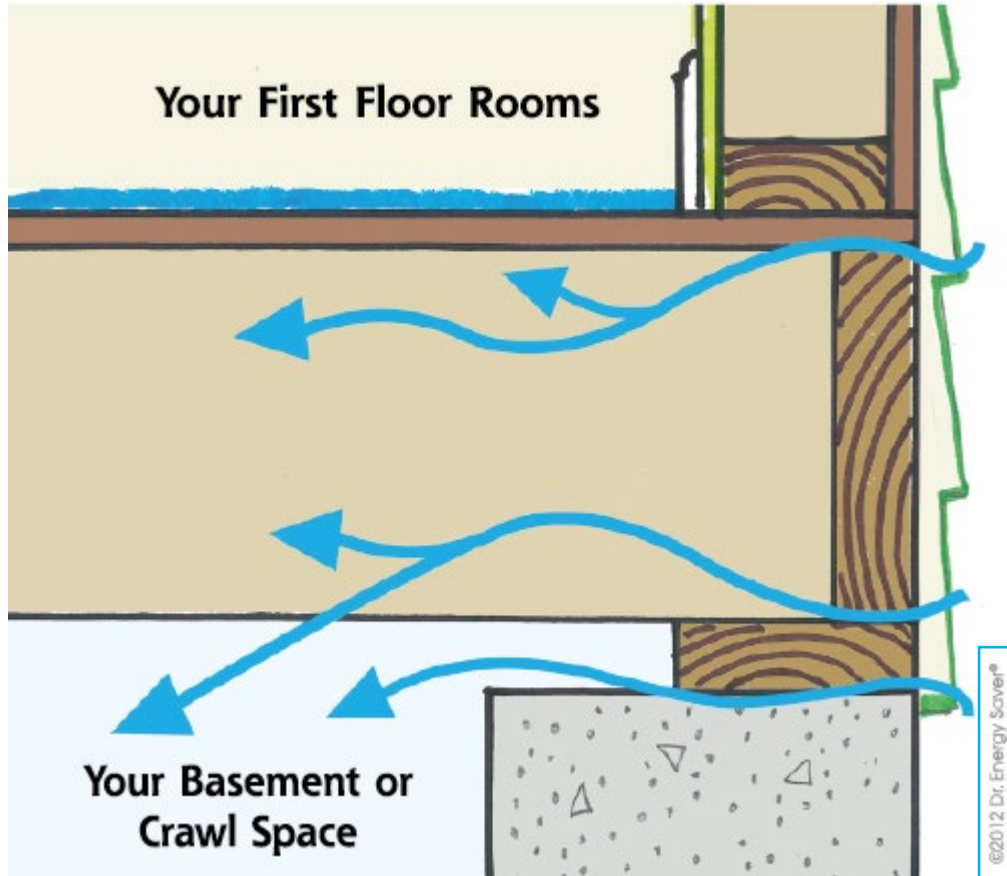


# What Does Air Barrier Mean?

## Continuity

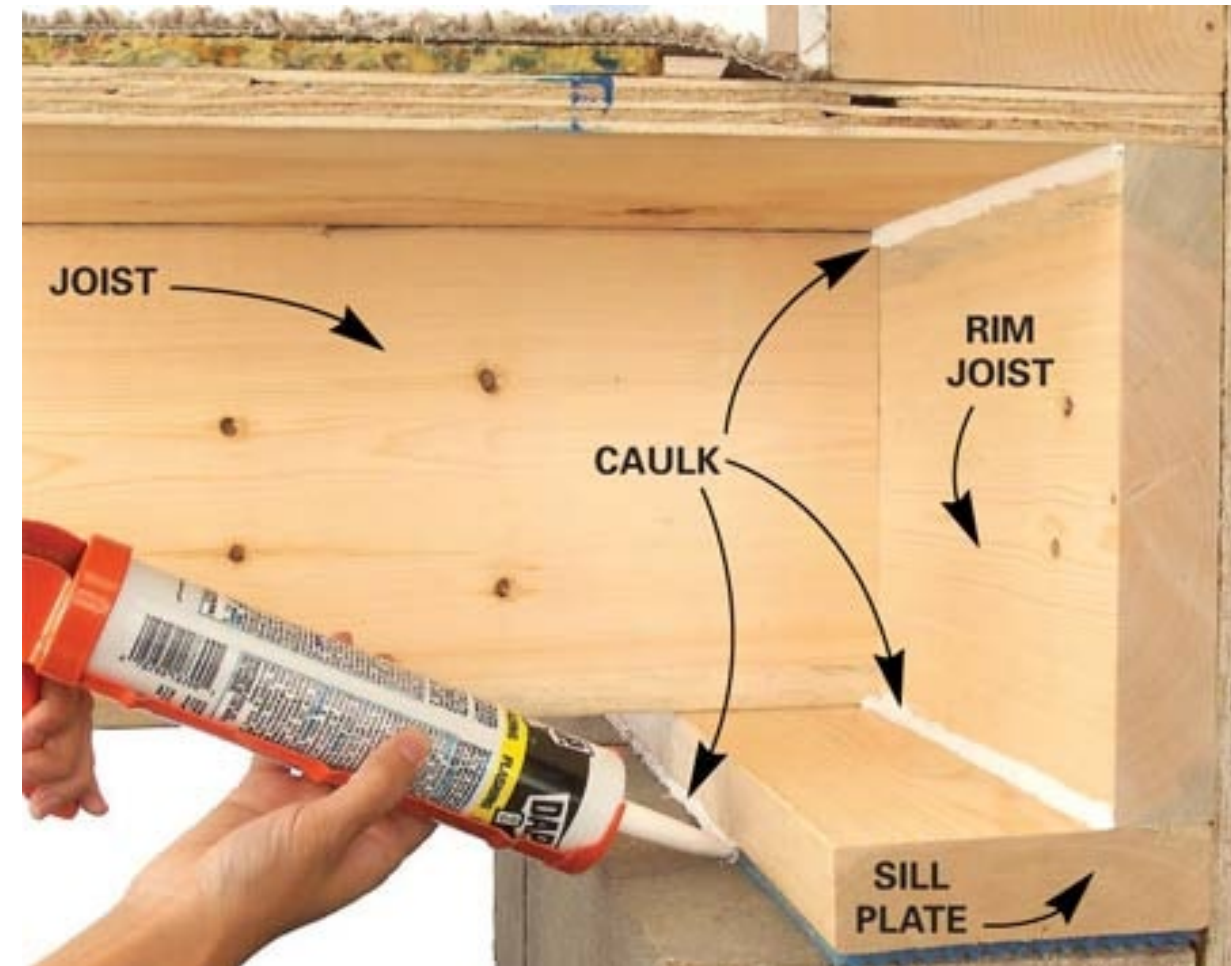


# Sill Seal is PRIMARILY a Capillary Break

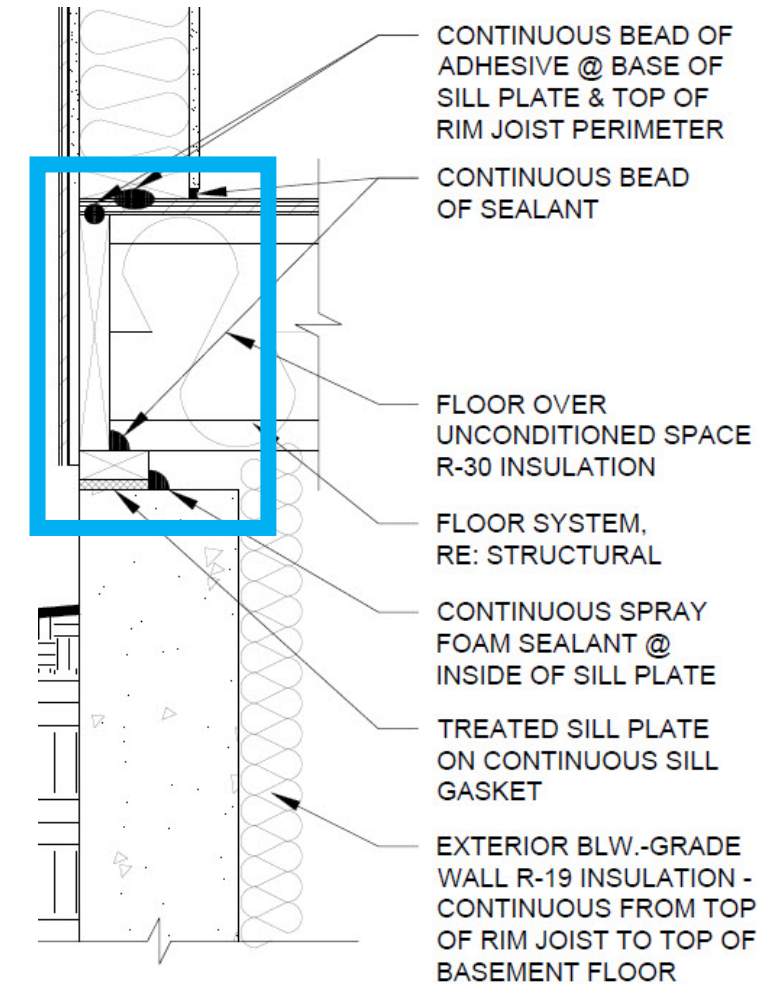




# Rim Joist Air Sealing done right



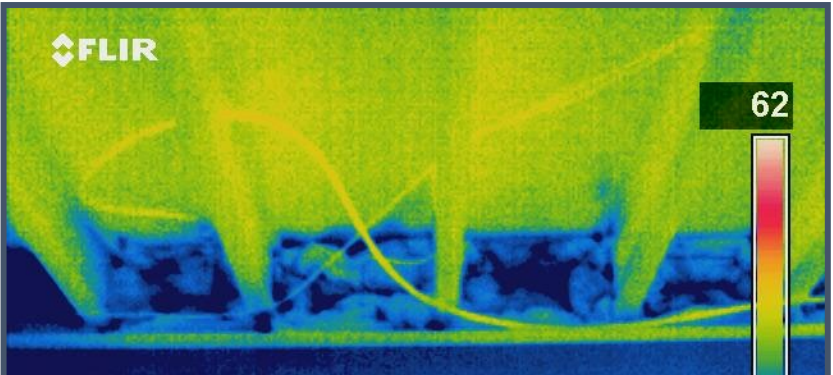
1. Rim Board to Sub Floor
2. Rim Board to Sill Plate
3. Sill Plate to foundation





