

# Massachusetts Energy Code Technical Support Initiative

*Massachusetts Residential Energy Code:  
Envelope & Building Science*

# Codes and Standards Initiative - Sponsors

# Who is Mass Save®?



- Mass Save® is an initiative sponsored by Massachusetts' gas and electric utilities and energy efficiency service providers, including
  - The Berkshire Gas Company
  - Cape Light Compact
  - Columbia Gas of Massachusetts
  - Eversource Energy
  - Liberty Utilities
  - National Grid
  - Unitil
- The Sponsors of Mass Save work closely with the Massachusetts Department of Energy Resources to provide a wide range of services, incentives, trainings, and information promoting energy efficiency that help residents and businesses manage energy use and related costs.

- **Individually Metered Low-Rise New Construction**
  - Performance Path – based upon kWh and therm savings, plus a % adder as compared to MA baseline – incentives up to \$10,000
- **Master Metered and High-Rise New Construction**
  - Incentives based upon modeling by Program Manager

Incentives also offered for existing buildings.  
Visit [www.MassSave.com](http://www.MassSave.com) for the details.



# MA RNC Incentives



## Single Family BSA Incentive Calculation

A	Electric Savings * \$0.35 / kWh
B	Fuel Savings * \$35 / MMBtu
C	Percent Savings * \$3,000
Participant Incentive	A +B +C
Rater Incentive	\$350

## Multifamily BSA Incentive Calculation

A	Electric Savings * \$0.35 / kWh
B	Fuel Savings * \$35 / MMBtu
C	Percent Savings * \$2,000
Participant Incentive	A +B +C
Rater Incentive	\$100

Details at

[www.masssave.com/en/saving/residential-rebates/new-construction](http://www.masssave.com/en/saving/residential-rebates/new-construction)

# Commercial New Construction Offers



- **Incentives for efficiency levels beyond code:**
  - **Whole building incentives**
  - **System incentives including**
    - Air Compressors
    - Chillers
    - Lighting and Lighting Controls
    - Gas-Fired Heating Equipment
    - Variable Speed Drives
    - Custom Measures
    - And more

We also offer incentives and rebates for existing buildings as well. Please visit [www.MassSave.com](http://www.MassSave.com) for the details.

# AIA Continuing Education



- CLEAResult is a Registered Provider with The American Institute of Architects Continuing Education Systems.
  - Credit earned on completion of this program will be reported to CES Records for AIA members.
  - Certificates of Completion for non-AIA members are available on request.
- This program is registered with the AIA/CES for continuing professional education.
  - As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.
  - Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

# Important Disclosure



These trainings are being offered through the support of Mass Save® and in cooperation with the Massachusetts Board of Building Regulations and Standards (BBRS).

- The Energy Code Technical Support staff, consisting of CLEAResult and other contractors, are not code officials, and the information provided through the program is not a formal interpretation of the code.
- **Local building code officials are responsible for the enforcement of the code** and the Massachusetts BBRS is the governing body responsible for interpretations of the code.

# Mass Save® Energy Code Technical Support



## Project Specific Code Assistance

- MA code officials
- Design professionals
- Contractors
- Sub contractors
- Material suppliers



Free energy code support

**855-757-9717**

Phone assistance

Office visits

Project site visits

# Learning Objectives



1. Building enclosure requirements
2. Compliance pathways
3. Strategies for compliance
4. How to reduce air leakage
5. Moisture considerations
6. Evaluation findings

# Outline



1. Overview of Changes
2. Compliance Paths
3. Insulation
4. Air Barrier
5. Basements and Slabs
6. Walls and Windows
7. Ceilings
8. Lighting





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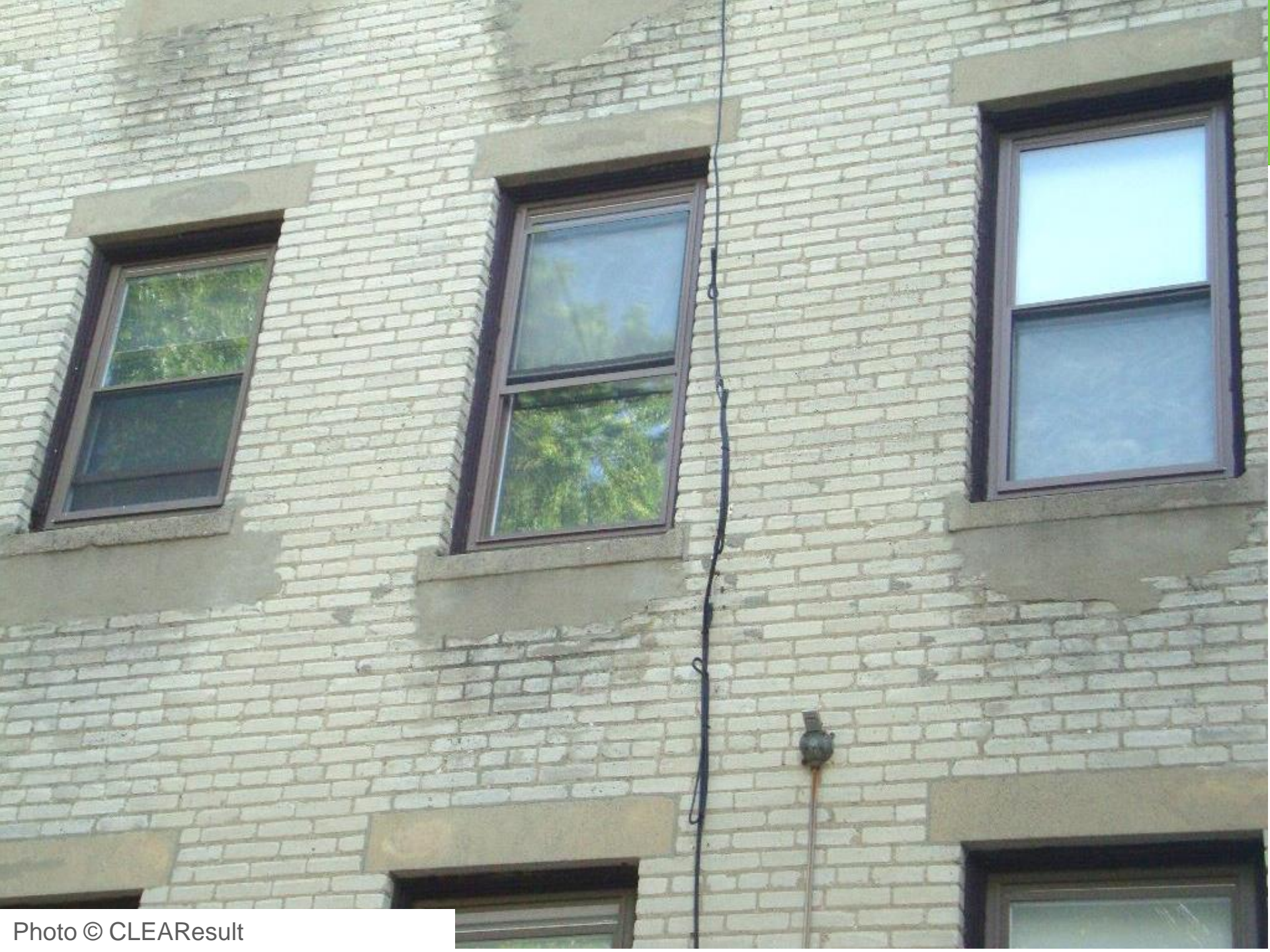


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Photo © Conservation Services Group



ANONYMOUSLY REPORT  
UNSAFE CONDITIONS  
THIS WORK SITE, CALL 311  
REPORTAR CONDICIONES PELIGROSAS  
EN SITIO DE TRABAJO, LLAME AL 311  
O EN EL SITIO DE TRABAJO





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Photo © CLEAResult

# Major Changes from 2012 to 2015 IECC



Section	Changes
R403.2.1	<b>Increases insulation requirements for return ducts in attics from R-6 to R-8.</b>
R403.4.1.1 (NEW) R403.4.1.2 (NEW)	Adds language on heated water circulation systems and heat trace systems. Makes IECC, IRC, and IPC consistent.
R403.4.2 Table R403.4.2	Deletes requirement for insulation on DHW pipes to kitchen and the generic requirement on long/large-diameter pipes. Adds DHW pipe insulation for all 3/4-inch pipes.
R403.4.2 (NEW)	Adds demand control requirements for recirculating systems that use a cold water supply pipe to return water to the tank.
R403.2 (New)	<b>Requirement for outdoor setback control on hot water boilers to control boiler water temperature based on the outdoor temperature.</b>

# MA Amendments to 2015 IECC



Section	Changes
R401.2 (NEW) R406.1.1 (NEW)	Allows for alternatives to HERS ERI <ul style="list-style-type: none"><li>a. Certified RESNET HERS rating with MA amendments</li><li>b. Certified Energy Star Homes, Version 3.1</li><li>c. Certified Passivehaus performance method</li></ul>
R401.3 (NEW)	Specifies that mandatory certificate must include final HERS index if HERS approach is used
Table R402.1.2	Reduces maximum Rx fenestration U-factor from 0.32 to 0.30
<b>R403.3.3 (NEW)</b>	<b>Specifies that duct leakage testing must be done by a HERS Rater, HERS Rating Field Inspector, or BPI Certified Professional</b>
R406.4 R406.4.1	Specifies that ERI must be satisfied without credits for onsite renewable electricity generation Allows higher ERI if using renewables
R502.1.2	Adds an exception allowing HERS index approach to be used for compliance of additions to an existing building

# New MA Stretch Code

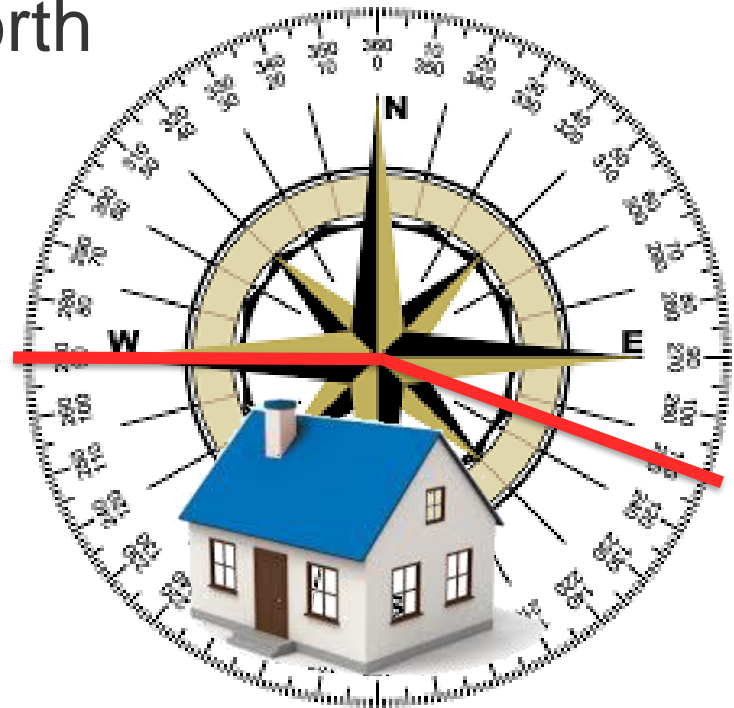


Section	Changes
AA 103.1 R-use buildings.	In all R-use buildings, of four stories or less above <i>grade plane</i> with one or more dwelling units, each <i>dwelling unit</i> shall comply with Section R406 (Energy Rating Index Compliance Method)
AA104 Existing (residential) buildings	For alterations, renovations, additions or repairs of existing buildings the energy efficiency requirements of the residential code shall be used.

# New in the 9<sup>th</sup> Edition – Solar Ready Provisions



- Anticipated to take effect January 2, 2018
- Applies only to new detached one- and two-family dwellings, and townhouses
- Only when  $\geq 600$  SF of roof area oriented between  $110^\circ$  and  $270^\circ$  of true north



# Solar Ready Provisions



- Exceptions:
  - new residential buildings with a permanently installed on-site renewable energy system
  - buildings with a solar-ready zone that is shaded for more than 70 percent of daylight hours annually
  - buildings and structures as designed and shown in construction documents that do not meet the conditions for a solar-ready zone area

# Solar Ready Provisions



- Construction documents must:
  - indicate the solar ready zone
  - include structural design dead and live roof loads
  - indicate pathways for routing conduit or plumbing to the electrical service panel or service hot water system
- Solar ready zone area must be:
  - minimum 300 SF (150 SF for townhouses with floor area  $\leq$  2000 SF per unit), exclusive of fire code access and setback requirements
  - made up of areas at least 5' wide and 80 SF in area
  - free from obstructions, including but not limited to vents, chimneys, and roof-mounted equipment
    - NOTE: construction documents do NOT need to be redesigned or reconfigured so as to create a solar-ready zone area

# Solar Ready Provisions



- Post construction:
  - main electrical service panel shall have a reserved space to allow installation of a dual pole circuit breaker for future solar electric installation and shall be labeled “For Future Solar Electric.” The reserved space shall be positioned at the opposite (load) end from the input feeder location or main circuit location.
  - a permanent certificate, indicating the solar-ready zone and other requirements, shall be posted near the electrical distribution panel, water heater or other conspicuous location by the builder or registered design professional



# Energy Use Due to Non-Compliance



Building System	2012 IECC	Stretch Code
Lighting	3%	1%
Ducts	4%	1%
Air Leakage	3%	<1%
Above Grade Walls	2%	1%
Frame Floors	2%	1%
Foundation Walls	1%	<1%
Ceilings	1%	<1%
Windows	1%	<1%
Slabs	<1%	<1%
<b>Overall</b>	<b>18%</b>	<b>5%</b>