# Rim Joist Insulation

Installation matters – Permanent contact with exterior air barrier





# Table 402.4.1.1

## Component – Floors (including above garage & cantilever floors)

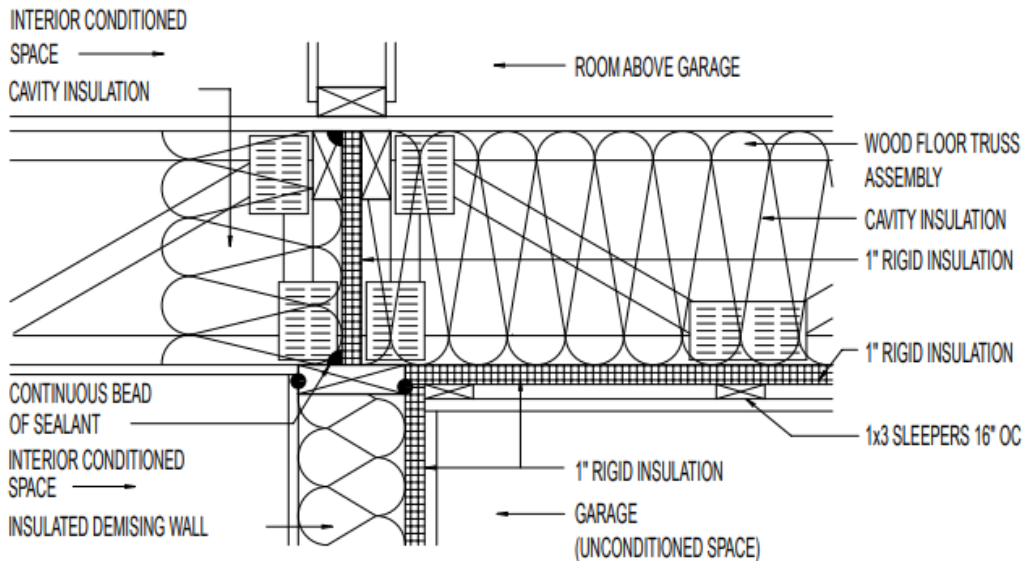


### Air Barrier Criteria

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

### Insulation Installation Criteria

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



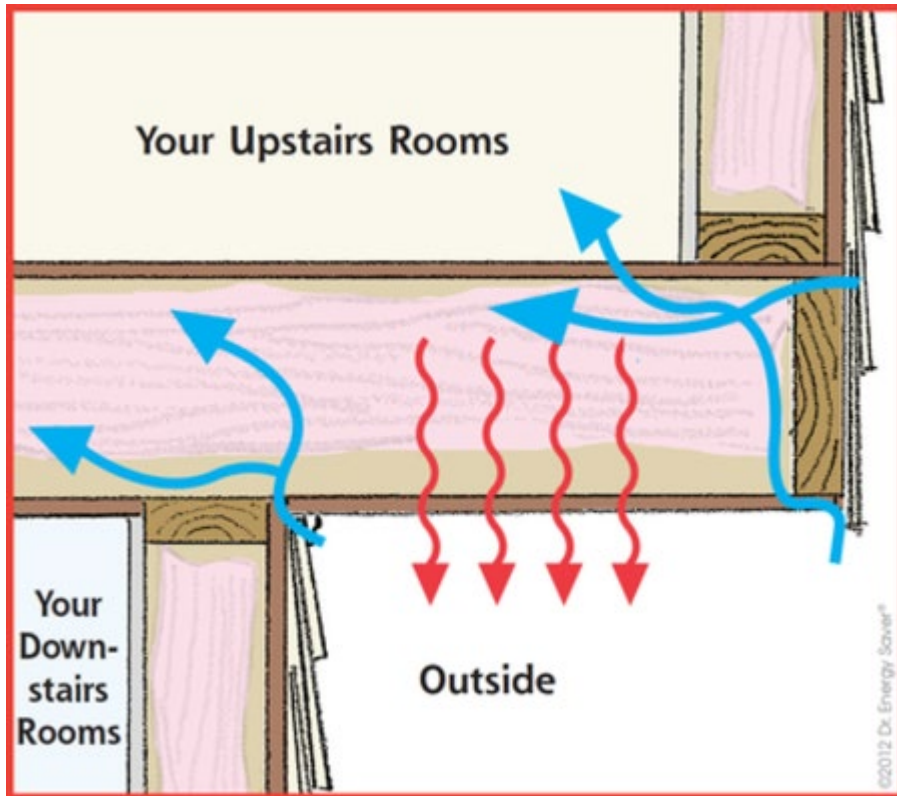
# The air barrier shall be installed at any exposed edge of insulation

## Garage/Home Interface





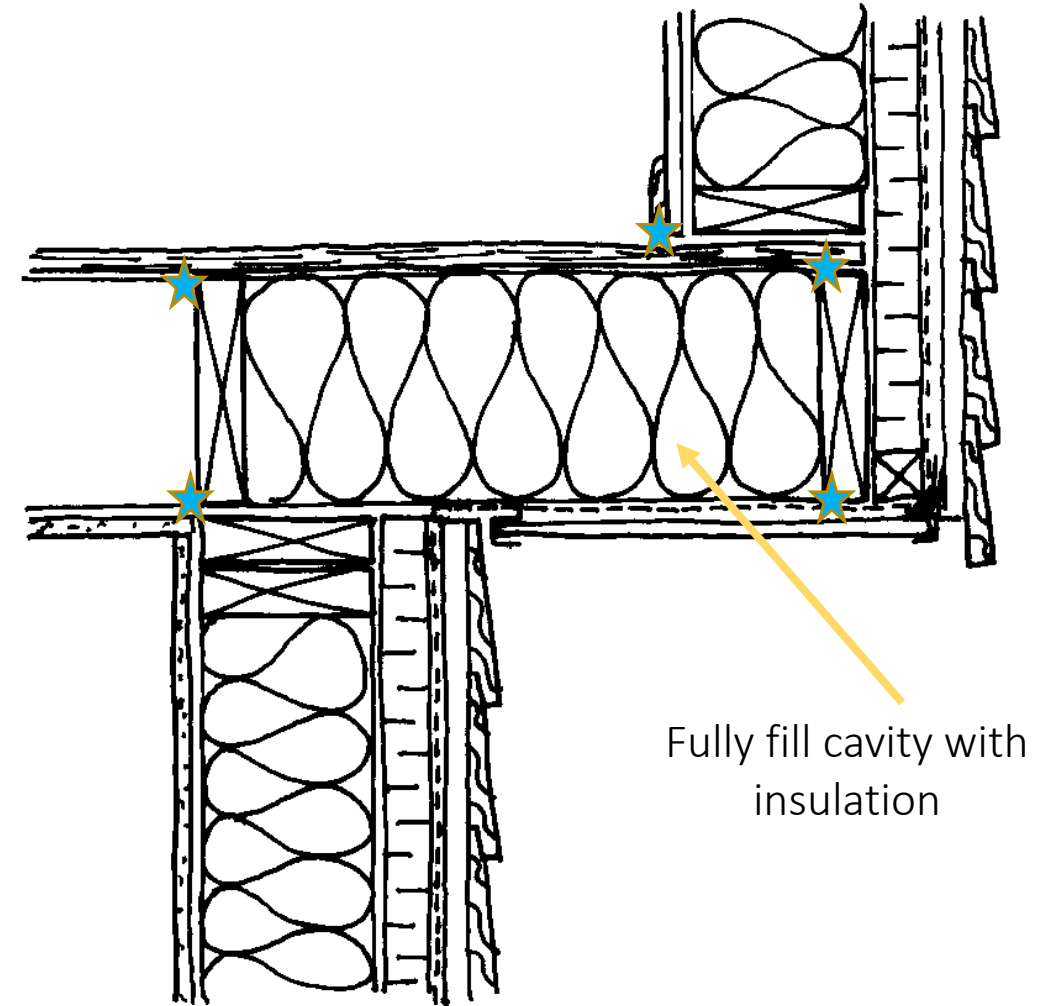
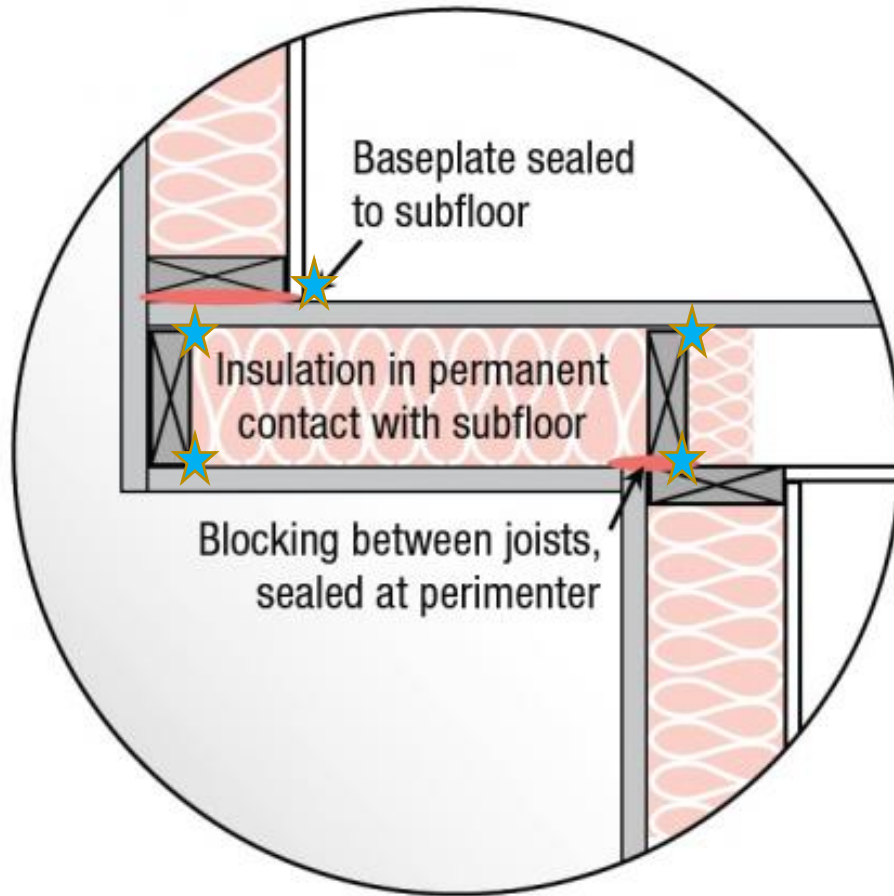
# Details: Cantilever Floor



<https://www.pinterest.com/pin/529947081143895081/?lp=true>

# CANTILEVERED FLOOR – do it right

A floor system is a wall laid flat with a six-sided air barrier





# Table 402.4.1.1

## Component – Basement, Crawl Space and Slab Foundation

### Air Barrier Criteria

- Exposed earth in unvented crawl spaces **shall be covered with a Class I vapor** retarder/air barrier in accordance with Section R402.2.10
- Penetrations through concrete foundation walls and slabs shall be air sealed
- Class 1 vapor retarders shall not be used as an air barrier on below-grade walls and shall be install in accordance with Section R702.7 of the IRC

### Insulation Installation Criteria

- Crawl space insulation where provided instead of floor insulation, shall be installed in accordance with section R402.2.10
- Conditioned basement foundation wall insulation shall be installed in accordance with section R402.2.8.1
- Slab on grade floor insulation shall be installed in accordance with Section R402.2.9.1





# Basement or other Slab Penetrations





# Table 402.4.1.1

## Component – Shafts, Penetrations

### Air Barrier Criteria

- Duct and flue shafts, and other similar penetration to exterior or unconditioned space **shall be sealed** to allow for expansion, contraction and mechanical vibration
- Utility penetrations of the air barrier shall be caulked, gasketed or otherwise sealed and shall allow for expansion, contraction and mechanical vibration

### Insulation Installation Criteria

- Insulation shall be fitted tightly around utilities passing through shafts and penetrations in the building thermal envelope to maintain required R-value







# Sequencing

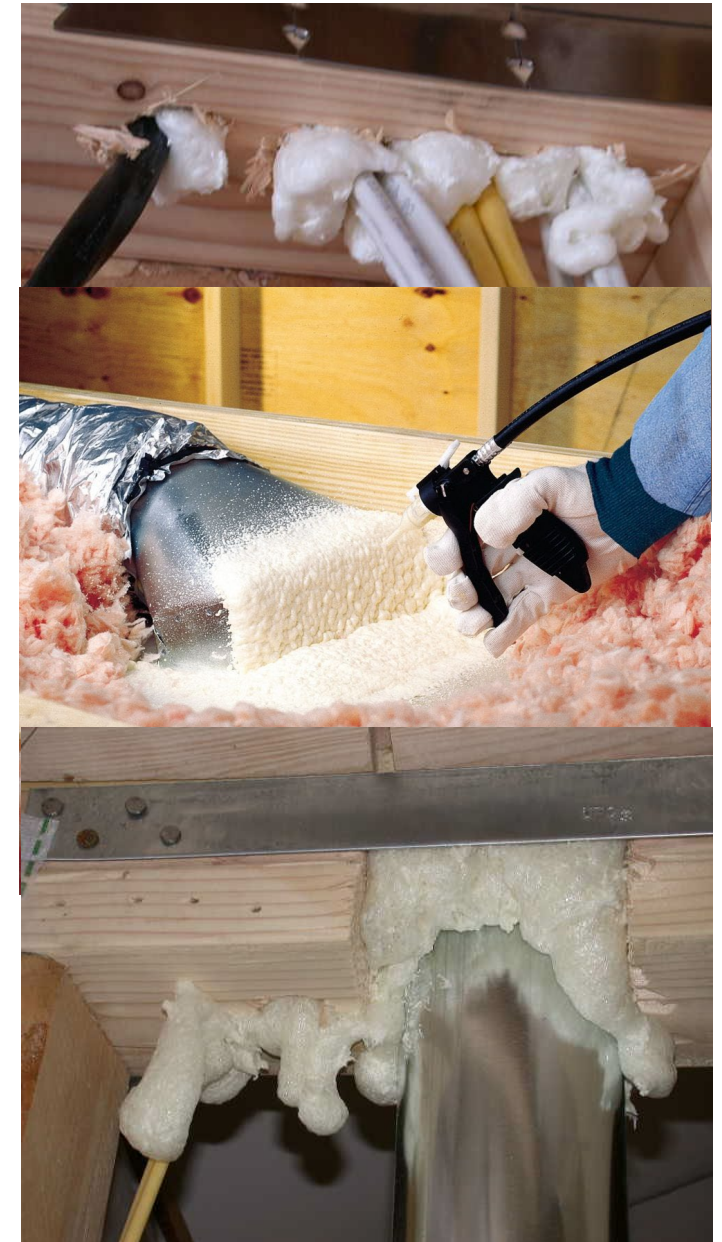
## 1. Install air barrier



## 2. Cut right size hole and pass utility through



## 3. Air seal the penetrations

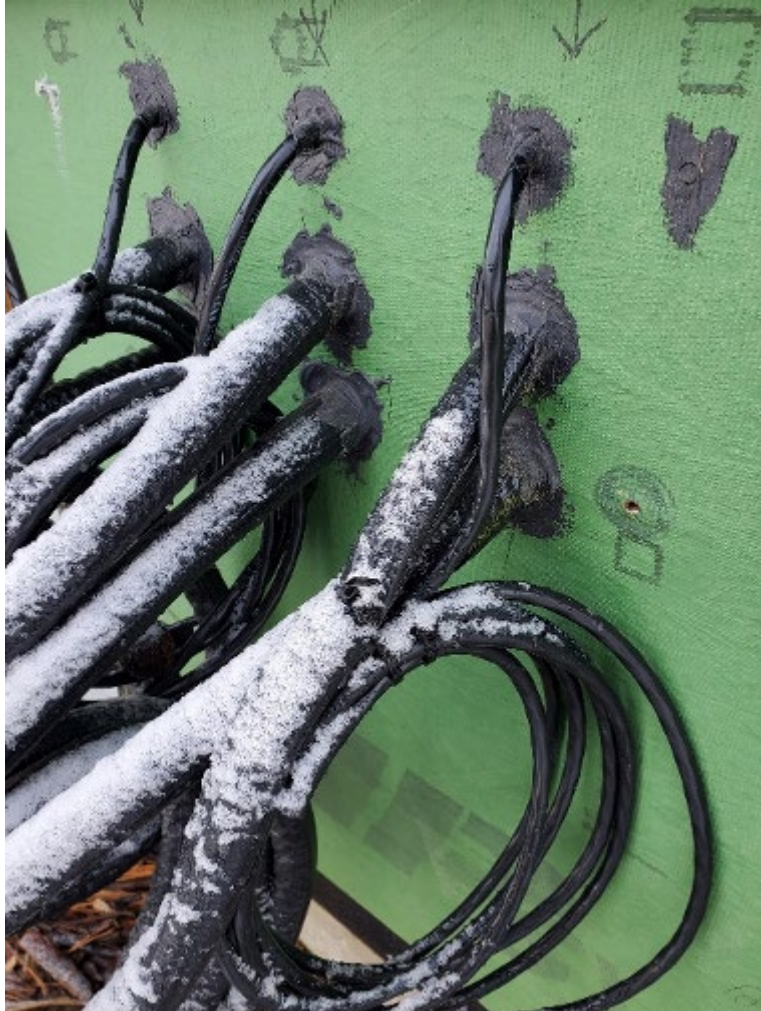


<https://www.spottinsulation.com/air-sealing-house/>

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# One Hole One Item





# Table 402.4.1.1

## Component – Narrow Cavities



### Air Barrier Criteria

- Narrow cavities of 1" or less that are not able to be insulated shall be air sealed



### Insulation Installation Criteria

- 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. 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**

<https://www.thisoldhouse.com/insulation/21016668/how-to-insulate-a-wall>

# Table 402.4.1.1

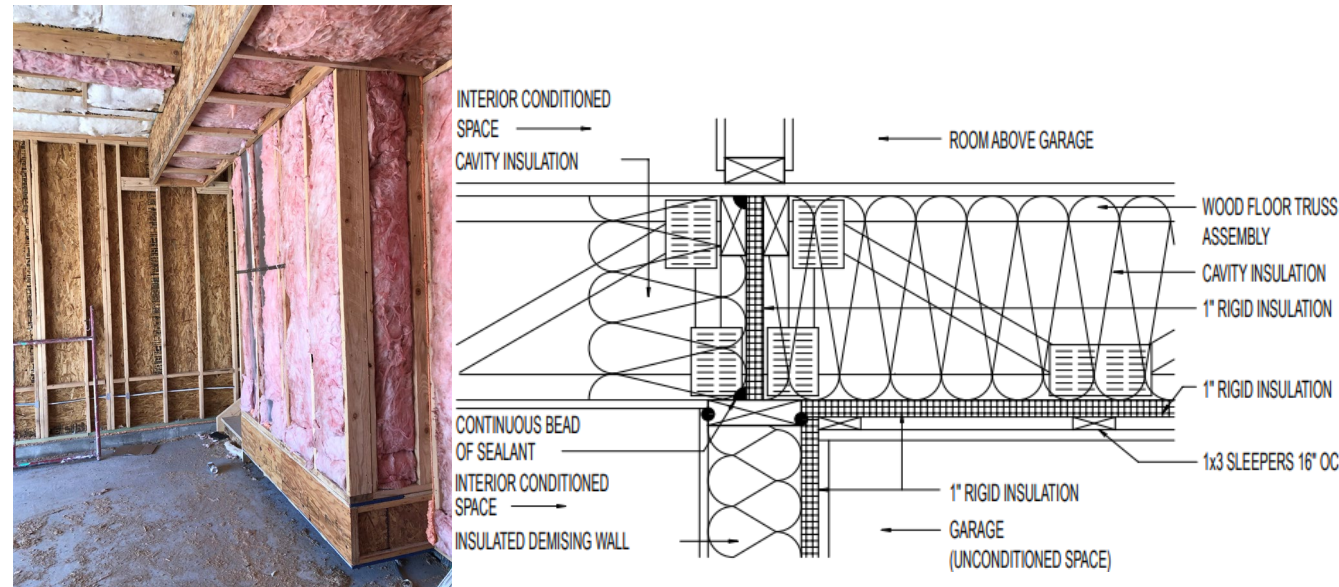
## Component – Garage Separation

### Air Barrier Criteria

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

### Insulation Installation Criteria

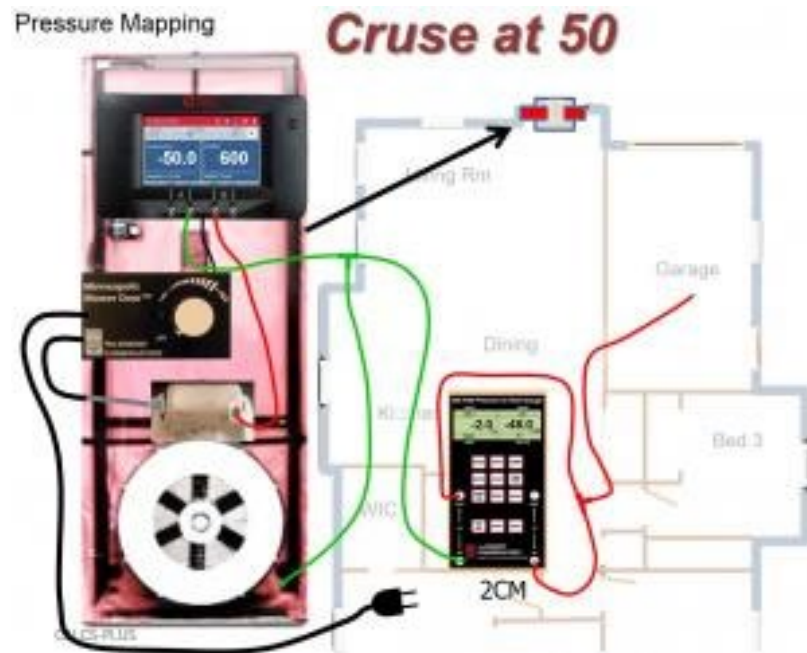
- Insulated portions of the garage separation assembly shall be installed in accordance with Section R303 and R402.2.7 Floors





# Garage Separation

What does this mean?



<https://basc.pnnl.gov/resource-guides/air-leakage-testing-garage-house-air-barrier>

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# Table 402.4.1.1

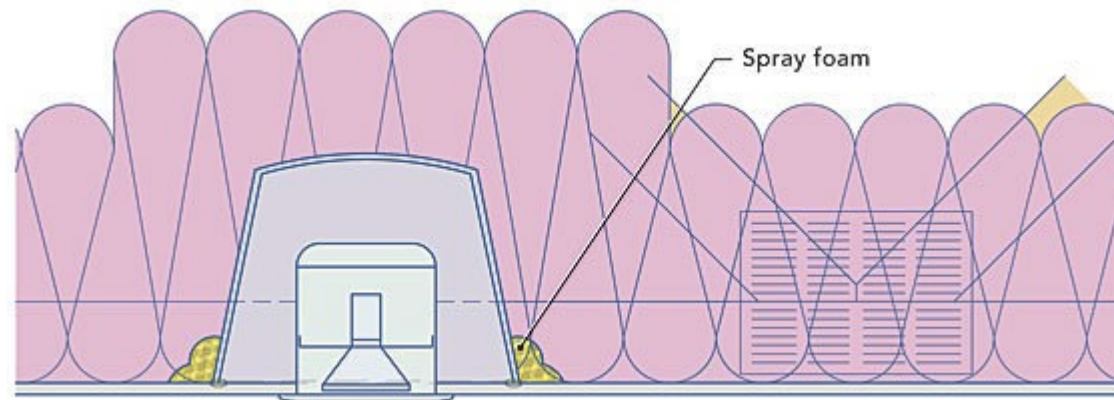
## Component – Recessed lighting

### Air Barrier Criteria

- Recessed light fixtures installed in the building thermal envelope **shall be Air sealed in accordance with Section R402.4.5**

### Insulation Installation Criteria

- Recessed light fixtures installed in the building thermal envelope **shall be airtight, IC rated, and shall be buried or surrounded with insulation**



<https://www.finehomebuilding.com/2013/07/11/recessed-can-lights>



# Table 402.4.1.1

## Component – Plumbing, Wiring, or other obstructions

### Air Barrier Criteria

- All holes created by wiring, plumbing or other obstruction in the air barrier assembly shall be air sealed

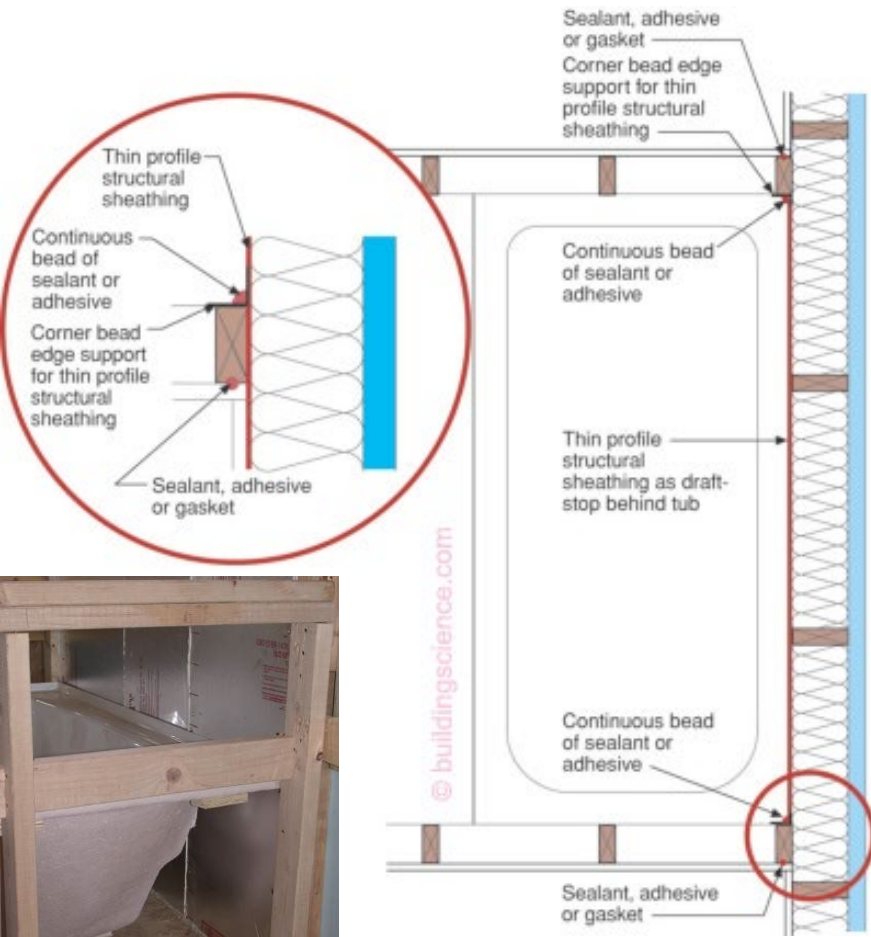
### Insulation Installation Criteria

- Insulation shall be installed to fill the available space and surround wiring, plumbing, or other obstructions, unless the required R-value can be met by installing insulation and air barrier systems completely to the exterior of the obstruction