# Compliance Paths

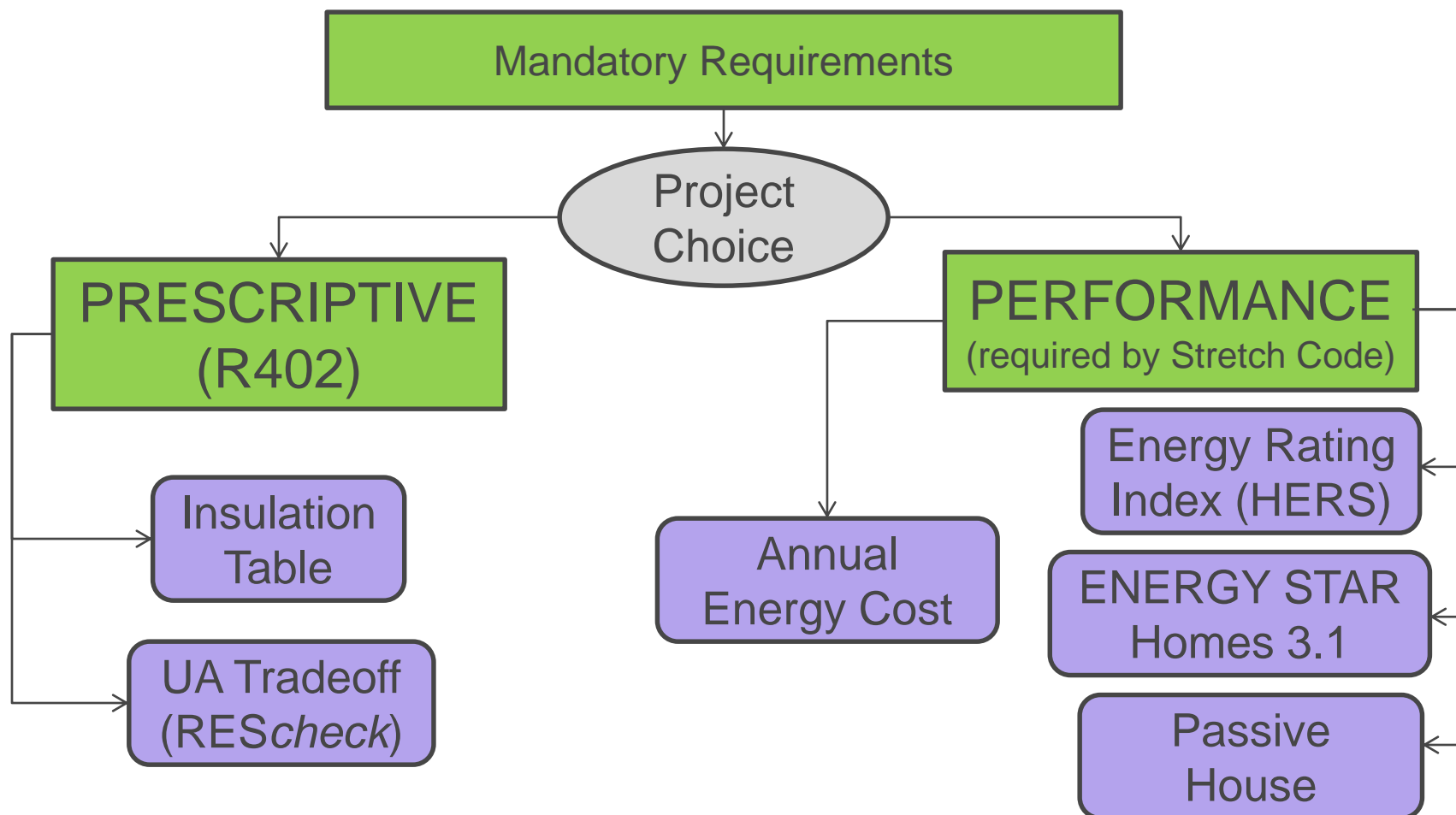
## R101.4.1 - Mixed Occupancy



Each occupancy shall be separately considered and meet the applicable IECC provisions

- Residential = 2015 IECC Residential
- Commercial = 2015 IECC Commercial
  - Including optional ASHRAE 90.1-2013 pathway

# Compliance Pathways



# Mandatory Requirements - Every Project Must Include . . .



- Permanent certificate
- Air Barrier testing
- Duct sealing / testing
- Controls / thermostat
- No building cavities used as ducts
- Pipe insulation
- Mechanical ventilation
- Equipment sizing
- 75% high efficacy lighting
- Snow Melt automatic shutoff
- Controls on re-circ. & heat trace systems
- Pools and spas requirements

# Insulation Requirements (Prescriptive)

## Table R402.1.2



Component	780 CMR
Windows	U-0.30
Skylight	U-0.55
Ceiling	R-49
Frame Wall	R-20 or R-13+5
Mass Wall	13 / 17 (Ext/Int)
Floor	R-30
Basement/Crawlspace Wall	R-15 / R-19
Slab R-Value / Depth	R-10 / 2 ft (+ R-5 if heated) <sup>34</sup>

# Prescriptive Path Compliance

## REScheck

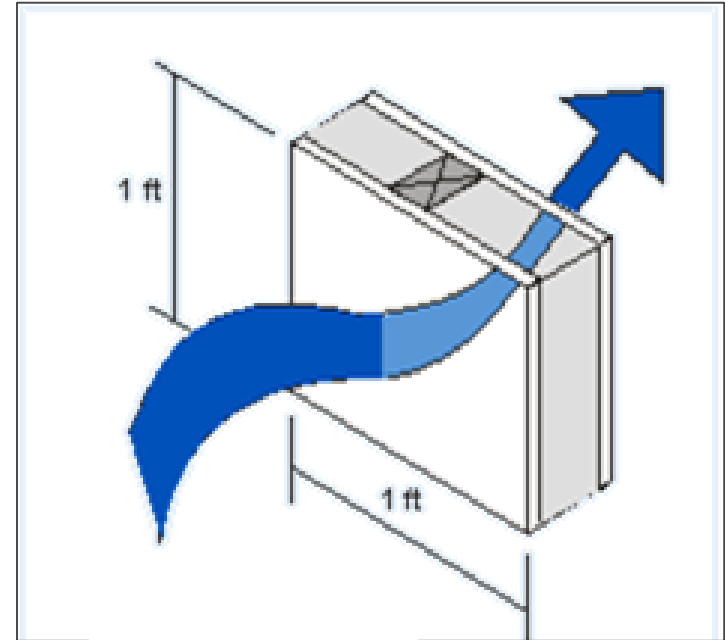


- Insulation and window trade-off calculations
- Includes thermal bridging effects
- Calculates heat loss of individual components:
  - Windows
  - Doors
  - Wall
  - Floor
  - Ceiling



# What is U-factor?

- Rate of heat flow (Btu/hr) through 1 ft<sup>2</sup> of material when there is a 1°F temperature difference from one side to the other
- Lower U-factor means less energy loss
- U-factor x Area x  $\Delta T$  = total heat flow





# What is R-value?



- $R = 1/U$
- Lower U-factor means higher R-value

# REScheck Example



	Component	Assembly	Gross Area		Cavity Insulation R-Value	Continuous Insulation R-Value	U-Factor	UA
	Building							
1	Cond>unc bsmnt	All-Wood Joist/Truss:Ove... ▼	2486	Ft2	30.0	0.0	0.033	82
2	Cond>amb	Wood Frame, 16" o.c. ▼	2155	Ft2	13.0	7.5	0.049	86
3	Window 1	Vinyl Frame:Double Pane ... ▼	350	Ft2			0.35	122
4	Door 1	Solid ▼	38	Ft2			0.3	11
5	Door 2	Solid ▼	17	Ft2			0.3	5
6	Cond>garage	Wood Frame, 16" o.c. ▼	281	Ft2	13.0	7.5	0.049	14
7	Cond>unc bsmnt	Wood Frame, 16" o.c. ▼	116	Ft2	13.0	0.0	0.082	10
8	Cond>attic	Wood Frame, 16" o.c. ▼	292	Ft2	20.0	0.0	0.059	17
9	Unc bsmnt>amb	Wood Frame, 16" o.c. ▼	223	Ft2	20.0	0.0	0.059	11
10	Window 2	Vinyl Frame:Double Pane ... ▼	23	Ft2			0.35	8
11	Door 3	Solid ▼	14	Ft2			0.3	4
12	Flat	Flat Ceiling or Scissor Truss ▼	716	Ft2	38.0	0.0	0.03	21
13	Sloped	Cathedral Ceiling ▼	722	Ft2	38.0	0.0	0.027	19

# Sample REScheck Output



## Compliance: Passes using UA trade-off

Compliance: **0.2% Better Than Code**

Maximum UA: **411**

Your UA: **410**

The % Better or Worse Than Code Index reflects how close to compliance the house is based on code trade-off rules. It DOES NOT provide an estimate of energy use or cost relative to a minimum-code home.

## Envelope Assemblies

Assembly	Gross Area or Perimeter	Cavity R-Value	Cont. R-Value	Glazing or Door U-Factor	UA
Cond> unc bsmnt: All-Wood Joist/Truss:Over Unconditioned Space	2,486	30.0	0.0	0.033	82
Cond>amb: Wood Frame, 16" o.c.	2,155	13.0	7.5	0.049	86
Window 1: Vinyl Frame:Double Pane with Low-E	350			0.350	122
Door 1: Solid	38			0.300	11
Door 2: Solid	17			0.300	5
Cond>garage: Wood Frame, 16" o.c.	281	13.0	7.5	0.049	14
Cond> unc bsmnt: Wood Frame, 16" o.c.	116	13.0	0.0	0.082	10
Cond>attic: Wood Frame, 16" o.c.	292	20.0	0.0	0.059	17
Unc bsmnt>amb: Wood Frame, 16" o.c.	223	20.0	0.0	0.059	11
Window 2: Vinyl Frame:Double Pane with Low-E	23			0.350	8
Door 3: Solid	14			0.300	4
Flat: Flat Ceiling or Scissor Truss	716	38.0	0.0	0.030	21
Sloped: Cathedral Ceiling	722	38.0	0.0	0.027	19

# Quick Inputs Review



- Check location
- Check R-value for reasonableness
- Window area typically 10-22% of wall area
- Wall area and floor area typically within 25%
- Ceiling area  $\geq$  floor area

# Performance Path



- R405 - Annual energy cost
  - Heating, cooling and DHW
- R406 - Energy Rating Index  $\leq 55$
- MA Amendments R406
  - retains HERS ERI  $\leq 55$ , but allows higher ERI if using renewables
  - adds ENERGY STAR v3.1 and Passive House certifications

# Performance Path - Permit Application Documentation (R406.1.2)



- HERS Preliminary Rating Certificate  $\leq 55$ 
  - Projected Rating: Based on Plans – Field Confirmation Required
- ENERGY STAR v3.1 Home Report
  - Projected Rating: Based on Plans – Field Confirmation Required
- Passive House Planning Package - Specific Space Heat Demand - “based on plans”
  - Listing compliance features
  - Statement by a Certified Passive House Consultant regarding Specific Space Heat Demand

# Performance Path - Certificate of Occupancy Documentation (R406.1.2)



- Rating type = Confirmed
- Passive House Planning Package (PHPP) Final Report
  - Specific Space Heat Demand –  
=/ $>16\text{KBtu/SF/YR}$
  - Max design temps for load calcs –  $72^{\circ}\text{F}/74^{\circ}\text{F}$

# Insulation



## R303.2 Installation



Materials shall be installed according to **manufacturer's instructions** . . .

### Insulation

- Full thickness
- Completely fill framing cavity
- No voids or gaps
- Fit neatly around all obstructions

# R303.1.2

## Insulation markings



Photo © CLEAResult

# R303.1.1.1 Blown or Sprayed Roof/Ceiling Insulation



Markers

1/300 sq.ft.

Facing  
access



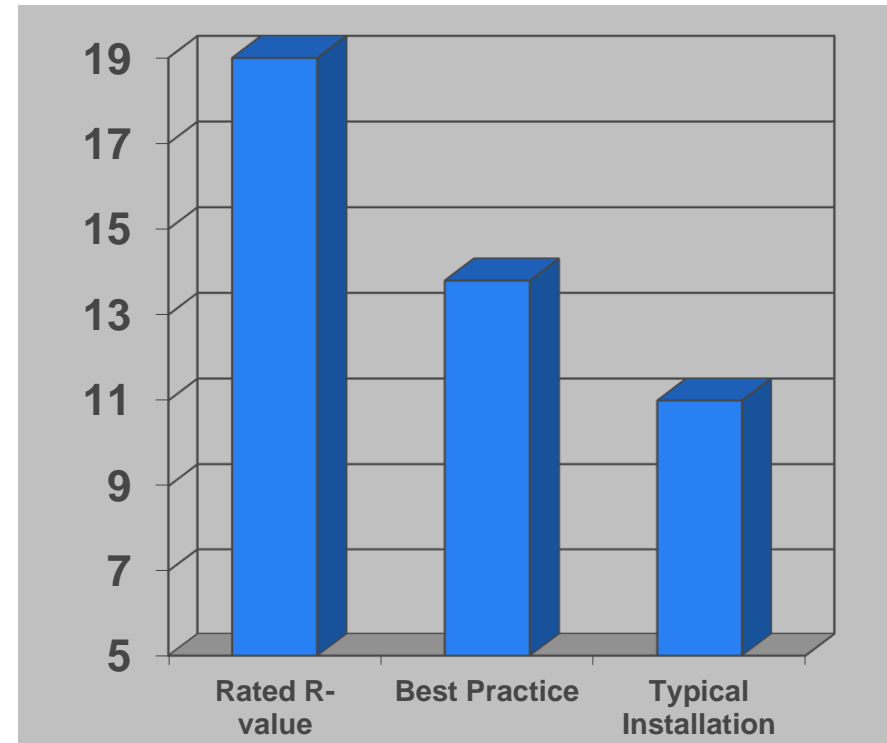
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# Insulation Grading System