# Tubs and Showers



[https://www1.eere.energy.gov/buildings/publications/pdfs/building\\_america/tub\\_fireplace\\_enclosure.pdf](https://www1.eere.energy.gov/buildings/publications/pdfs/building_america/tub_fireplace_enclosure.pdf)







# Table 402.4.1.1

## Component – Fireplace

### Air Barrier Criteria

An air barrier shall be installed on fireplace walls. Fireplaces shall have gasketed doors

- This specific section was moved in the 2015 IECC
- This item is now picked up by Shaft penetrations and Flues
- Very important area also covered by the general section and principals outlined in this table

### Insulation criteria









# Sequencing is the Issue

## Air barrier 1<sup>st</sup> then over framing





# Table 402.4.1.1

## Component – Electrical/phone box on exterior walls



### Air Barrier Criteria

- The air barrier shall be installed behind electrical, or communication boxes. **Alternatively**, air sealed boxes shall be installed



### Insulation Installation Criteria



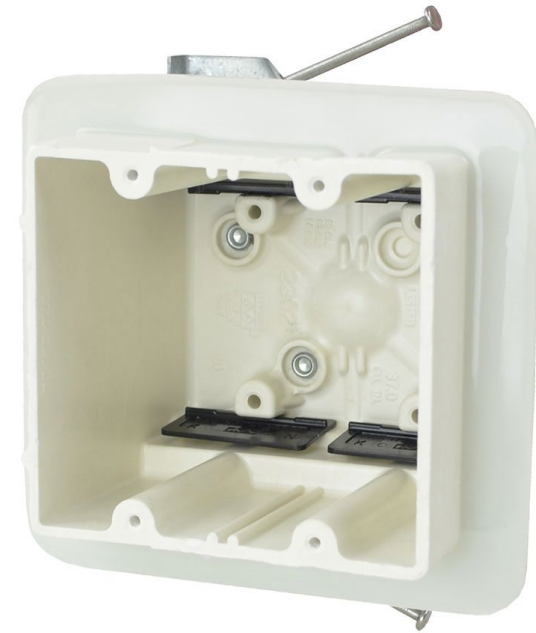
<http://houseofnumbers.blogspot.com/2010/05/air-sealing-details.html>

# R402.4.6 Electrical and Communication Outlet boxes

(air-sealed boxes)



- Electrical and communication outlet boxes installed in the building thermal envelope **shall be sealed to limit air leakage between conditioned and unconditioned space**
- Shall be tested per NEMA OS4 requirements for air sealed boxes
- Shall have an air leakage rate no greater than 2.0 ft<sup>3</sup>/minute
- Shall be marked with “NEMA OS4” or “OS4”
- Shall be installed per manufacture instruction

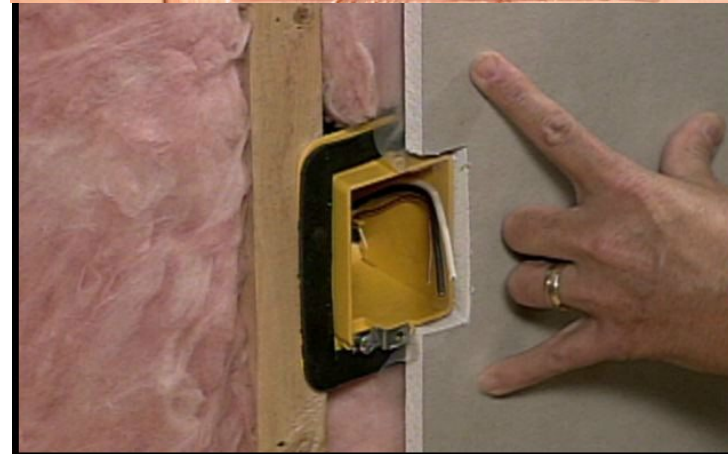
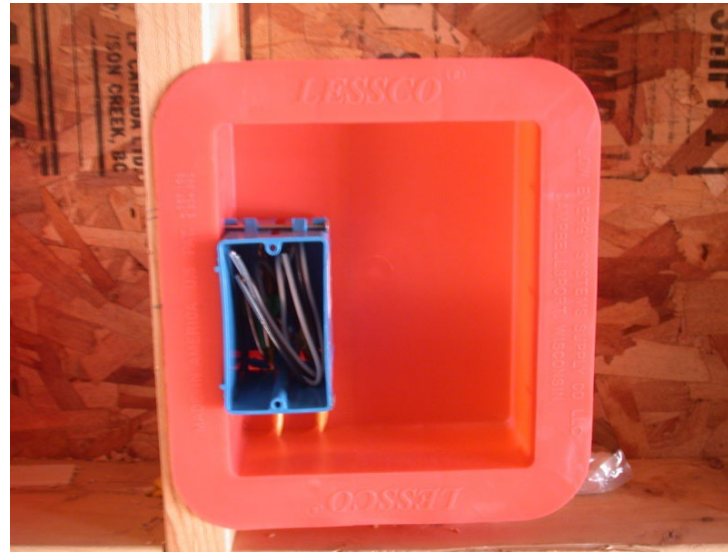
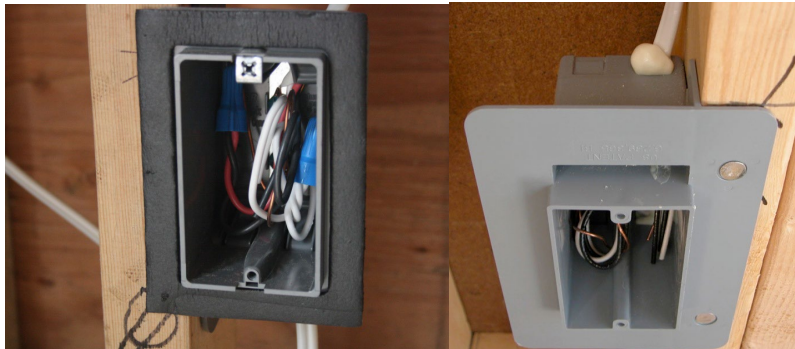
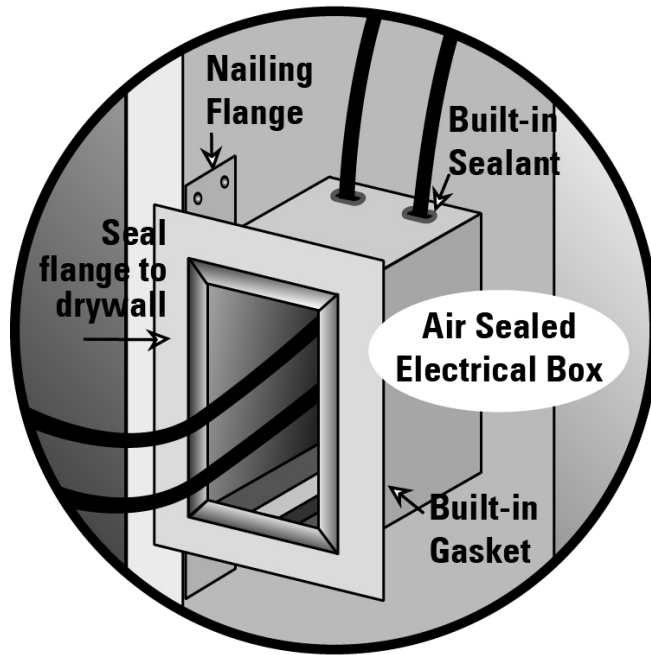


**NEMA OS 4 – Energy Efficient Air-Sealed Boxes  
for Electrical Applications**





# Electrical/phone box on exterior walls



<https://www.joneakes.com/jons-fixit-database/1428-What-is-an-air-tight-electrical-box> <https://bascc.pnnl.gov/images/air-tight-electrical-boxes-have-built-gaskets-and-self-sealing-wire-holes>

# Table 402.4.1.1

## Component – HVAC Register boots



### Air Barrier Criteria

- HVAC supply and return register boots that penetrate building thermal envelope **shall be sealed** to the subfloor, wall covering, or ceiling penetrated by the boot

### Insulation Criteria



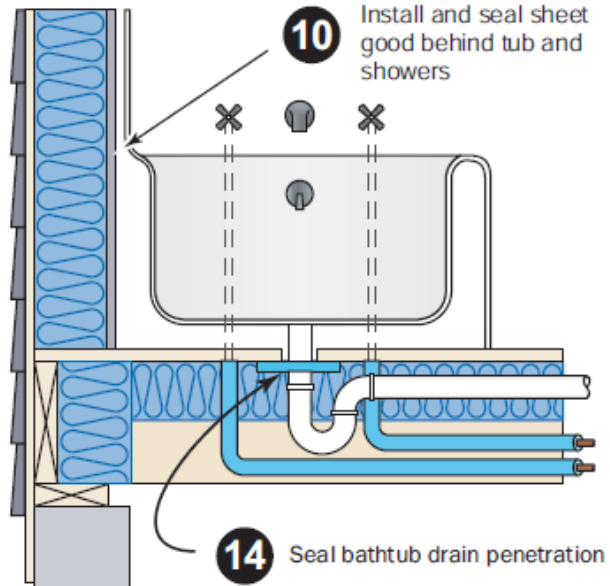


# Other Potential Problem Areas





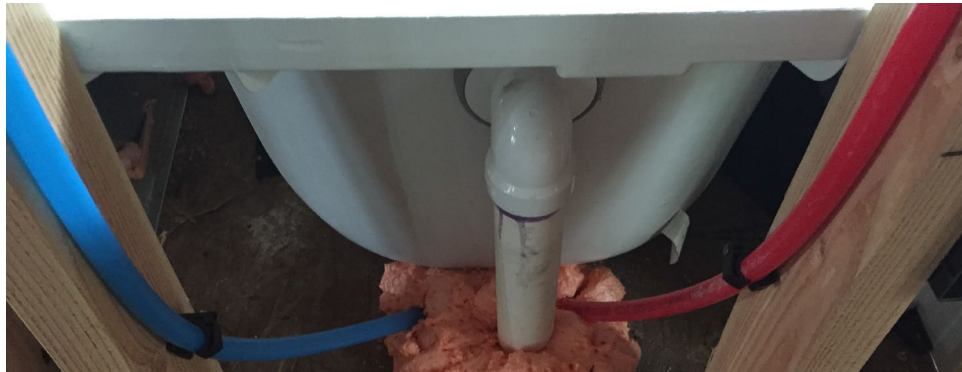
# Traps: Seal them!













# Table 402.4.1.1

## Component – Concealed Sprinklers



### Air Barrier Criteria

- When required to be sealed, concealed fire sprinklers **shall only be sealed in a manner that is recommended by the manufacturer.** Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings