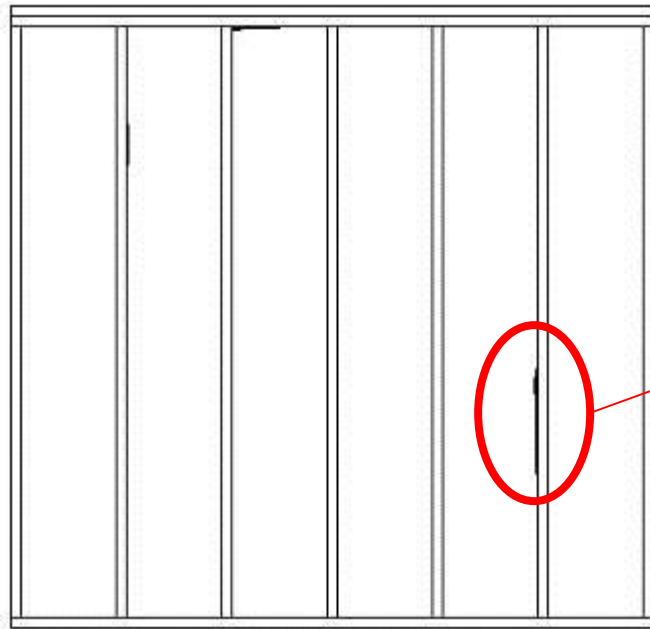


## Three “Grades” - I, II and III

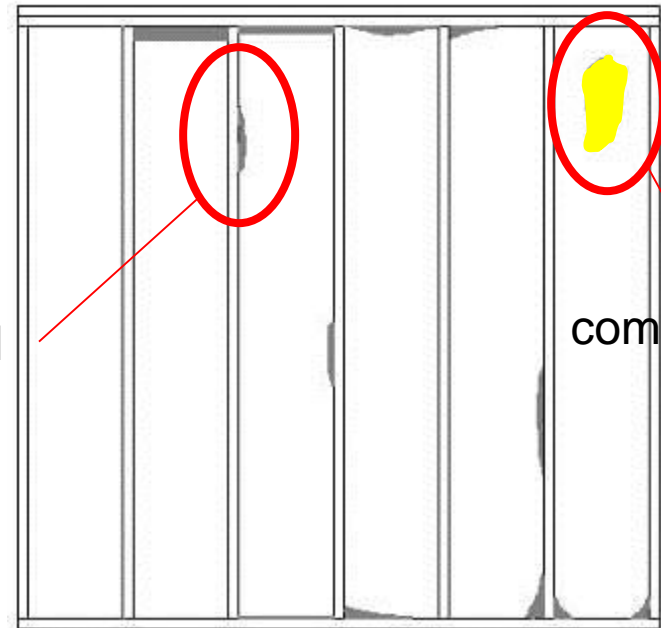
- Grade I: Installed according to manufacturer's instructions - nearly perfect
- Grade II: Moderate defects
- Grade III: Numerous voids and widespread compression



# Boundary Condition for “Grade I”



void



compression

Minimal gaps clear through insulation

<2% of area Compression or incomplete fill

Compressed by <30% of intended thickness

# Bad Installation



Photo © CLEAResult



# Good Installation



Photo © CLEAResult





# Bad Installation



Photo © CLEAResult

# Good Installation



Photo © CLEAResult

# Bad Installation



Photo courtesy of CLEAResult





Photo courtesy of CLEAResult

# Alterations to Existing Buildings; What do I Have to do?



Component	Requirement
Wall	Fill the cavity
Vented Attic Ceiling	R-49
Enclosed Ceiling (Cathedral)	Fill the cavity
Basement wall	15/19
Windows	0.30

# Air Barrier

**Positive  
pressure  
(relative to  
outdoors)**

**Negative  
pressure  
(relative to  
outdoors)**





# Why the Stripes?



# AIR LEAKAGE



courtesy CLEAResult



# Moisture Control



Moisture  
Moves on Air



courtesy of CLEAResult

**Moisture + Food + Acceptable Temp =**



courtesy CLEAResult

- Control
  - Rain water and ground water
  - Water vapor
  - Air movement
  - Heat loss

# Types of Environmental Barriers



- Groundwater Barrier
- Rain / Weather Barrier
- Air Barrier
- Vapor Barrier
- Thermal Barrier

Control layers should be continuous around the exterior of the building



# So Where are the Leaks?



courtesy of CLEAResult

# R402.4

## Air Leakage (**Mandatory**)



## 2015 IECC

**Air Barrier &  
Insulation  
Installation  
Table**

**AND**

**Blower Door Test  
3 ACH50**

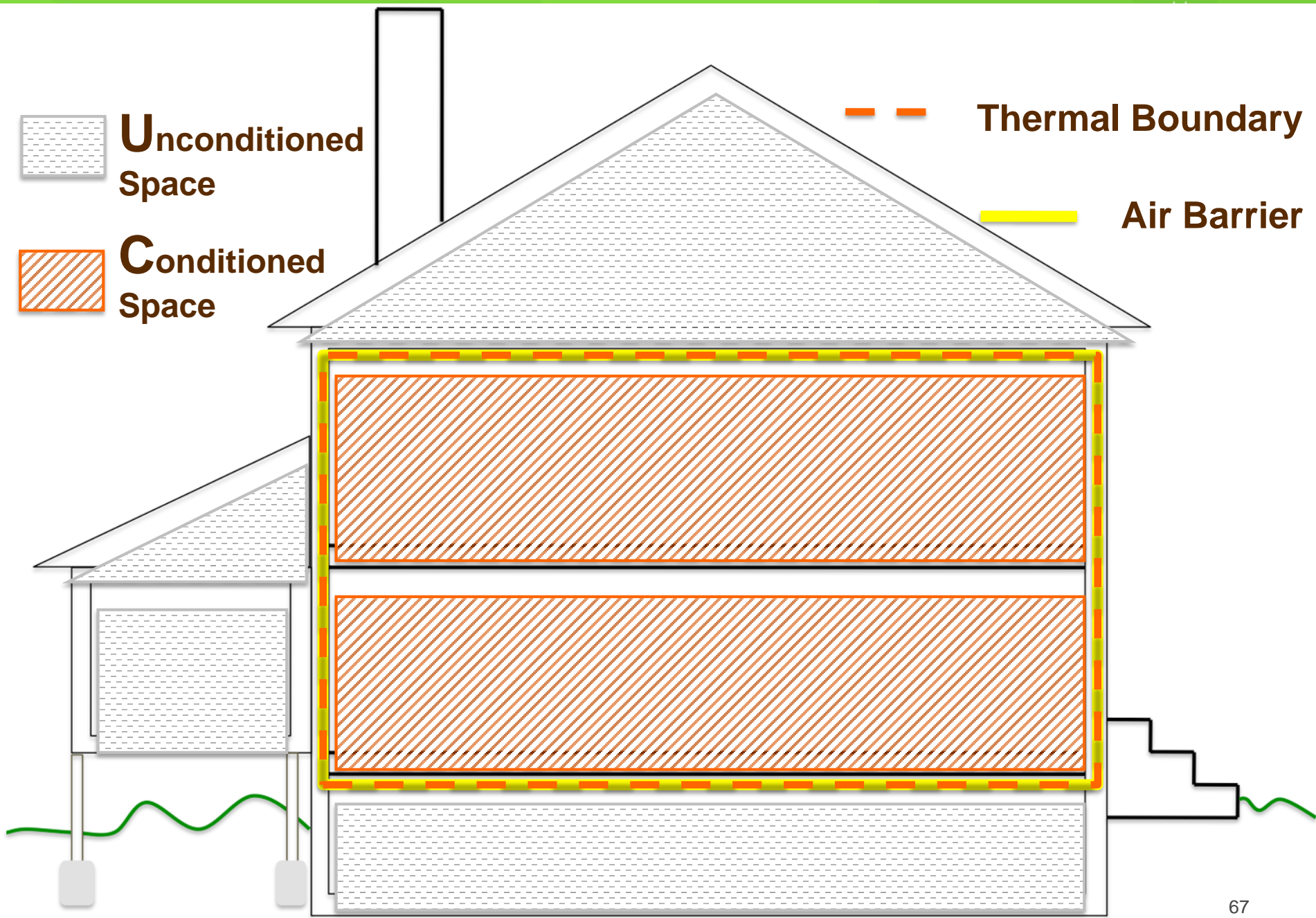


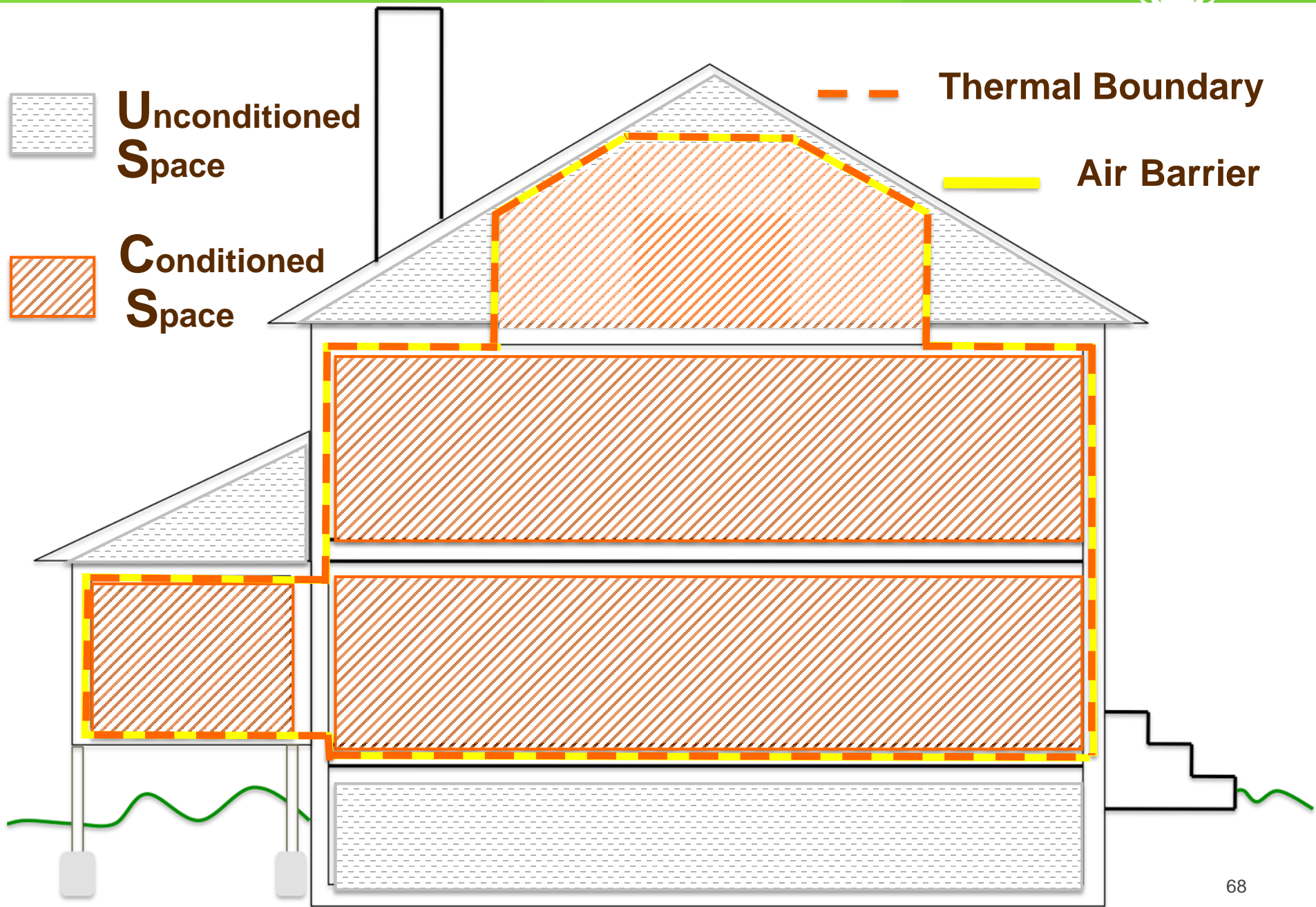
 **Unconditioned Space**

 **Conditioned Space**

 **Thermal Boundary**

 **Air Barrier**





# Table R402.4.1.1

## Air Barrier and Insulation Installation



TABLE R402.4.1.1  
AIR BARRIER AND INSULATION INSTALLATION

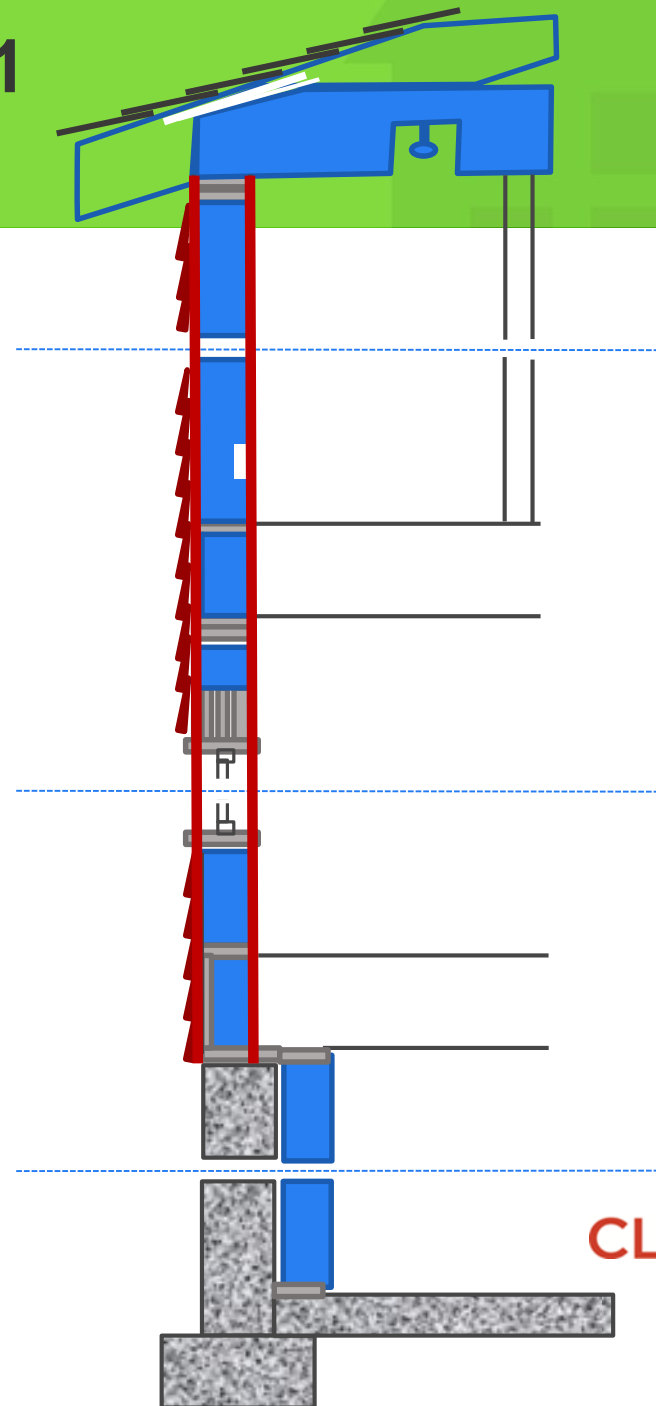
COMPONENT	AIR BARRIER CRITERIA <sup>a</sup>	INSULATION INSTALLATION CRITERIA
General requirements	A continuous air barrier shall be installed in the building envelope. The exterior thermal envelope contains a continuous air barrier. Breaks or joints in the air barrier shall be sealed.	Air-permeable insulation 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 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 of R-3 per inch minimum. 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.

# Table R402.4.1.1 Air Barrier



- Define  
Exterior or Interior  
Air Barrier



**CLEAResult**

# Table R402.4.1.1

## Air & Thermal Barrier (**Mandatory**)



Continuous air barrier shall be installed in the building envelope.



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Photo © CLEAResult

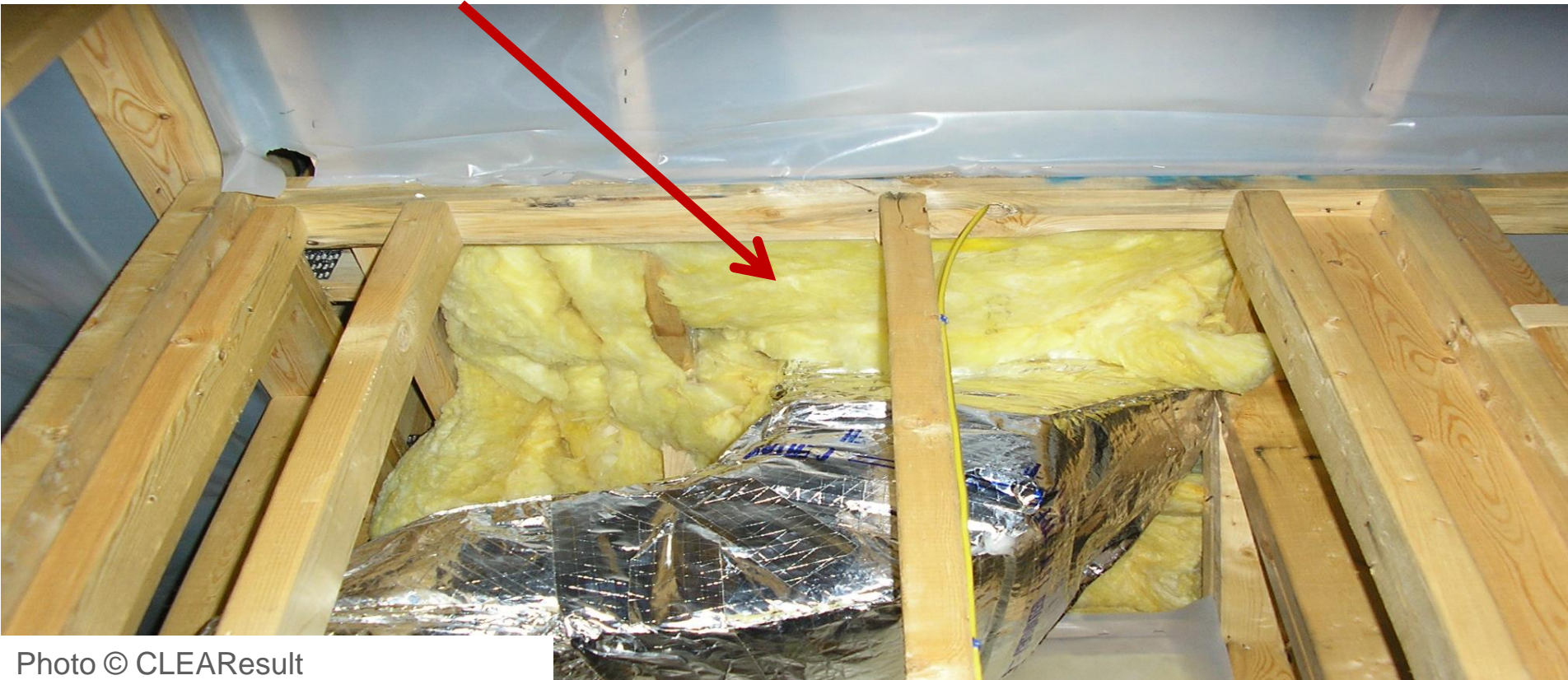


# Table R402.4.1.1

## Air and Thermal Barrier (**Mandatory**)



Air permeable insulation shall not be used as a sealing material





## Table R402.4.1.1 Ceiling / Attic (**Mandatory**)



The air barrier in any dropped ceiling/soffit shall be aligned with the insulation and any gaps in the air barrier sealed

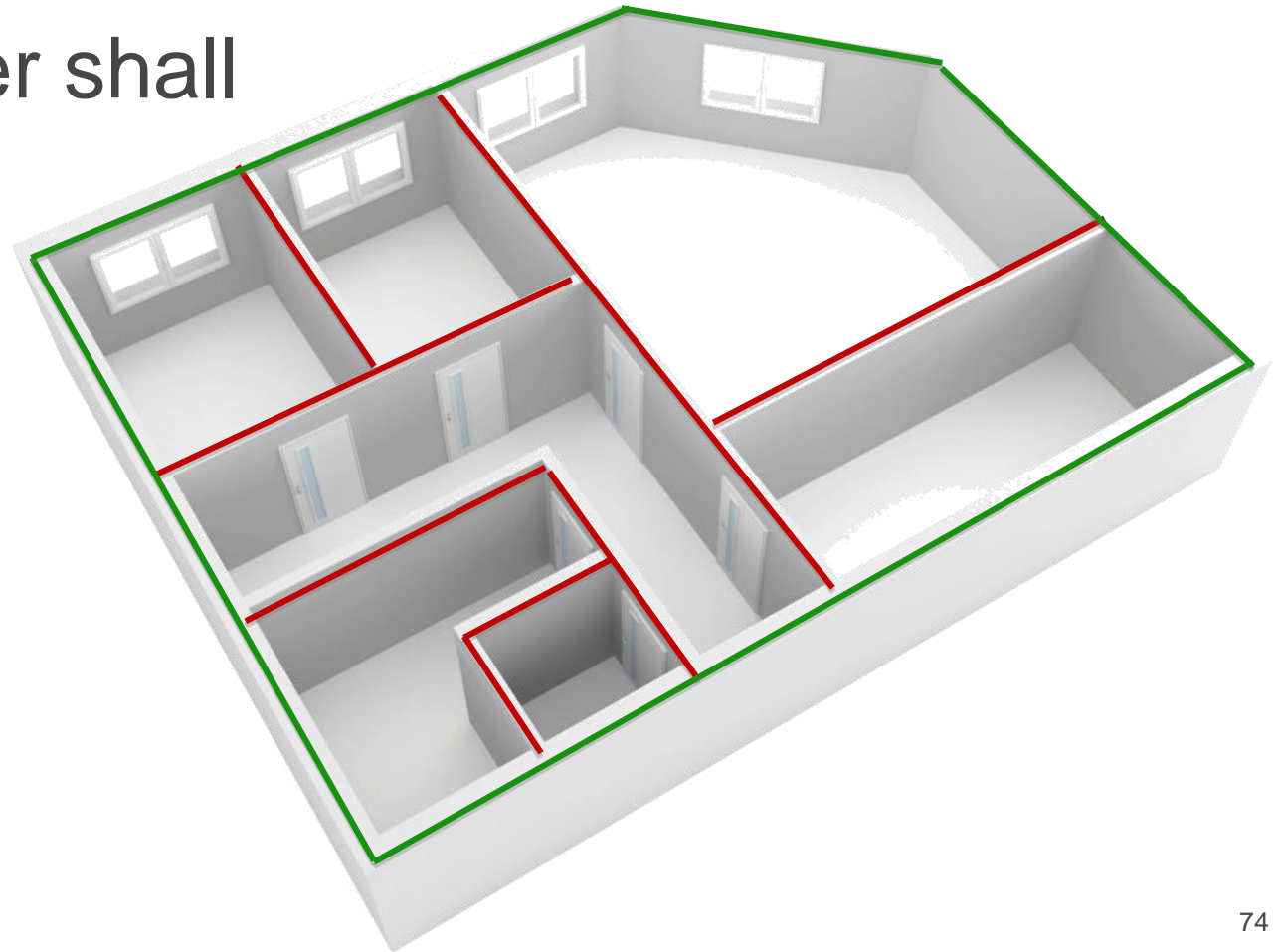


courtesy of CLEARresult

# Table R402.4.1.1 Ceiling / Attic (**Mandatory**)



Breaks or joints in  
the air barrier shall  
be sealed



# Table R402.4.1.1 Ceiling / Attic (**Mandatory**)

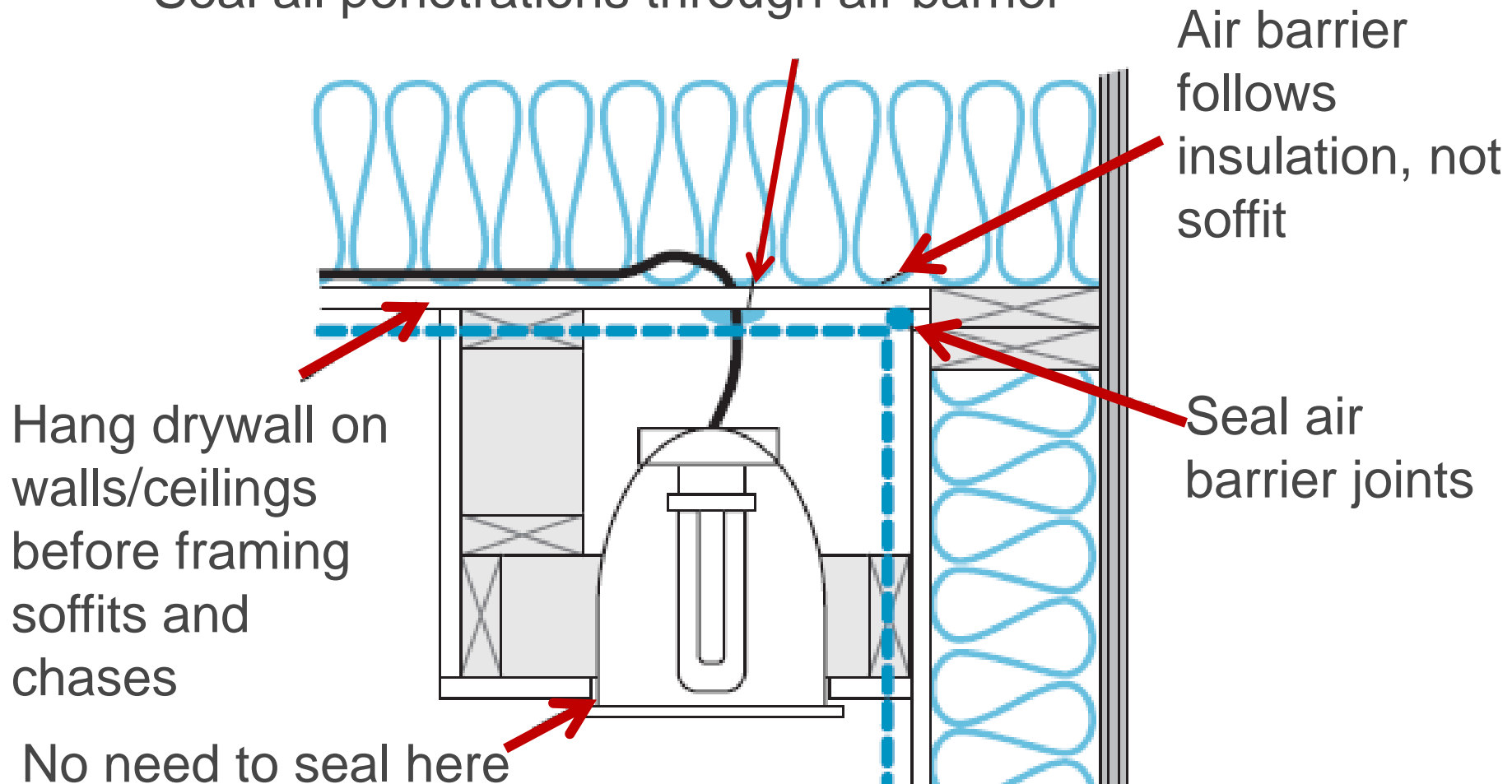


courtesy of CLEAResult

# Table R402.4.1.1

## Dropped Ceiling / Attic (**Mandatory**)

Seal all penetrations through air barrier





# Table R402.4.1.1

## Air and Thermal Barrier (**Mandatory**)



courtesy of CLEAResult



# R402.4.1.1

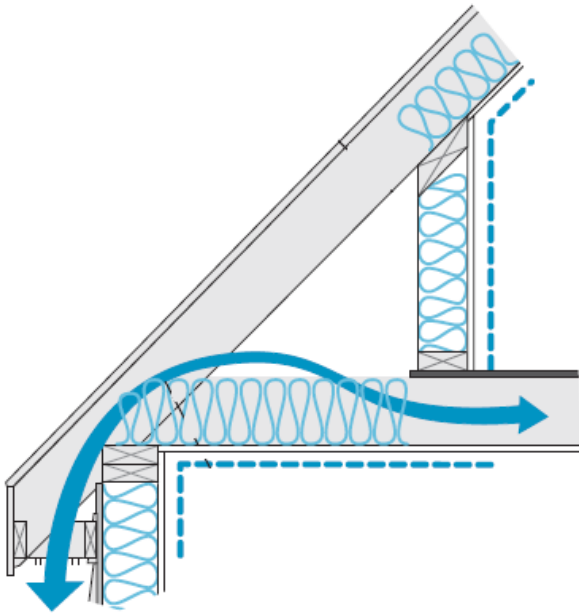
## Ceiling / Attic (**Mandatory**)