### Insulation Installation Criteria





# Fire Sprinklers and Insulation

Figure 1

## CONCEPTUAL PIPE TENTING DETAIL

SCALE: NOT TO SCALE

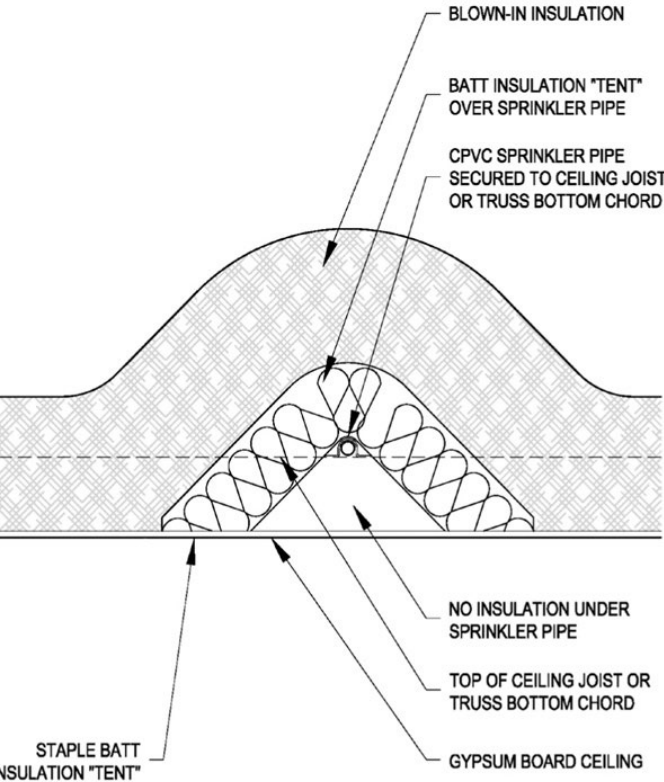


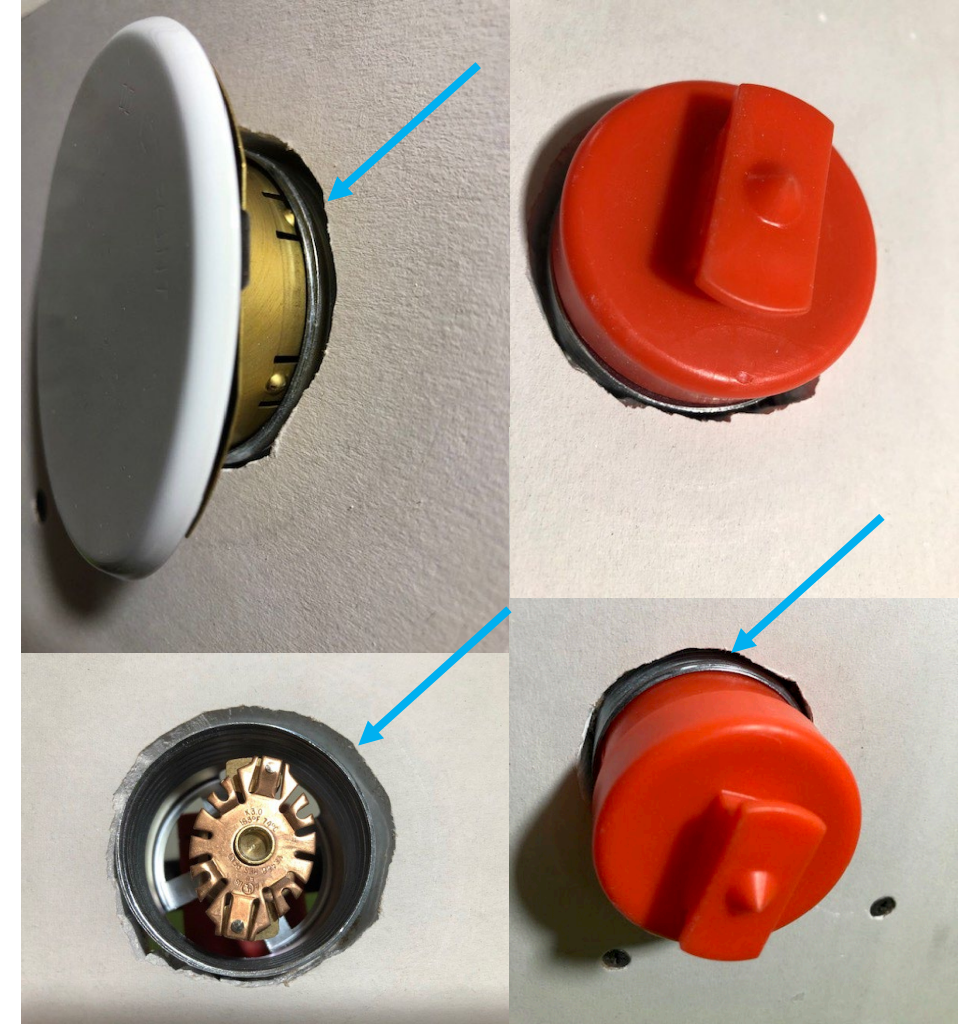
Diagram courtesy of CASE Forensics



<https://www.atlashomeenergy.com/blog/blog-post-1>



# Fire Sprinklers and air leakage?



<https://www.multihousingnews.com/post/rehau-upgrades-residential-fire-sprinkler-system-with-fitting-technology/>



# Table 402.4.1.1

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# Fire Sprinklers and Insulation

Figure 1

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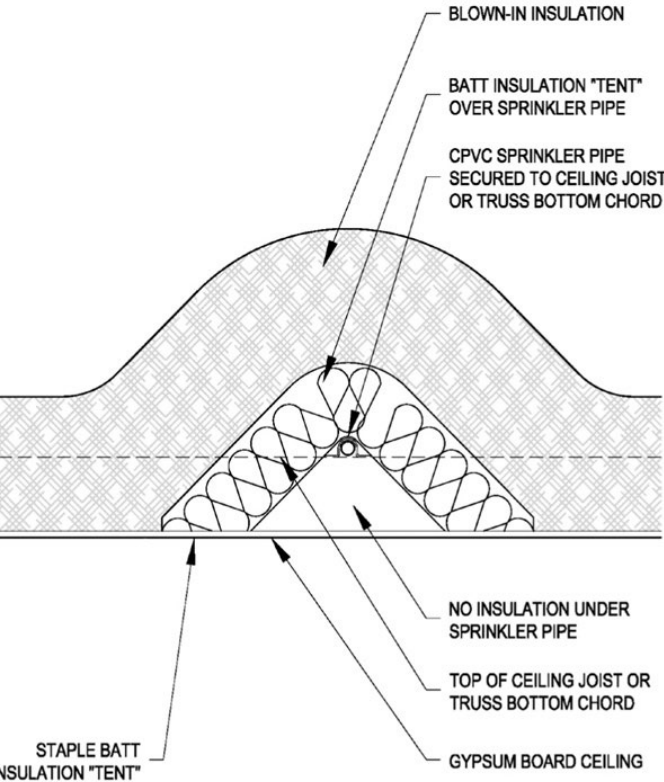


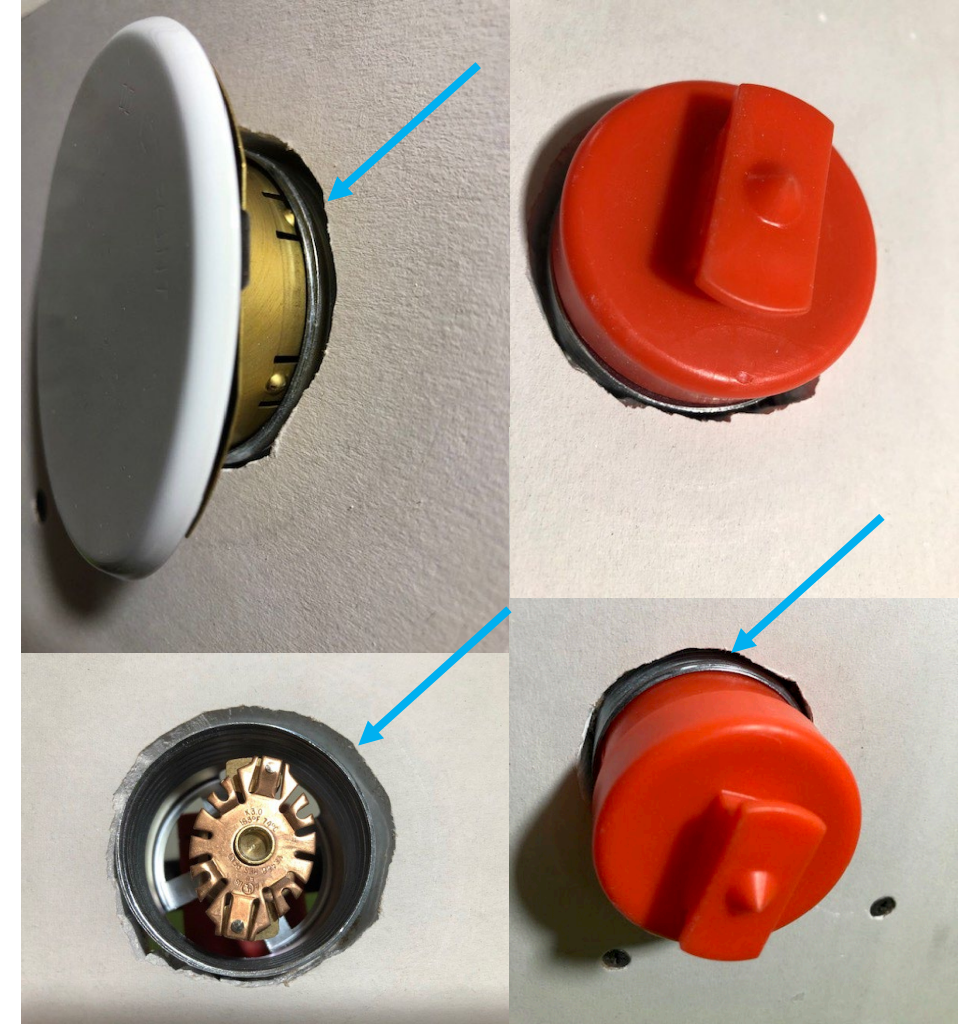
Diagram courtesy of CASE Forensics



<https://www.atlashomeenergy.com/blog/blog-post-1>



# Fire Sprinklers and air leakage?



<https://www.multihousingnews.com/post/rehau-upgrades-residential-fire-sprinkler-system-with-fitting-technology/>



# Single Family vs. Attached Housing







©2022

BUILD *Tank* inc.



# The Problem





# New to UL Design U 373,336,347,366,375

## Caulking and Sealants

**Intended for use as an air barrier** - Not intended to be used as fire blocking

- A bead of sealant applied around the partition perimeter in the 3/4 in. air space between wood framing and shaftliner panels to create an air barrier
  - Great Stuff, Handi Foam





# Fill the gap

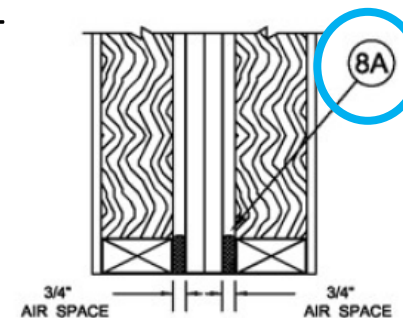
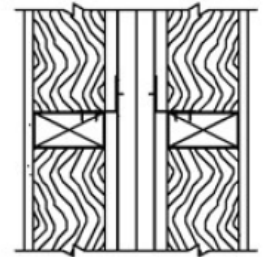
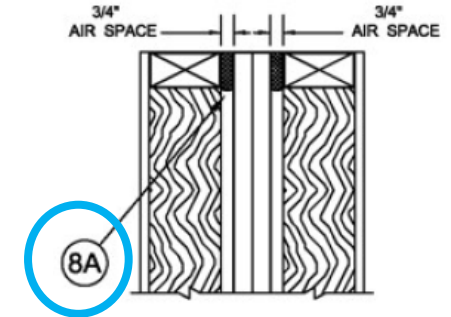


# Shaft Liner Assemblies Allowing Air Sealing

- **8. Caulking and Sealants\*** —  
(Optional - Intended for use as an air barrier - Not intended to be used as fire blocking)
- **A bead of sealant applied around the partition perimeter in the 3/4 in. air space between wood framing (Item 4) and shaftliner panels (Item 3) to create an air barrier.**
- **DUPONT DE NEMOURS, INC.** — Great Stuff Gaps & Cracks, Great Stuff Pro Gaps & Cracks, Great Stuff Pro Window & Door
- **ICP ADHESIVES & SEALANTS INC** — Handi-Foam Fireblock, Handi-Foam Fireblock West, and Fast Foam Fireblock

BXUV Guide Updated December 2020

- U336 - UNITED STATES GYPSUM CO
- U347 - NATIONAL GYPSUM CO
- U366 - CERTAINTEED GYPSUM INC
- U373 - GEORGIA-PACIFIC GYPSUM L
- U375 - AMERICAN GYPSUM CO



SECTION B1-B1





Most ASW perform like an exterior wall

- Treat Common / Party Walls Like any Exterior Walls and require all air sealing and air barriers adjacent to the assembly
- Use IECC table [R402.4.1.1](#) as a guide

# Some additional Requirments

---





# R404.1 Lighting Equipment

Airtight and efficient

ALL permanently installed lighting fixtures shall contain only High-efficacy lighting sources

- Exception kitchen appliance lighting fixtures

standard incandescent	CFL compact fluorescent lamp	LED
		
watts >>	60	18
lumens >>	840	825
life (years) >>	0.9	9.1
estimated annual energy cost* >>	\$7.23	\$5.18
initial cost per bulb >>	\$2.00	\$8.00
		\$12.00

\*based upon 3hrs/day and rate of \$0.11 per kilowatt hour

<https://www.pinterest.ca/pin/555913147746720665/>



# R404.2 Interior Lighting Controls

- Permanently installed lighting fixtures shall be controlled with either Dimmer, an occupant sensor control, or other control that is installed or built into the fixture
  - Exception areas
    - Bathrooms
    - Hallways
    - Exterior
    - Safety and security lighting





# R404.3 Exterior Lighting

Where total permanently installed exterior lighting, power is greater than 30 watts, the installed lighting shall comply with the following:

- Controlled by a manual on/off switch that permits automatic shut-off actions.
  - Exception: lighting serving multiple dwelling units
- Automatic shut-off when daylight is present to satisfy the needs
- Automatic shut-off must be able to return automatic controls to normal operation within 24 hours



# R403.6.3 Testing

## Ventilation Systems

Mechanical ventilation systems shall be tested and verified to provide the minimum ventilation flow rates required by Section R403.6

Fan Type	Flow Rate
Bath Fans	50 CFM intermittent / 20 CFM continuous
Kitchen Hood	100 CFM intermittent / 25 CFM continuous
Whole House Mechanical Ventilation	PER ASHRAE 62.2

Testing shall be performed according to the ventilation equipment manufacturer's instructions, or by using a flow hood or box, flow grid, or other airflow measuring device .....