Sealed  
Access  
Opening

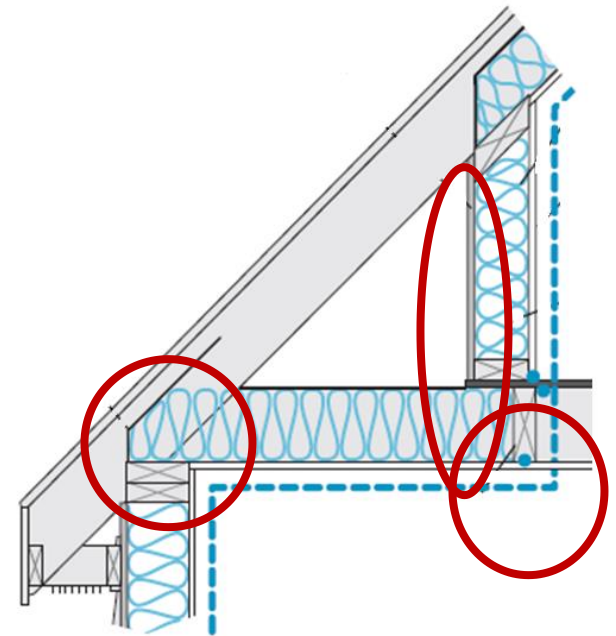


courtesy of CLEAResult



Knee  
walls  
shall be  
sealed

MA Field Guide

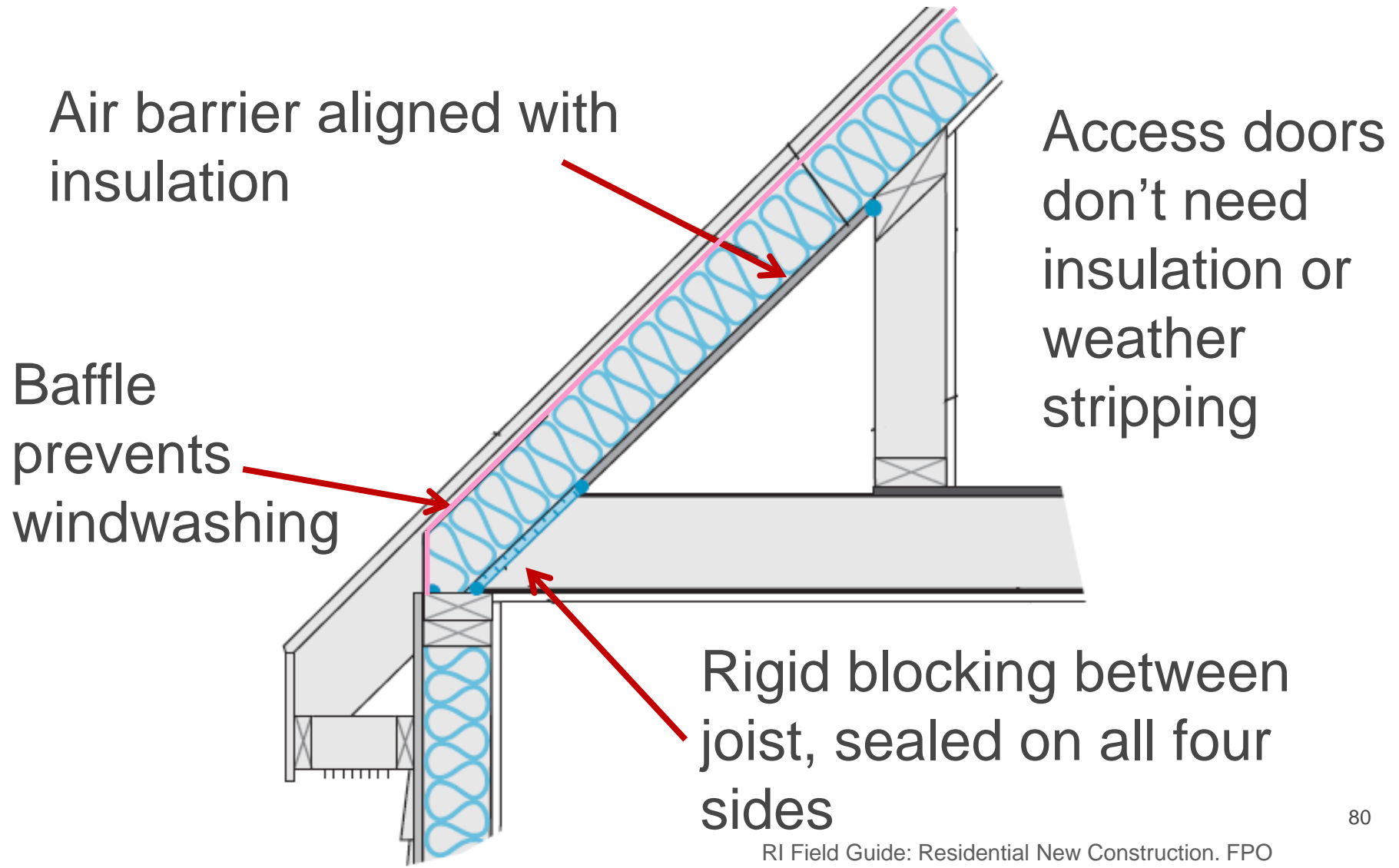


courtesy of CLEARresult



courtesy of CLEARresult

# Table R402.4.1.1 Ceiling / Attic (**Mandatory**)

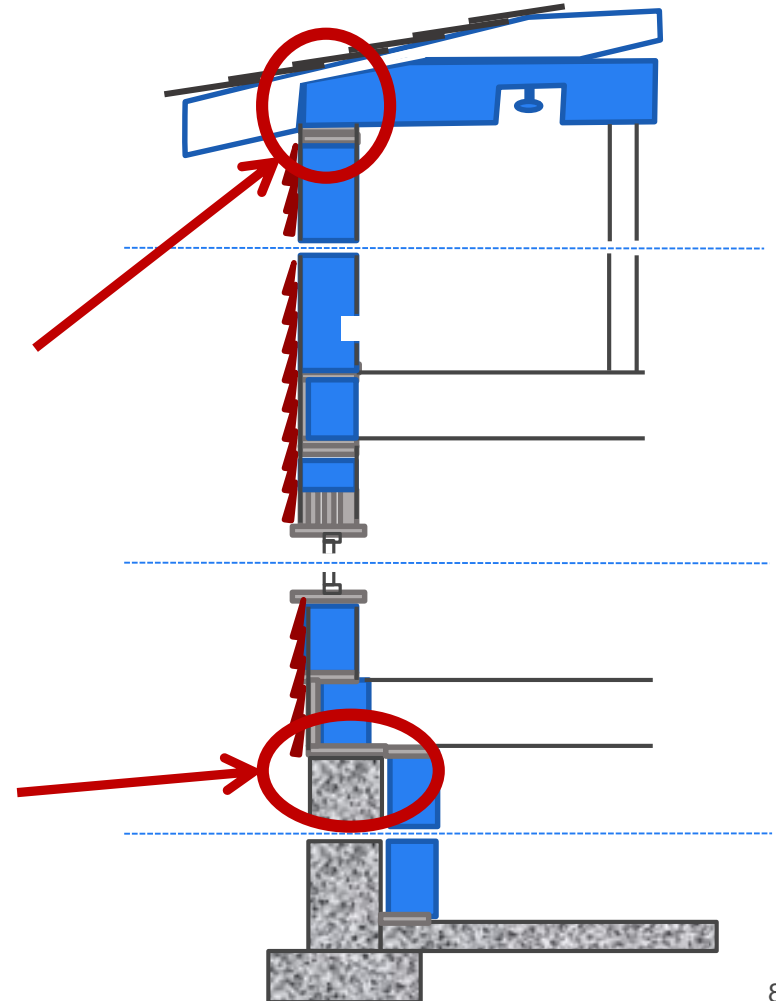


# R402.4.1.1

## Walls (**Mandatory**)

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

Junction of foundation and sill plate is sealed





# Table R402.4.1.1 Walls (**Mandatory**)



courtesy of CLEAResult



courtesy of CLEAResult

Cavities within corners and headers shall be completely filled with insulation



# R402.4.1.1 Walls (**Mandatory**)



courtesy of CLEAResult

# Table R402.4.1.1 Windows, Skylights & Doors (**Mandatory**)



courtesy of CLEARResult



courtesy of CLEARResult



# Table R402.4.1.1 Rim Joists (**Mandatory**)



Rim joists shall be insulated and include air barrier



courtesy of CLEARresult



courtesy of CLEARresult

## Table R402.4.1.1 Floors (**Mandatory**)



courtesy of CLEAResult



courtesy of CLEAResult

- Air barrier installed at any exposed edge
- Insulation must maintain contact with subfloor



# Table R402.4.1.1 Crawl Space Walls (Mandatory)



Exposed earth  
in unvented  
crawl space  
covered with  
Class 1 vapor  
retarder

*(6" overlap, all  
joints sealed)*



# Table R402.4.1.1 Duct Shafts (**Mandatory**)



courtesy of CLEAResult

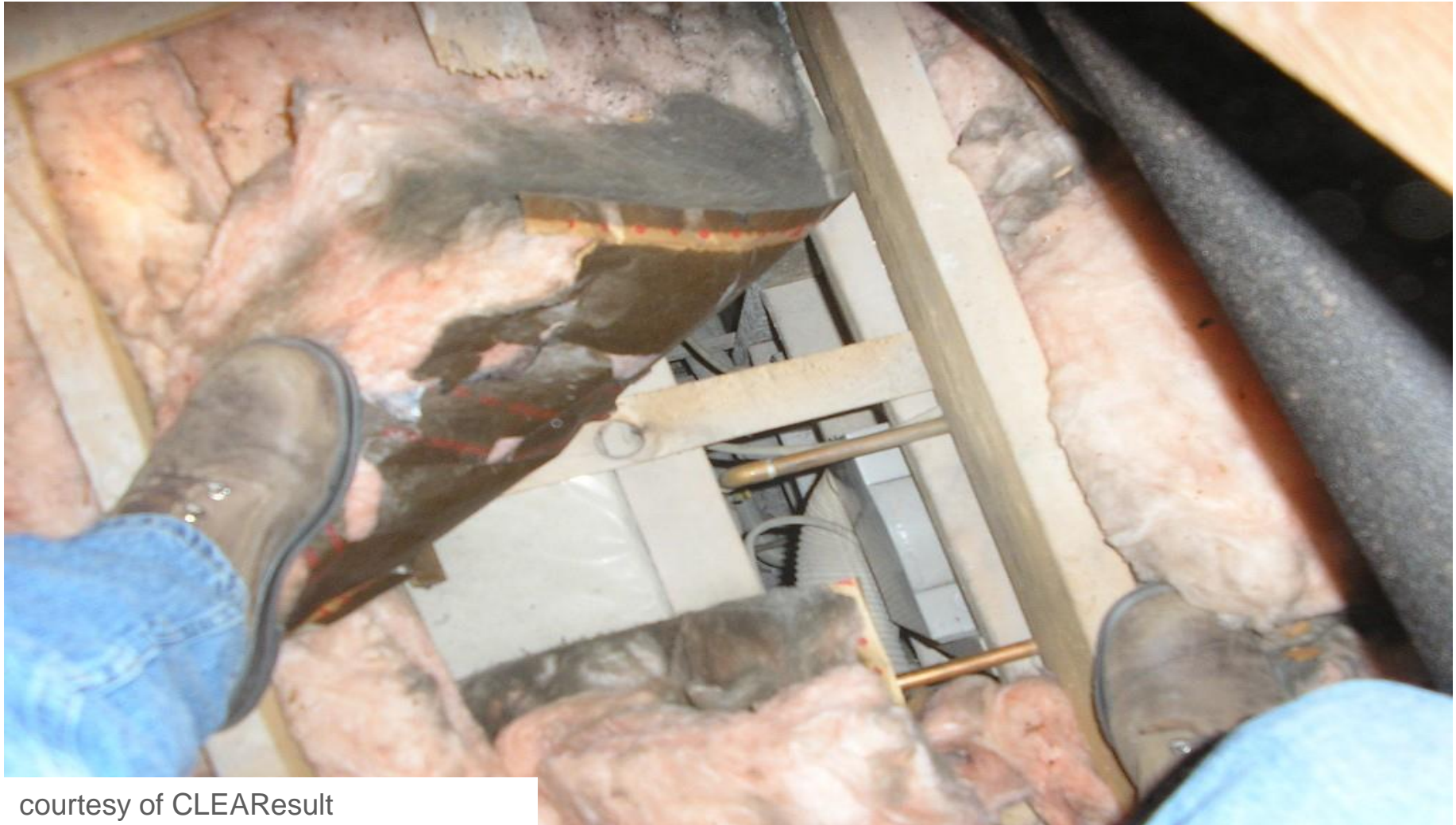
# Table R402.4.1.1 Duct Shafts (**Mandatory**)



courtesy of CLEAResult



# Table R402.4.1.1 Utility Penetrations (**Mandatory**)



courtesy of CLEAResult

# Table R402.4.1.1 Flue Shafts (**Mandatory**)



courtesy of CLEAResult



# Table R402.4.1.1 Narrow Cavities (**Mandatory**)



courtesy of CLEAResult



courtesy of CLEAResult

# Table R402.4.1.1 Garage Separation (**Mandatory**)



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

# Table R402.4.1.1 Recessed Lighting (**Mandatory**)



courtesy of CLEAResult

Recessed light fixtures shall be sealed to the drywall



# Table R402.4.1.1 Wiring (**Mandatory**)



courtesy of CLEAResult



# Table R402.4.1.1 Plumbing (**Mandatory**)



courtesy of CLEAResult



courtesy of CLEAResult

## Table R402.4.1.1 Shower/Tubs (**Mandatory**)



The air barrier shall separate exterior walls from showers and tubs



# Poly Can Be Unforgiving



courtesy of CLEAResult

# Vapor Retarders



## 2015 IRC R702.7

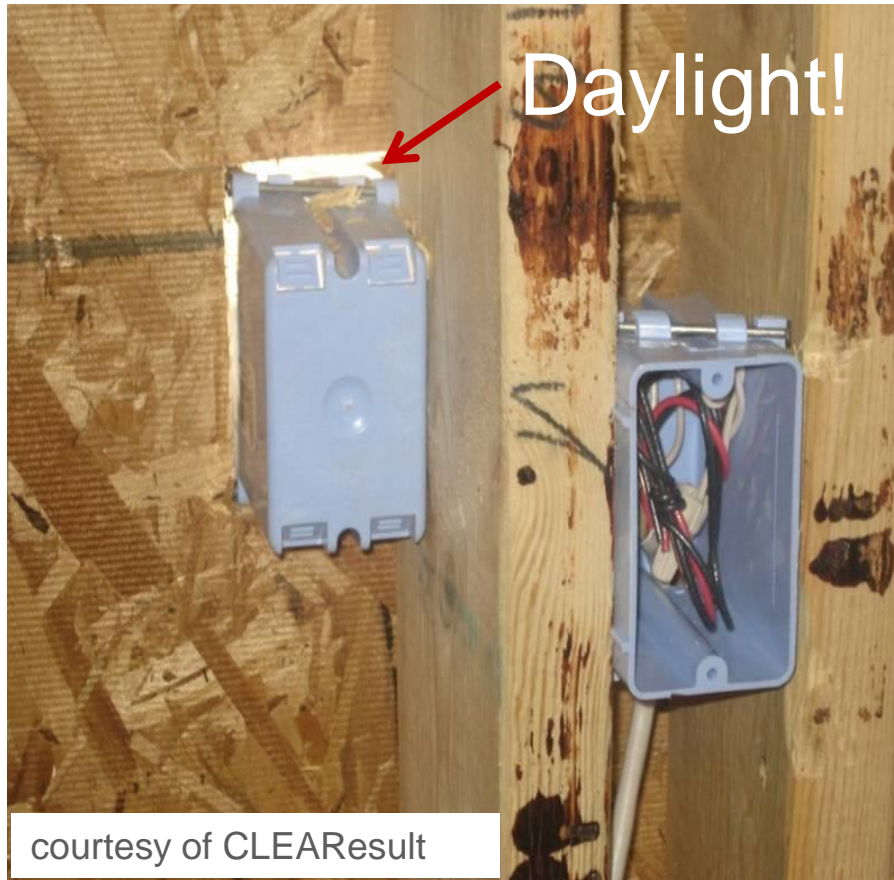
- Class I or II vapor retarders are required on the interior of frame walls in Zone 5
- Class III allowed for:
  - Vented cladding over wood structural panels, fiberboard, or gypsum
  - Continuous insulation with  $R$ -value  $\geq 5$  over 2 x 4 wall
  - Continuous insulation with  $R$ -value  $\geq 7.5$  over 2 x 6 wall