- Where required by the building official, testing shall be conducted by an approved third party
- A written report of the results of the test shall be signed by the party conducting the test and provided to the building official

Exception: Kitchen range hoods that are ducted to the outside with 6" or larger duct and one or less 90° elbow or equivalent in the duct run are exempt from this requirement to test air flow



# IECC Ventilation Trigger

## 2018 IRC - R303.4 Mechanical ventilation.

- Where the air infiltration rate of a *dwelling unit* is 5 air changes per hour or less, where tested with a blower door at a pressure of 0.2 inch w.c (50 Pa) in accordance with Section N1102.4.1.2, the *dwelling unit* shall be provided with whole-house mechanical ventilation in accordance with Section M1505.4.

## 2021 IRC - R303.4 Mechanical ventilation.

- Buildings and *dwelling units* complying with Section N1102.4.1 shall be provided with mechanical ventilation in accordance with Section M1505, or with other *approved* means of ventilation.



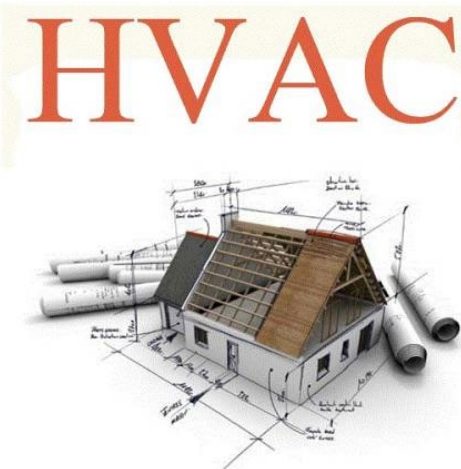
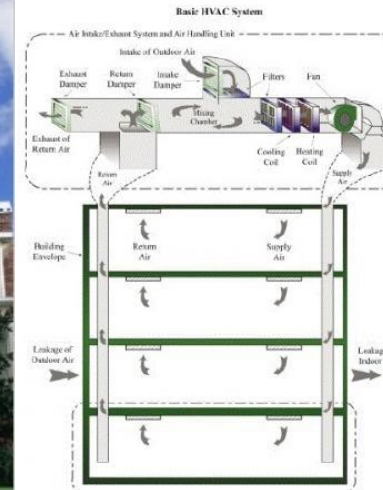
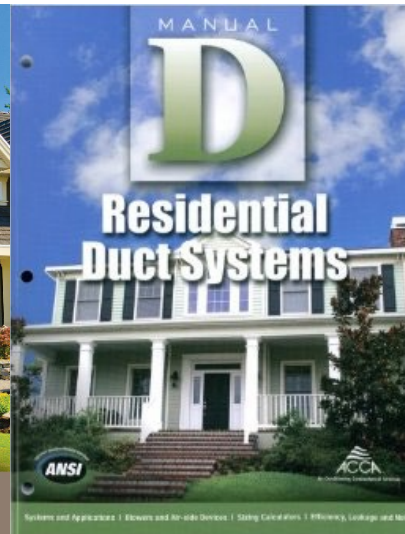
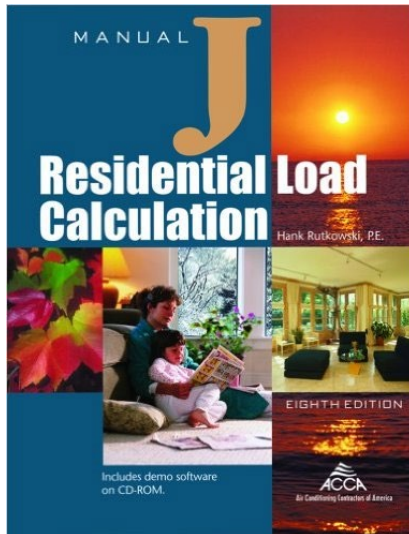
# Blower Door Testing





# 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 delivers, and returns air to all rooms (Manual D)



# R402.4.1.2 Testing (required)

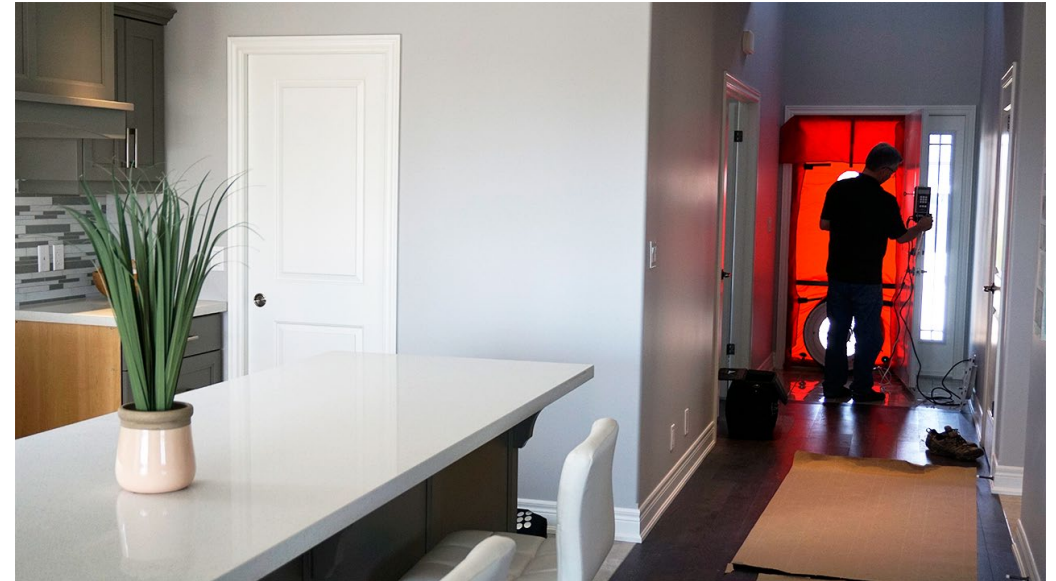


- The building or dwelling unit shall be tested for air leakage.
- The maximum air leakage rate for any building or dwelling unit under any compliance path shall not exceed 5.0 ACH or 0.28 CFM/ft<sup>2</sup> of dwelling enclosure area

## Exception:

- Heated and attached or detached garages

Intended for Section  
R405 and R406  
Compliance paths





## R402.4.1.2 Testing (Exception)

When testing individual dwelling units

- 0.30 CFM/ft<sup>2</sup> of dwelling enclosure area shall be an accepted alternative permitted in all climate zones for

1. Attached single family and multifamily building dwelling units
2. Building or dwelling units that are 1500 sqft or smaller



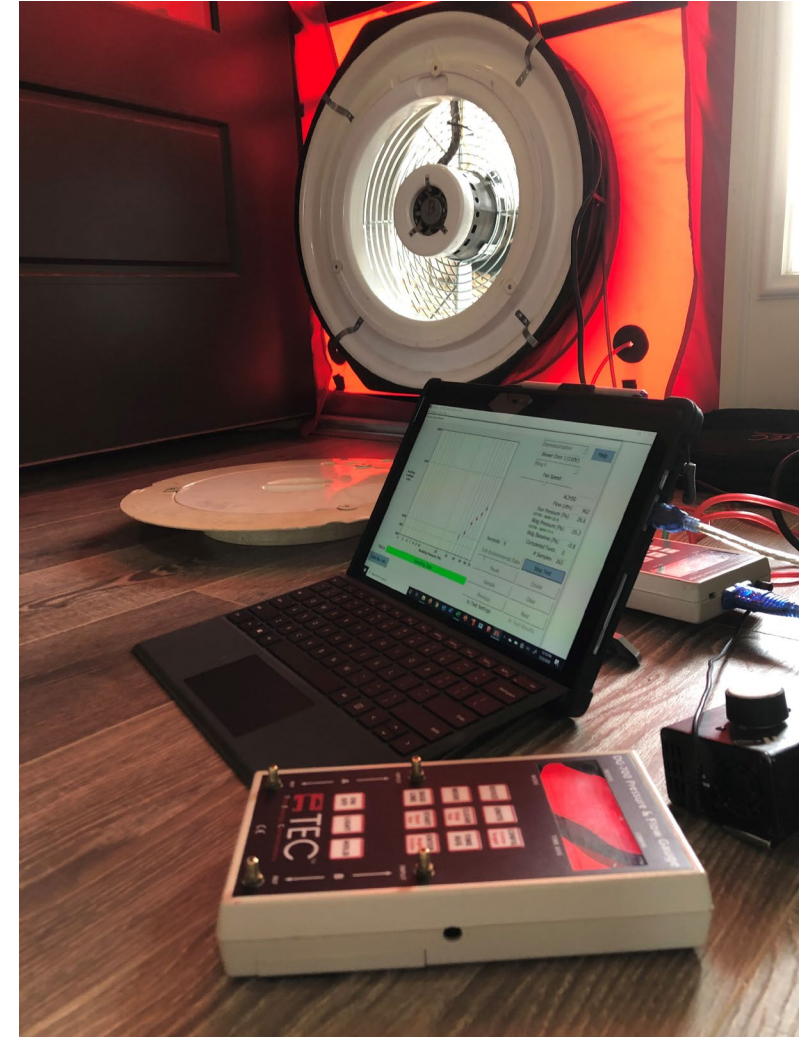
# R402.2.1 Prescriptive Compliance Path

## Air Leakage Rates



### R402.4.1.3 Leakage Rate

- When complying with **the prescriptive compliance** path R402.2.1, the building or dwelling unit shall have an air leakage rate not exceeding:
  - **5.0 ACH@50** in Climate Zones 1 and 2
  - **3.0 ACH@50** in Climate Zones 3 through 8
- Testing **may** be conducted by an approved third party
- Testing methodology and Reporting requirements





# Air Leakage Reports



## R402.4.1.2 Testing.

- ..... A written report of the results of the test shall be signed by the party conducting the test and provided to the *code official*. Testing shall be performed at any time after creation of all penetrations of the *building thermal envelope*.

**8925 Place to live**  
Denver, CO 80238  
Best Builder In America Homes

**THIS HOME IS CERTIFIED TO MEET THE IECC 2015 (4 ACH50 MF) ENERGY CODE**

**Building Features**

Ceiling Attic, R-38	Duct Supply R-19.0, Return R-0.0
Above Grade Walls R-23	Duct Leakage to Outside 0.0 CFM @ 25 Pa
Foundation Walls R-11	Total Duct Leakage 140.0 CFM @ 25 Pa
Framed Floor R-44	Heating Furnace • Natural Gas • 92.5 AFUE
Slab R-0.0 Perimeter, R-0.0 Under	Cooling Air Conditioner • Electric • 13 SEER
<b>Infiltration 3 ACH50</b>	Water Heating Water Heater • Natural Gas • 0.62 Energy Factor
Window U-value: 0.34 SHGC: 0.28	

The organization below certifies that the proposed building design described herein is consistent with the building plans, specifications, and other calculations submitted with the permit application.

Name: Robby Schwarz Signature: \_\_\_\_\_  
Organization: EnergyLogic Date: Mar 07, 2018

Ekotrope RATER - Version 2.2.4.1876  
This software has been accredited by RESNET to demonstrate International Energy Conservation Code (IECC) Performance Path Compliance. It has not been reviewed or approved by the state of Colorado, the International Code Council or their affiliates.