## Materials that meet 2015 IRC:

- Class I: Sheet polyethylene, unperforated aluminum foil
- Class II: Kraft-faced fiberglass batts
- Class III: Latex or enamel paint



# Table R402.4.1.1 Electrical/Phone Boxes (**Mandatory**)



Air barrier shall be installed behind boxes, or air-tight boxes used

# Table R402.4.1.1 HVAC Register Boots (**Mandatory**)

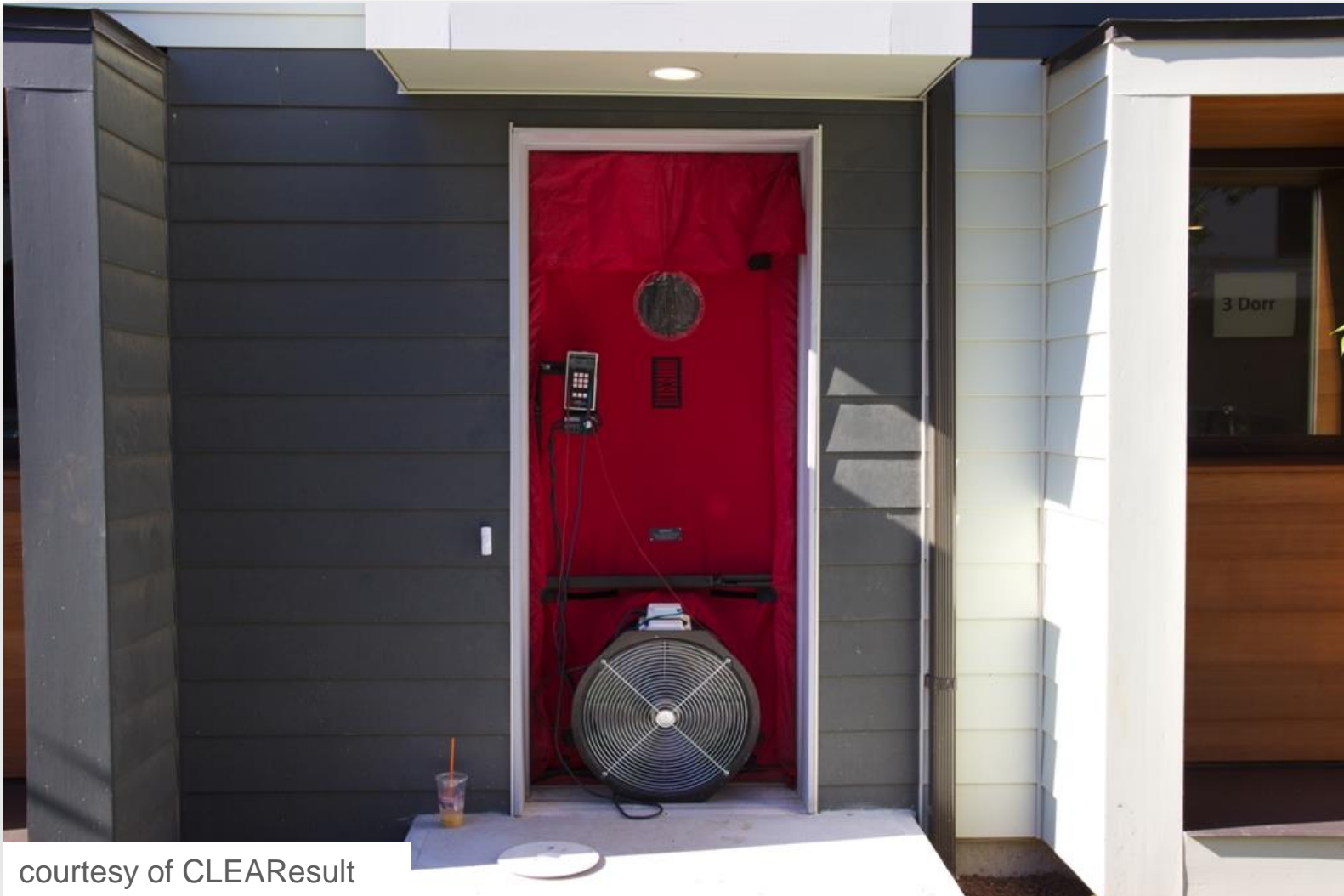


courtesy of CLEAResult

HVAC registers penetrating the air barrier shall be sealed to the subfloor or drywall

# R402.4.1.2

## Blower Door Testing (**Mandatory**)



courtesy of CLEAResult

# R402.4.1.2

## Air Leakage Testing (Mandatory)



R402.4.1.2	Blower Door Testing
2015 IECC	3 ACH <sub>50</sub>
Testing	Where required by code official, approved third party
Submittal	Written results submitted to code official
Time of Test	After creation (and sealing) of all penetrations



# Benchmarks



- 2009 IECC – 7 ACH<sub>50</sub>
- 2012 & 2015 IECC – 3 ACH<sub>50</sub>
- ENERGY STAR Homes v3.1 Optional Pathway - 2 ACH<sub>50</sub>
- Canadian R-2000 – 1.5 ACH<sub>50</sub>
- Passive House – 0.6 ACH<sub>50</sub>

Air Changes/Hour @ 50 Pascal (ACH<sub>50</sub>)

$$\text{ACH}_{50} = \frac{\text{CFM}_{50} \times 60}{\text{Volume}}$$

## Example



- $\text{CFM}_{50} = 750 \text{ CFM}_{50}$

- Volume of the home

$$\text{Volume} = 1,500 \text{ ft}^2 \times 10 = 15,000 \text{ ft}^3$$

$$\text{ACH}_{50} = \frac{750 \text{ CFM}_{50} \times 60}{15,000 \text{ ft}^3} = 3.0 \text{ ACH}_{50}$$

## R403.6 Mechanical Ventilation (Mandatory MA Amendment)



Each dwelling unit of a residential building shall provide mechanical ventilation per:

1. Energy Star Homes Version 3.1  
*or*
2. ASHRAE 62.2-2013  
*or*
3. Formula (1- & 2- family detached or townhouse  
≤3 stories above grade)



## R402.4.2 Fireplaces (Mandatory)

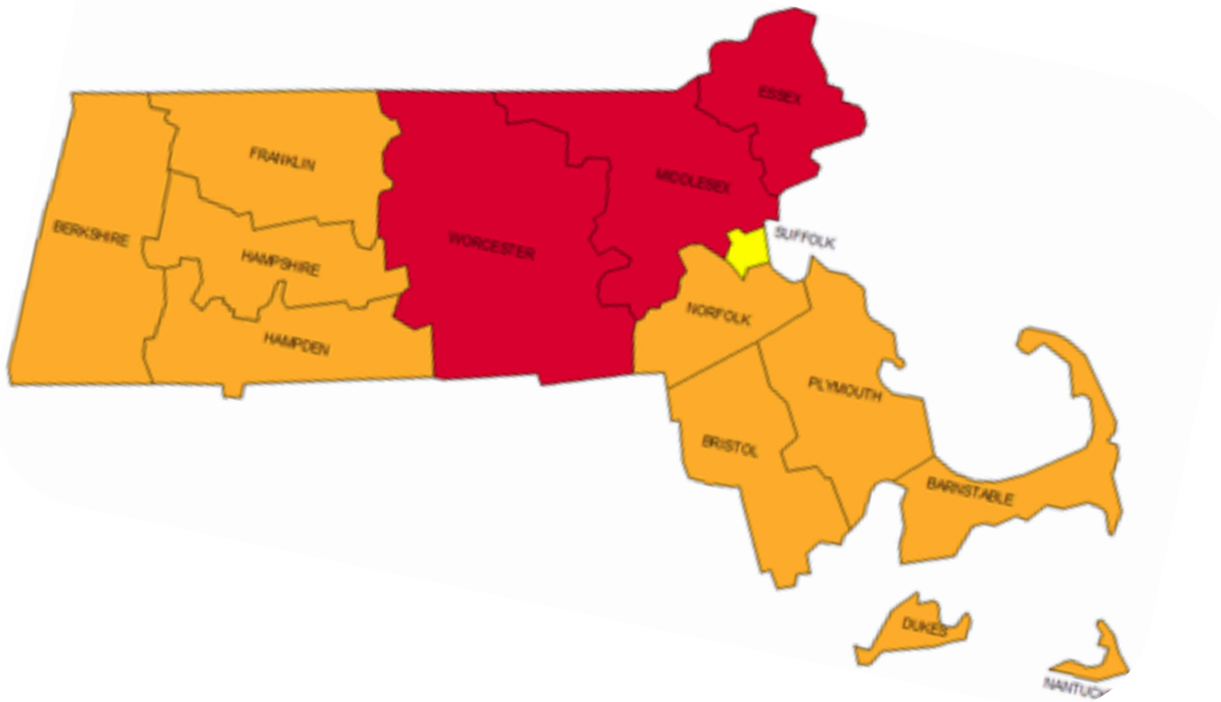
New wood burning  
fireplaces shall have  
tight-fitting flue dampers  
OR tight-fitting door AND  
outdoor combustion air



courtesy of CLEAResult

# Basements and Slabs

# Passive Radon System required in EPA Zone 1



 Zone 1

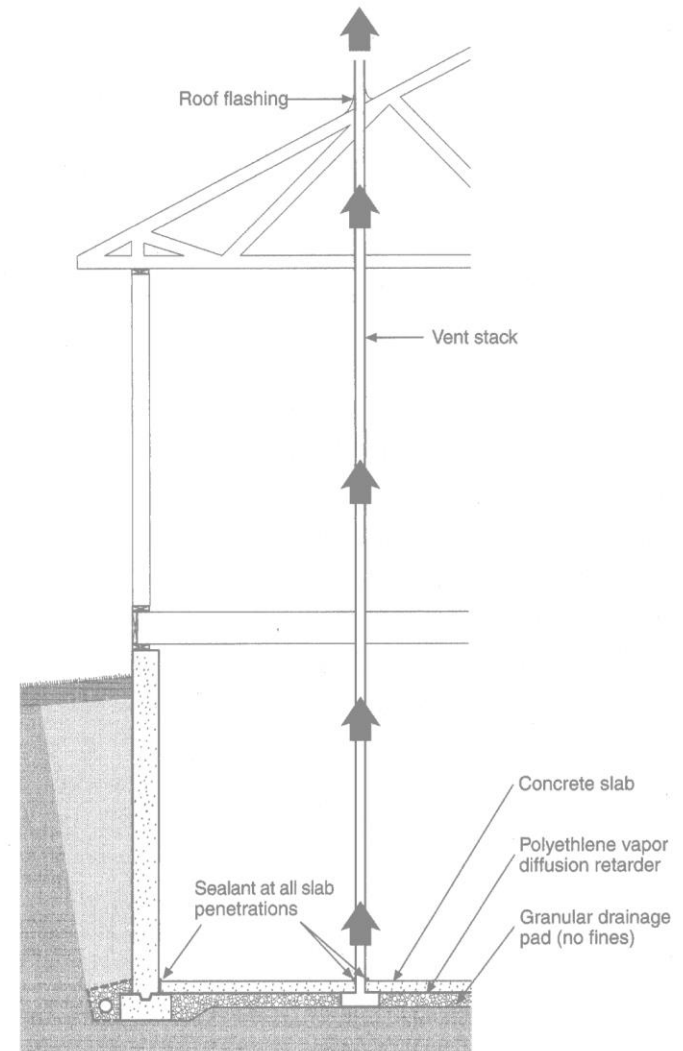
 Zone 2

 Zone 3

# Passive Radon System



- Amendment to 780 CMR (Appendix F, AF 101.1)
- Required for new one- and two- family dwellings and townhouses of three stories or less in Zone 1 (Essex, Middlesex, Worcester counties)
- Radon testing is not required