## Air Leakage Report

Property  
123 Place to Live Dr.  
Denver, CO 80211  
Model: Village N4101  
Community: Cliffside

REM16 2018 SPP compliance  
Study House

Organization  
BuildTank, Inc.  
Robby Schwarz  
303-927-0025

Inspection Status  
Results are projected

**BUILD**Tank

**BUILD**Tank

## BUILDING LEAKAGE TEST

BUILDTank, Inc.  
4456 Beach Ct  
Denver, CO 80211

Email: robby@btankinc.com Website: www.btankinc.com

### General Information

Conditioned Floor Area [sq. ft.]	4,640
Infiltration Volume [cu. ft.]	45,142
Number of Bedrooms	4

### Air Leakage

Measured Infiltration	2144 CFM50 (2.85 ACH50)
ACH50 (Calculated)	2.85
ELA [sq. in.] (Calculated)	117.92
ELA per 100 s.f. Shell Area (Calculated)	1.263
CFM50 (Calculated)	2,144
CFM50 / s.f. Shell Area (Calculated)	0.230

### Duct Leakage

	System 1
Leakage to Outdoors	1 CFM @ 25Pa (0.02 / 100 s.f.)
Total Leakage Test Type	Post-Construction
Total Leakage [CFM @ 25 Pa]	1.0
Total Leakage [CFM25 / 100 s.f.]	0.0
Total Leakage [CFM25 / CFA]	0.000

### Mechanical Ventilation

Rate [CFM]	85 CFM
Hours per day	24.0
Fan Power	15 Watts
Recovery Efficiency %	0.0
Runs at least once every 3 hrs?	true
Average Rate [CFM]	85.0 CFM
2010 ASHRAE 62.2 Req. Cont. Ventilation	83.9
2013 ASHRAE 62.2 Req. Cont. Ventilation	86.5

Date of Test: 1/19/2020 Test File: Example house

Technician: Robby Schwarz

Project Number:

Customer: Best Builder

Building Address: 123 Place to Live

Phone:  
Fax:

### Test Results at 50 Pascals:

cfm50 Airflow	1030 (+/- 0.5 %)
ACH50	0.90
cfm/ft <sup>2</sup> (Floor Area)	0.1534
cfm/ft <sup>2</sup> (Surface Area)	0.0832

### Leakage Areas:

166.6 in<sup>2</sup> (+/- 5.1 %) Canadian EqLA @ 10 Pa or 0.0135 in<sup>2</sup>/ft<sup>2</sup> Surface Area  
114.6 in<sup>2</sup> (+/- 7.8 %) LBL ELA @ 4 Pa or 0.0093 in<sup>2</sup>/ft<sup>2</sup> Surface Area

### Building Leakage Curve:

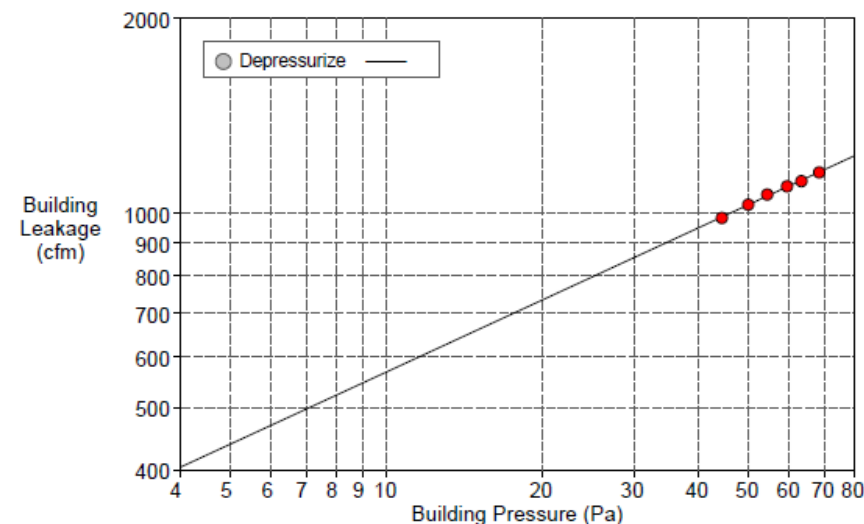
Flow Coefficient (C) = 241.5 (+/- 11.8 %)  
Exponent (n) = 0.371 (+/- 0.029)  
Correlation Coefficient = 0.99838

Test Standard:

E779-10

Test Mode:

Depressurization





# Duct Leakage Testing

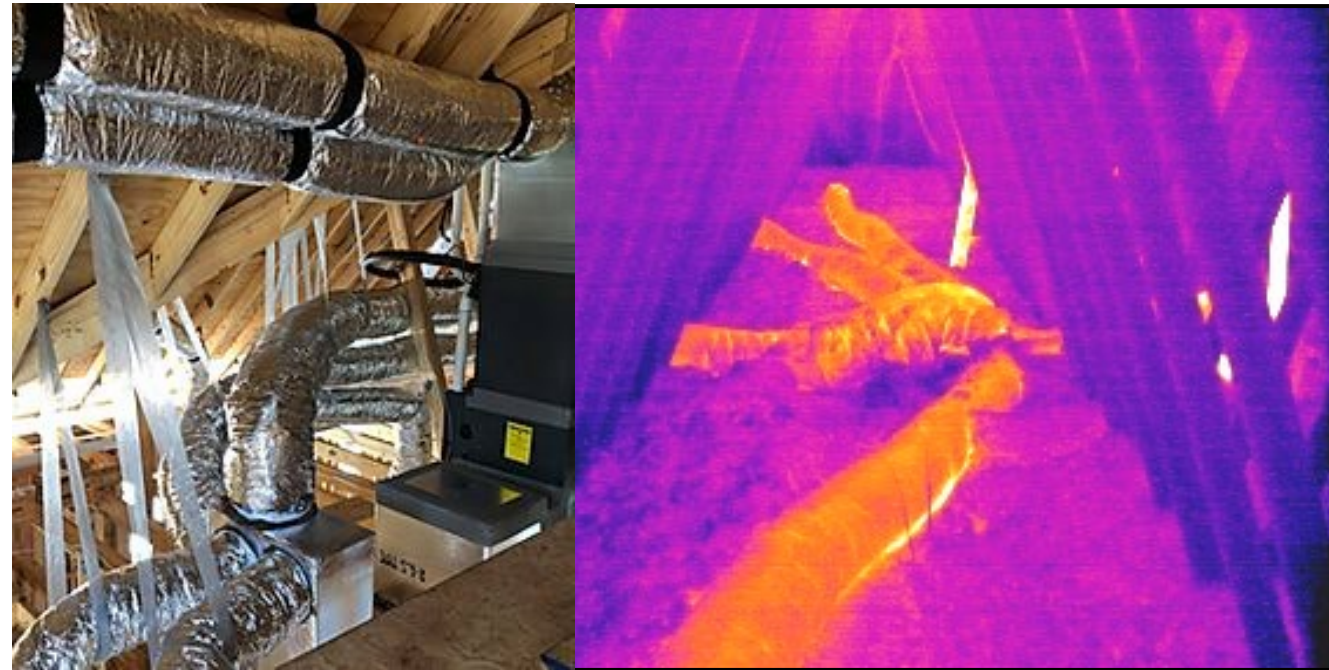


# R403.3.5 Duct testing (Required)

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

## 2021 IECC Regardless of location

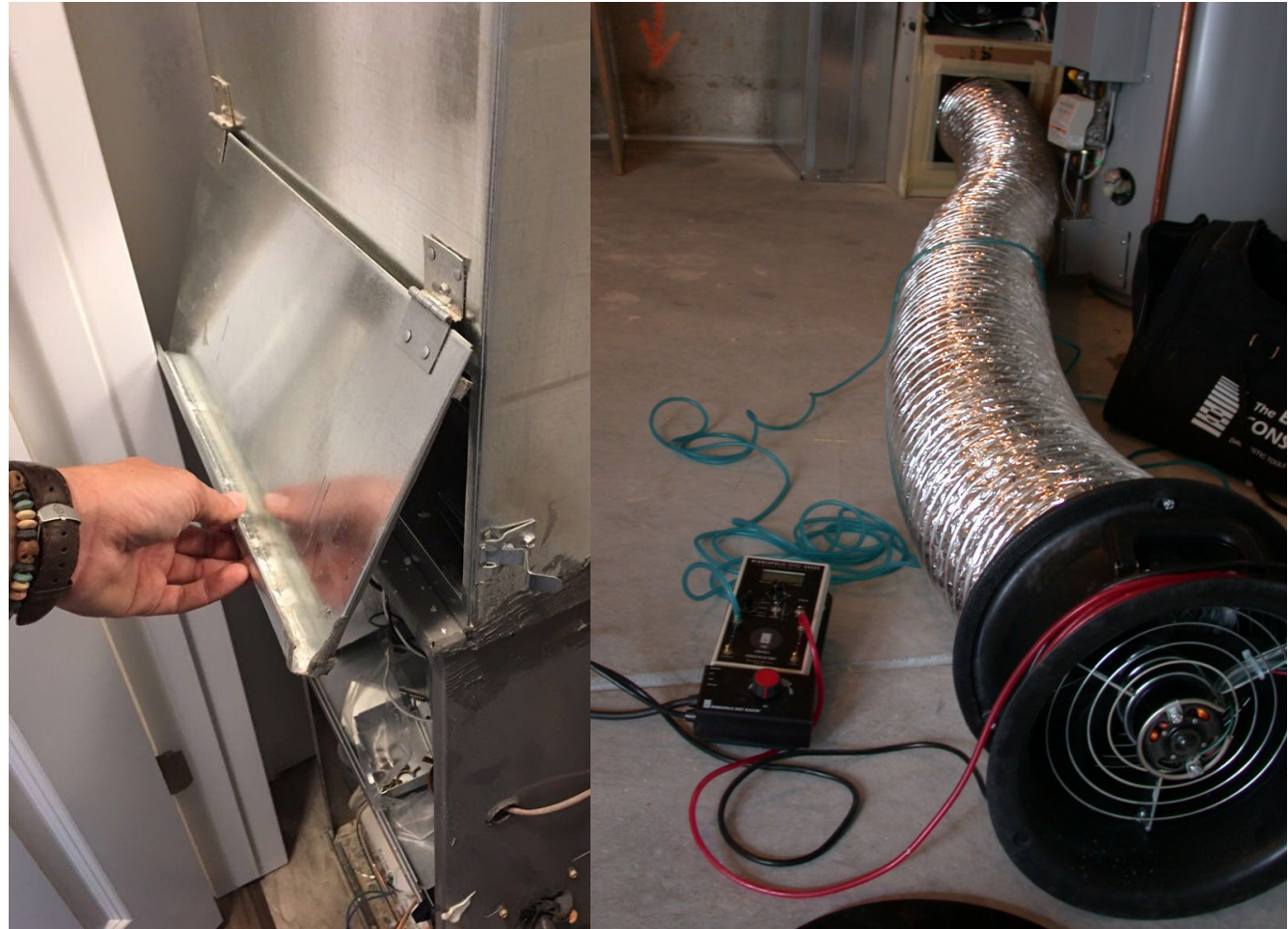
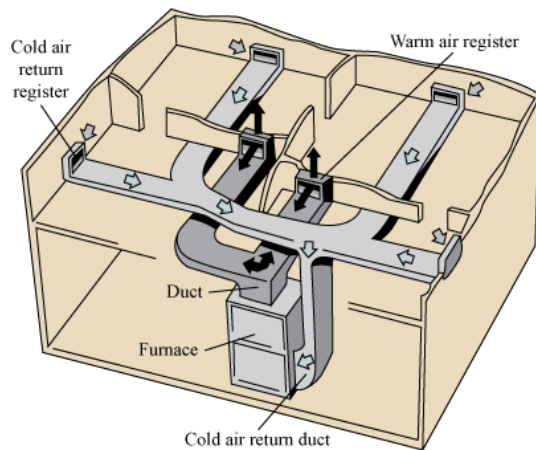
- Attic
- Unconditioned crawl space
- Isolated mechanical room
- Floor over garage
- Exterior walls





# Duct Leakage Testing

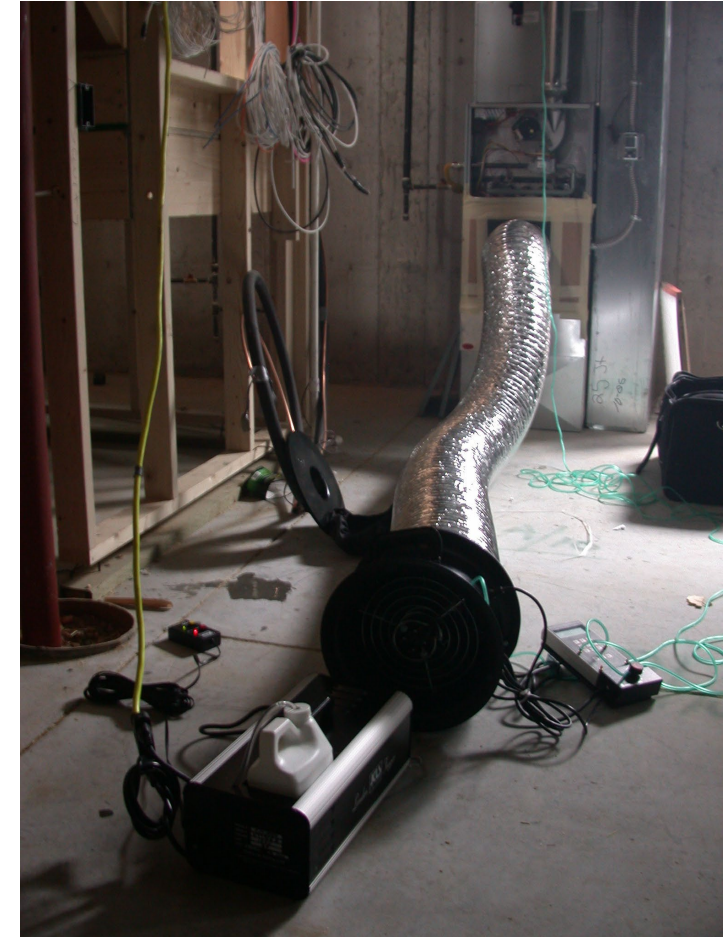
- The Duct System includes
  - Air handlers
  - Ducts
  - Filter boxes
  - Building cavities?