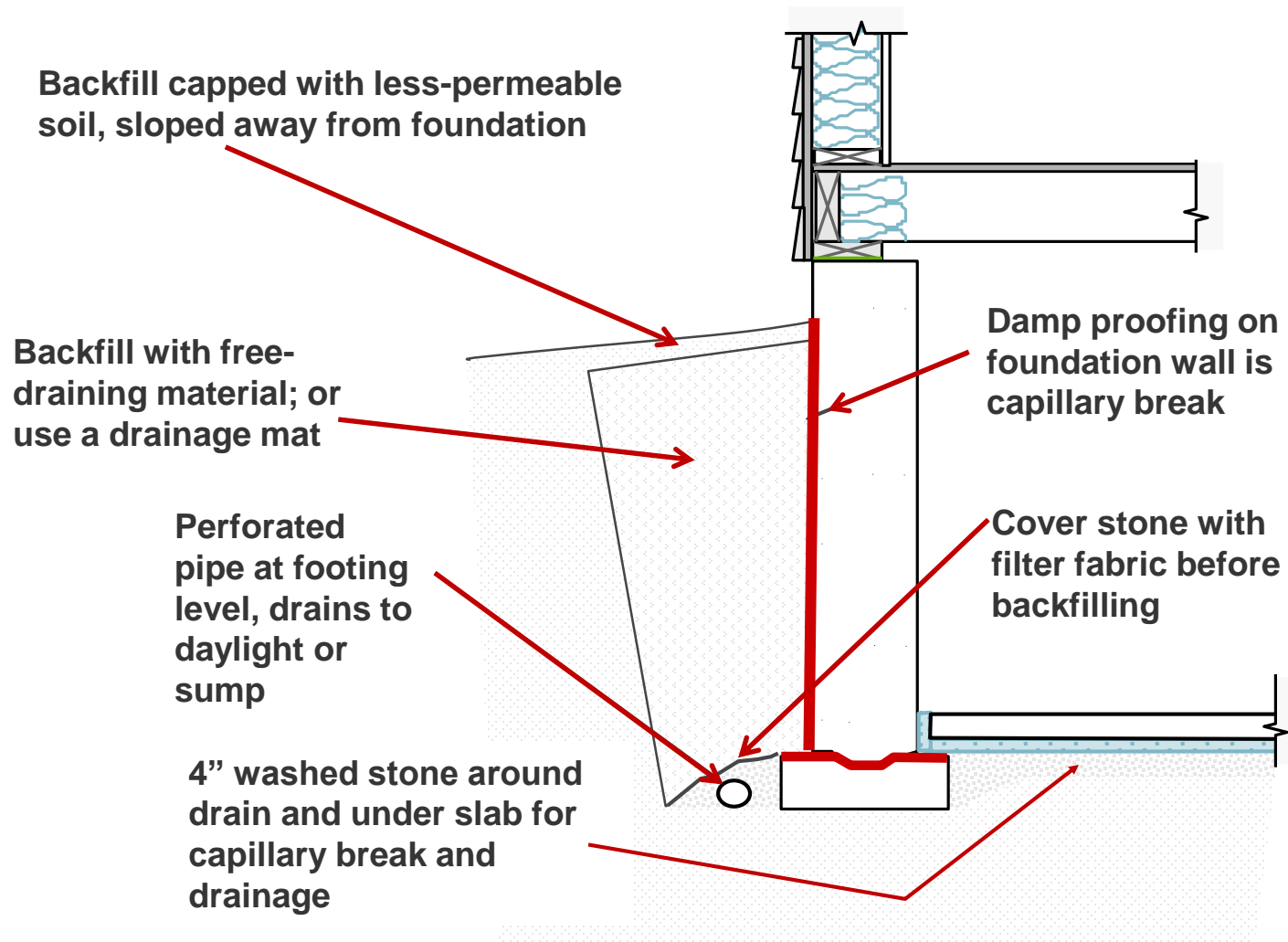




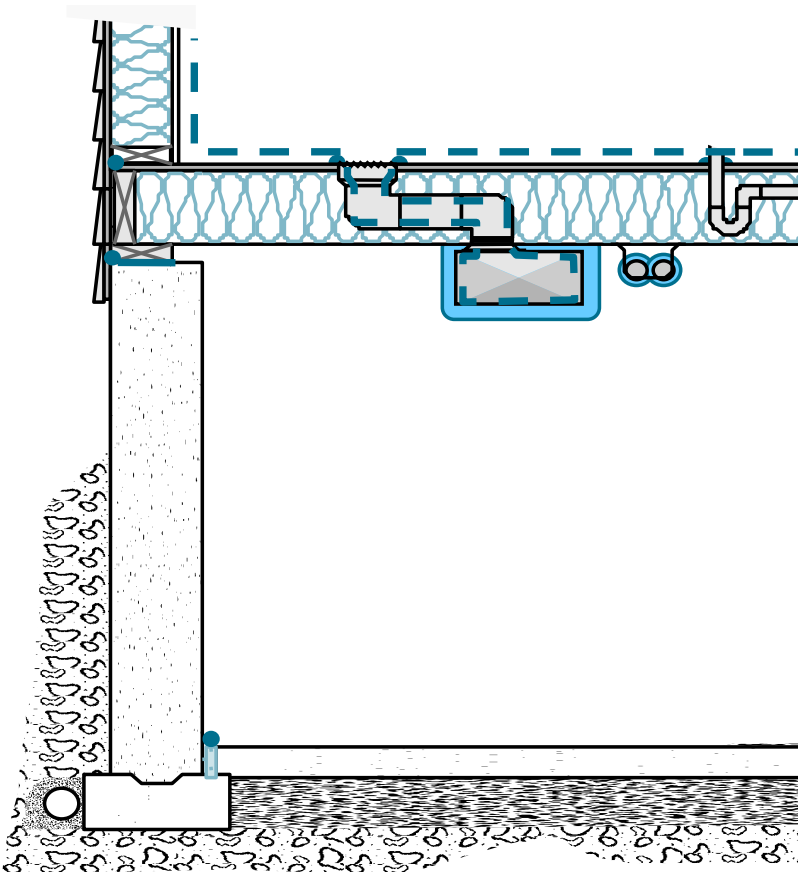
# What Can Defy Gravity?



# Exterior Water Control



# Unconditioned Basement (Prescriptive)



Floor: R-30 min **OR** fill framing depth (R-19 min.)

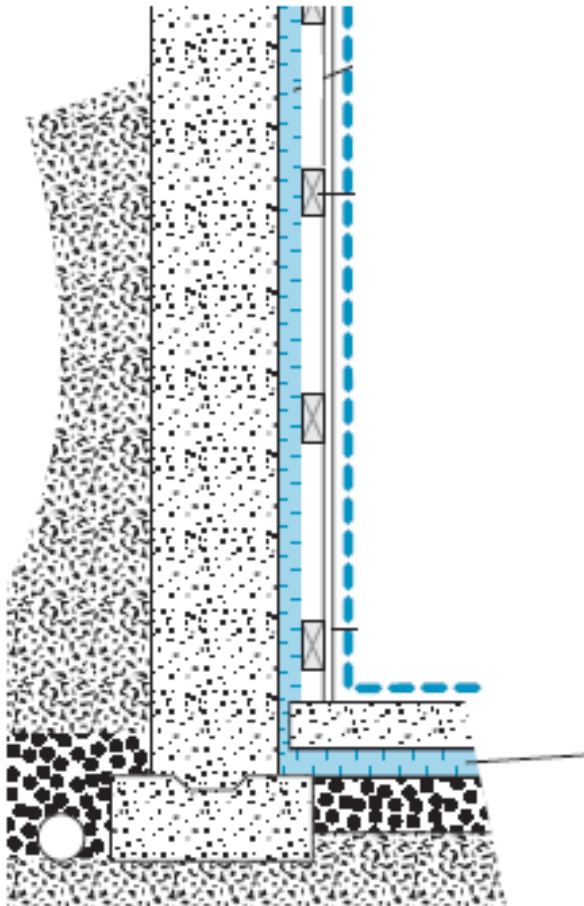
R403.3.1: Ducts R-6 for  $\geq 3"$  (R-4.2 for  $< 3"$ )

R403.3.2: Ducts sealed

R403.4: Mechanical pipes: R-3

R403.5.3: DHW pipes  $\geq \frac{3}{4}"$ : R-3

# R402.1.2 (Table) Conditioned Basement (Prescriptive)



R-15 continuous OR  
R-19 in the cavity

Extruded polystyrene insulation under slab  
and at slab edge to control condensation



# Class I or II Vapor Retarders Not Required Below Grade



- **R702.7 Vapor Retarders.** Class I or II vapor retarders are required on the interior side of frame walls in Climate Zone 5

## **Exceptions:**

1. Basement walls
2. Below grade portions of any wall
3. Construction where moisture or its freezing will not damage the materials (e.g., properly vented attics)

# What's Happening?

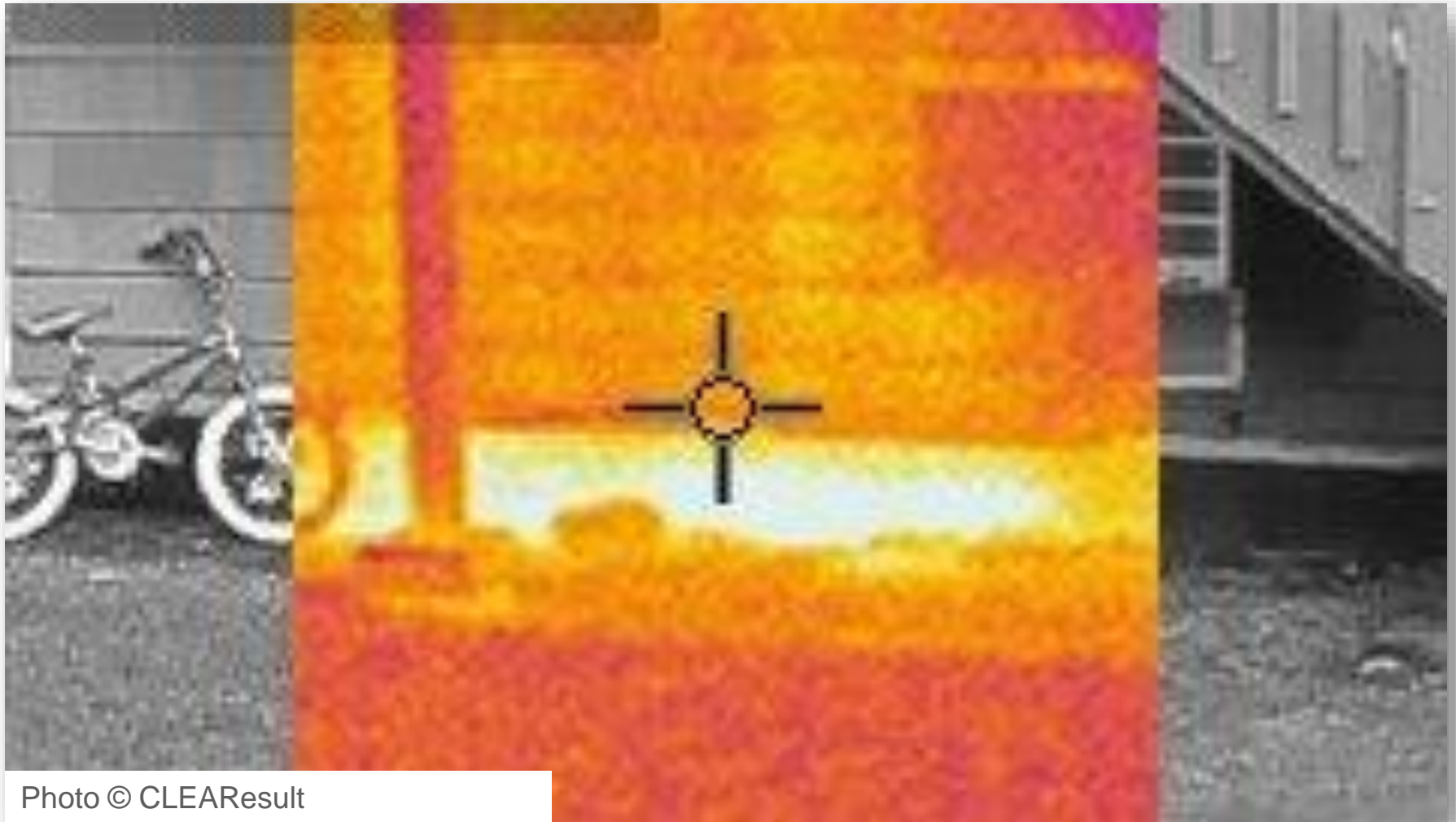
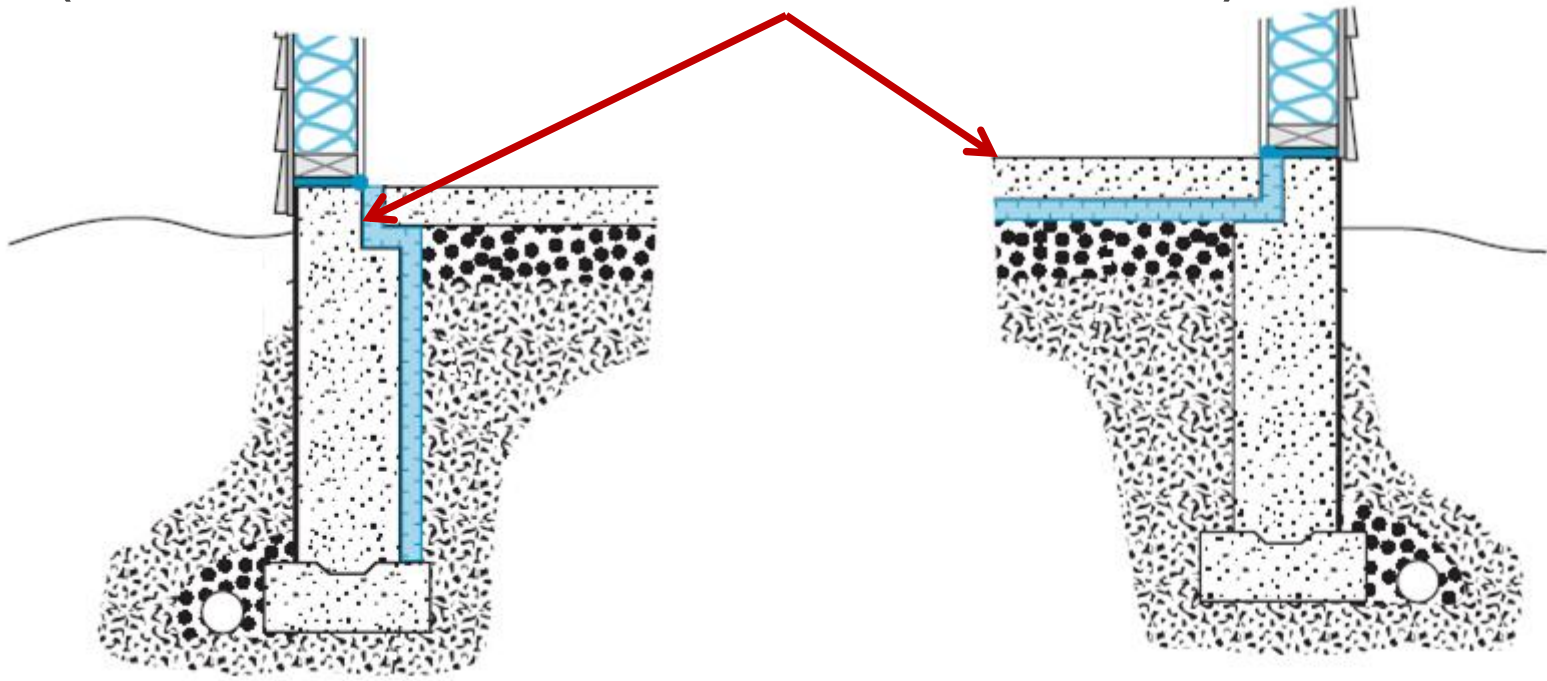