<https://www.ck12.org/physics/heating-systems/lesson/Heating-Systems-MS-PS/>

# R403.3.6 Leakage (Required)

- Rough In Test
  - $\leq 4.0$  CFM 25 per 100 sqft of conditioned floor area
    - 2000 sqft house  $\leq 80$  CFM 25 total
  - $\leq 3.0$  CFM 25 per 100 sqft of conditioned floor area is air handler has not been installed
    - 2000 sqft house  $\leq 60$  CFM 25 total
- Post Construction
  - $\leq 4.0$  CFM 25 per 100 sqft of conditioned floor area
    - 2000 sqft house  $\leq 80$  CFM 25 total
- When **air handler and All duct** is entirely within the building thermal envelope
  - $\leq 8.0$  CFM 25 per 100 sqft of conditioned floor area
    - 2000 sqft house  $\leq 160$  CFM 25 total





# Duct Leakage to Outside



# Required if Present



**STRICTLY  
OVER 18'S**

**I.D.**

**MAYBE  
REQUIRED**

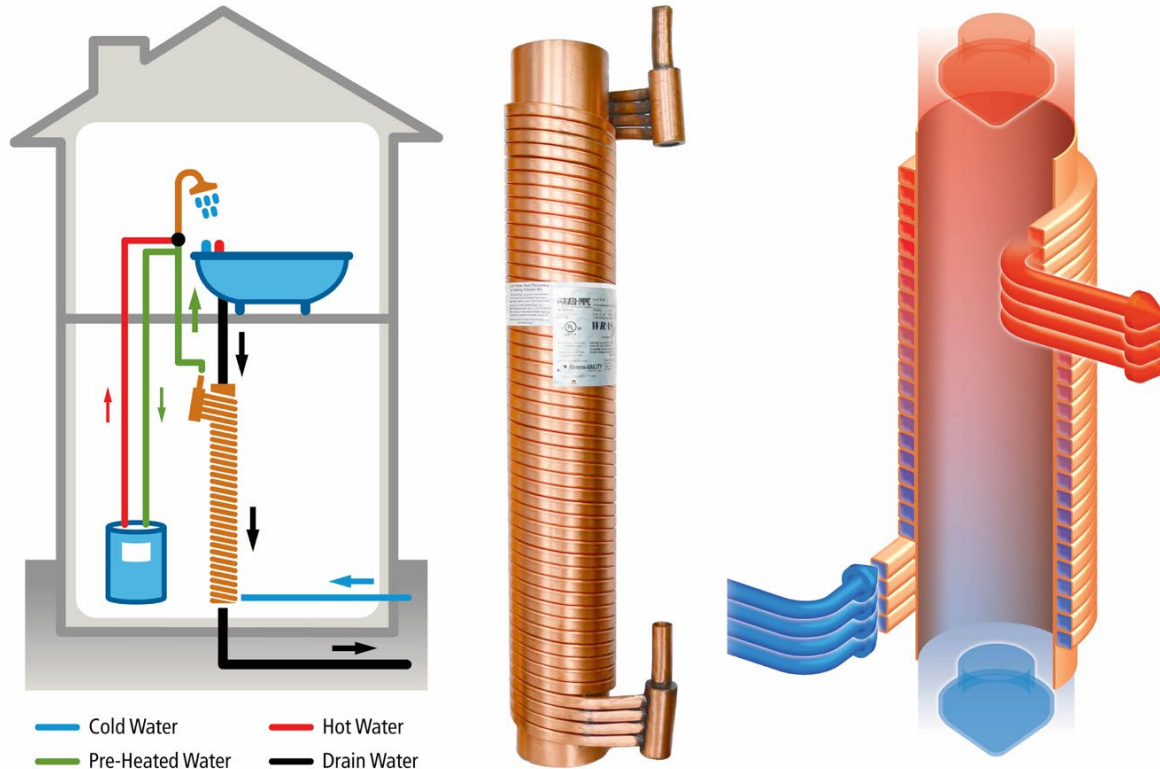
<https://keepcalms.com/p/strictly-over-18-s-i-d-maybe-required/>

**BUILD***Tank*<sub>inc.</sub>



# R403.5.3 Drain water heat recovery units

- **Where installed**, drain water heat recovery units shall comply with CSA B55.2.....

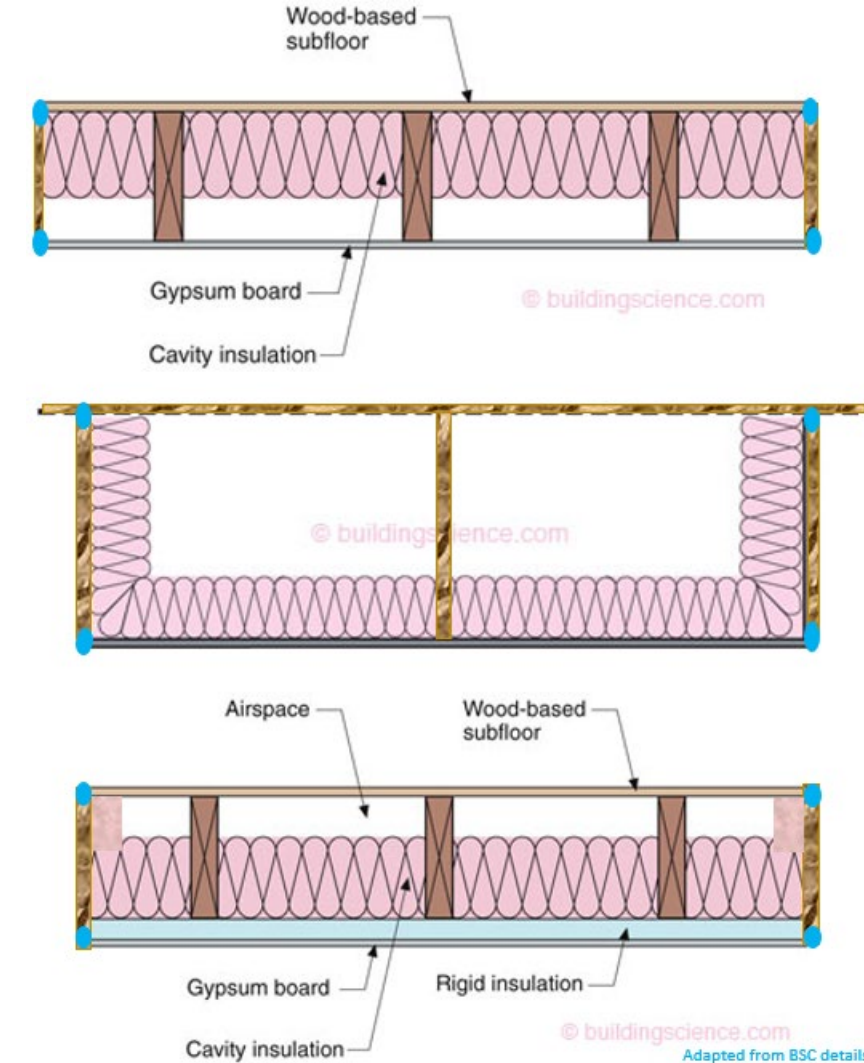


<https://www.phamnews.co.uk/wise-up-to-water-waste-heat-recovery/>

# R403.3.2 Ducts Located in Conditioned Space

3. Ductwork in Floor cavities located over unconditioned spaces shall comply with the following:

- **Continuous air barrier** installed between unconditioned space and the duct
- Insulation installed in accordance with Section **R402.2.7 Floors**
- A **minimum R19** installed in the cavity width between the duct and the unconditioned space



Adapted from BSC details



# R403.3.2 Ducts Located in Conditioned Space

4. Ductwork located within exterior walls of the building thermal envelope shall comply with the following:

- **Continuous air barrier** installed between unconditioned space and the duct
- A **minimum R10** installed in the cavity width between the duct and the outside sheathing
- The remainder of the **cavity fully insulated to the drywall side**



# Conclusion

---





# Thank you!

Robby Schwarz  
robby@btankinc.com  
303-927-0025

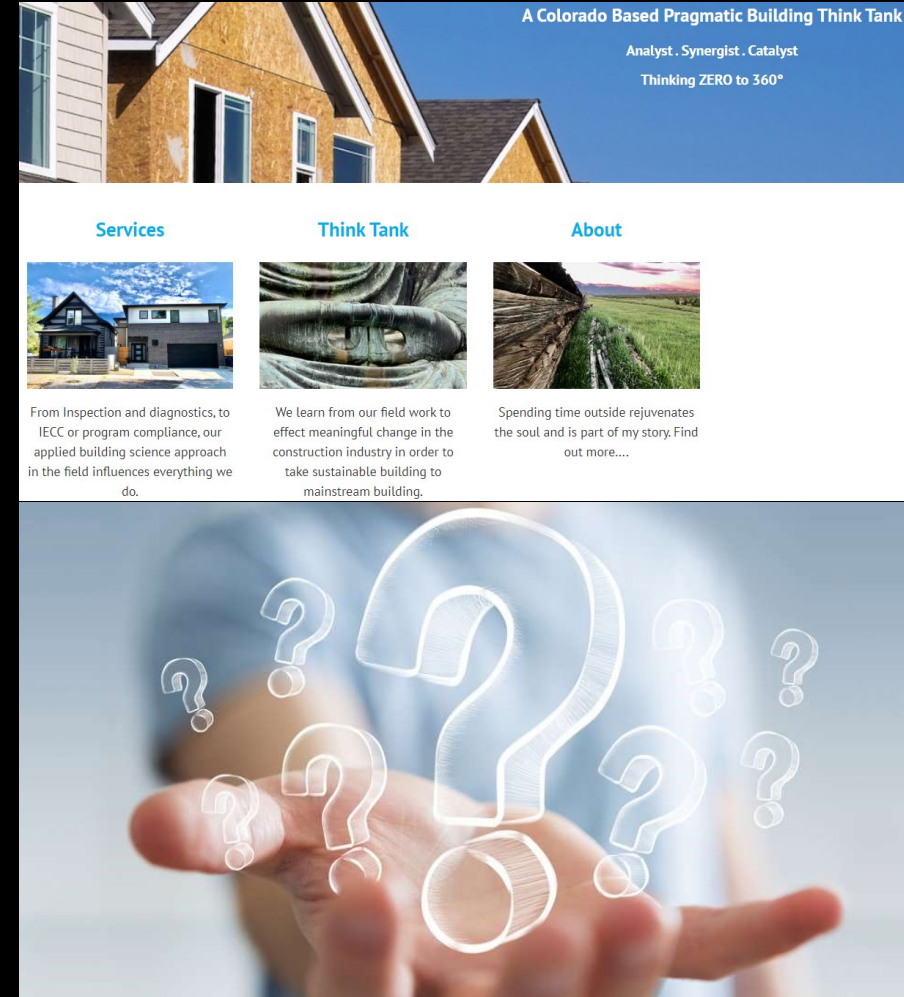
 @ buildtankinc

buildCAST



On your favorite podcast platform

[www.btankinc.com](http://www.btankinc.com)



# Thinking **ZERO** to 360°

All slides in this presentation © 2022

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