Photo © CLEAResult

## R402.2.9 Slab-on-Grade Floors (Prescriptive)

2' of R-10 in any direction  
(horizontal/vertical/combination)



R-15 for heated slabs

# R402.2.9 Slab-on-Grade Floors (Prescriptive)



Photo © Conservation Services Group





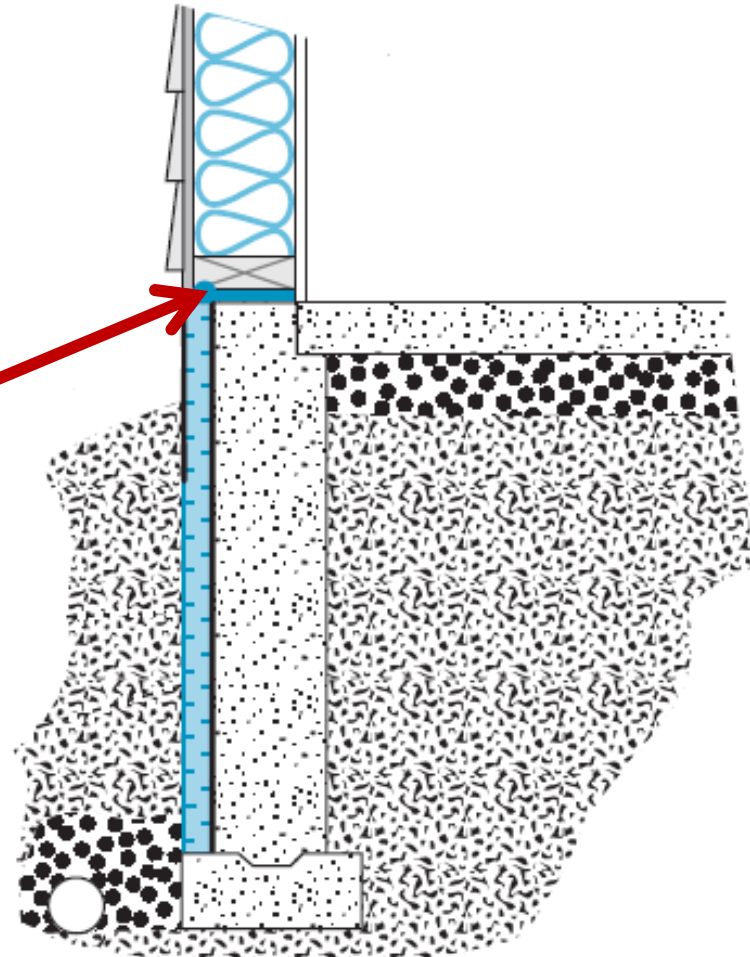
courtesy of CLEAResult

# R402.2.9 Slab-on-Grade Floors (Prescriptive)



2' of R-10

Protect insulation,  
Install termite shield



## R402.4.1.2 (Table) Crawl Space Walls R402.2.11

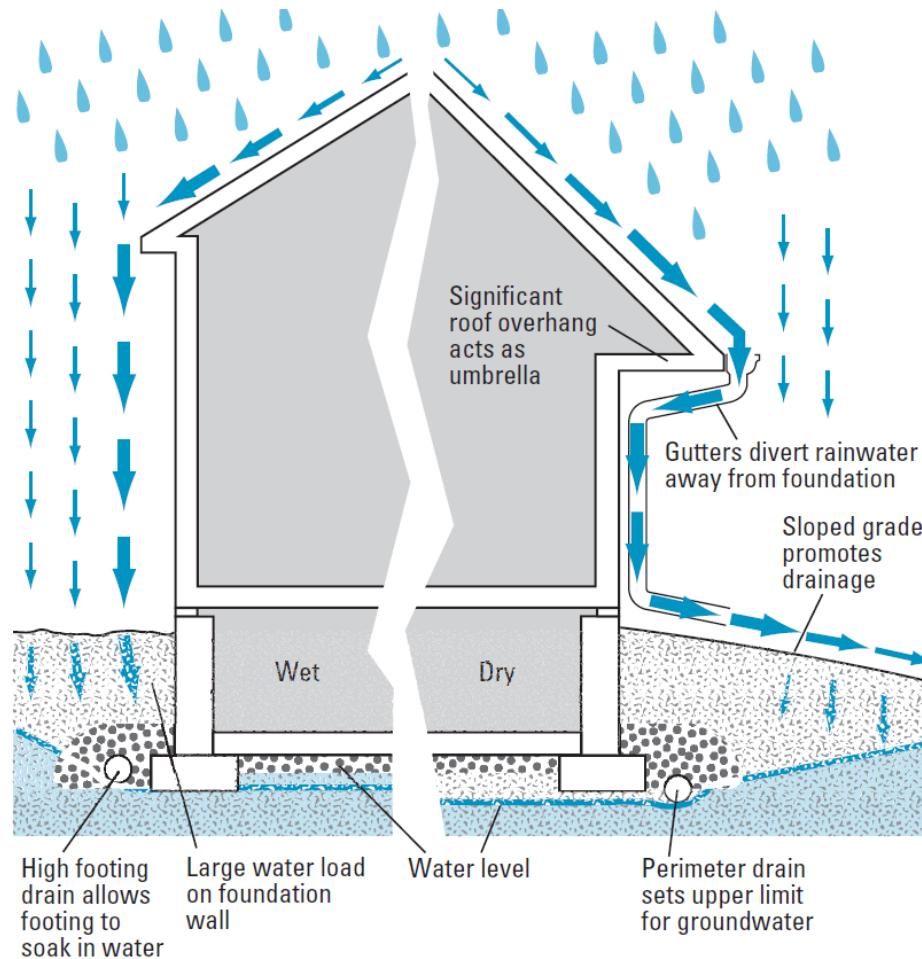


Insulation permanently fastened  
Floor to grade + 2' vertically or horizontally below grade  
R15/19  
Exposed earth covered with class I vapor retarder

# Walls and Windows



# Keep Bulk Water Out (Best Practice)



Rain

Plumbing  
leaks

Ground  
water

# Durability (Best Practice)



courtesy of CLEAResult



# Durability (Best Practice)



Photo © CLEAResult

# Bulk Water Protection





# Proper Installation is Important



courtesy of CLEARResult

courtesy of CLEARResult

# Roofs Concentrate Water



courtesy of CLEAResult



# Gutters Control Water

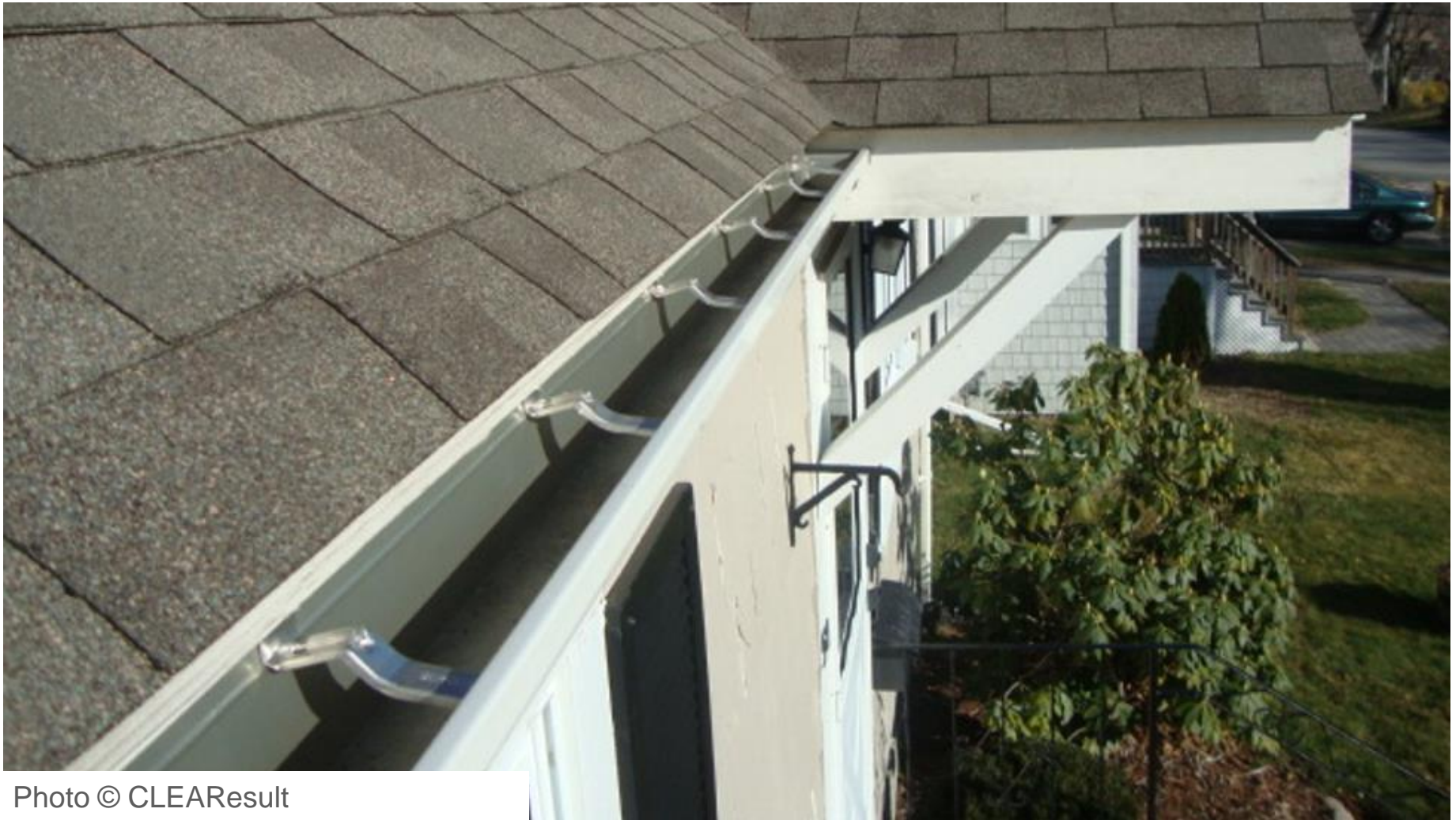
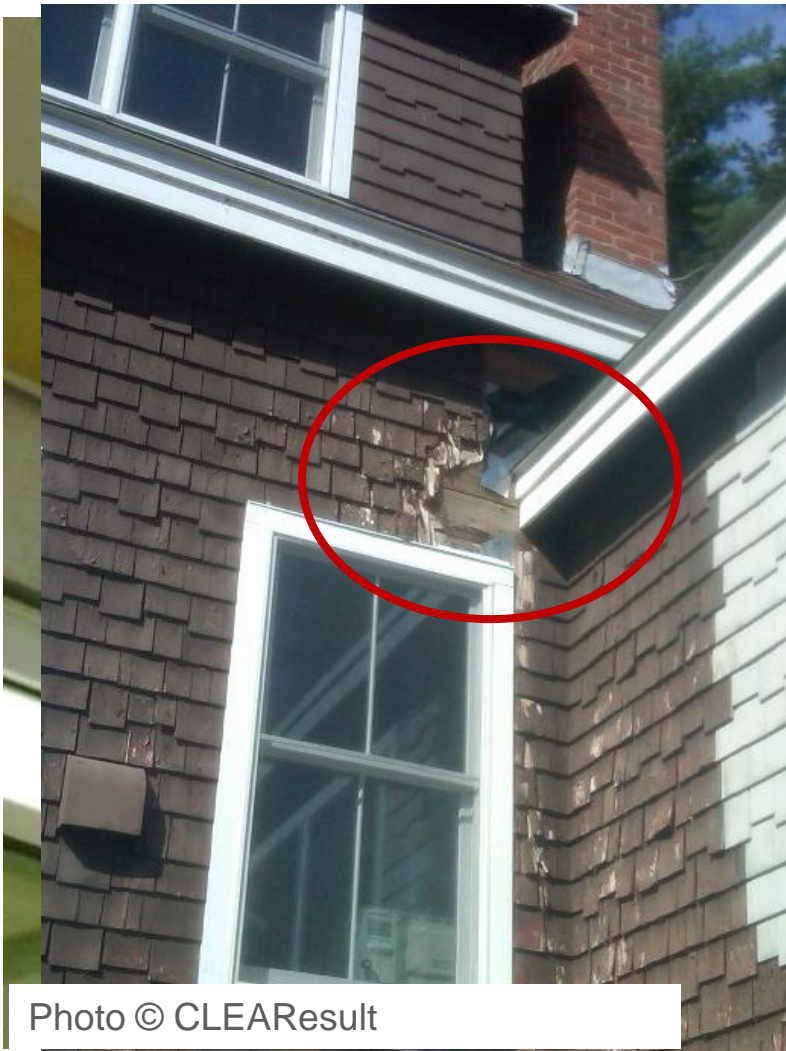


Photo © CLEAResult

# 2015 IRC R905.2.8.3 Sidewall Flashing







# Water Gets Behind the Siding



Photo © CLEARresult



# Best Practice - Vented Cladding



Photo © CLEARresult



Photo © CLEARresult


## R402.4.3

# Fenestration Air Leakage (**Mandatory**)



## Air Leakage

- $\leq 0.30$  CFM/sq ft windows, skylights & sliders
- $\leq 0.5$  CFM/sq ft doors

 National Fenestration Rating Council®	<b>Kasson &amp; Keller, Inc.</b> Series 200 Double Hung Vinyl Frame + Double Glaze Low E Soft Coat Product Type: Vertical Slider      Grids CPD #: KKI-K-9-00021-00002	
<b>ENERGY PERFORMANCE RATINGS</b>		
U-Factor (U.S./I-p)	Solar Heat Gain Coefficient	
<b>0.33</b>	<b>0.26</b>	
<b>ADDITIONAL PERFORMANCE RATINGS</b>		
Visible Transmittance	Air Leakage (U.S./I-p)	
<b>0.49</b>	<b>≤ 0.3</b>	
<p>Manufacturer stipulates that ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. NFRC does not recommend any product and does not warrant the suitability of any product for any specific use. Consult manufacturer's literature for other product information.</p> <p><a href="http://www.nfrc.org">www.nfrc.org</a></p>		
<b>ENERGY STAR® Qualified in Highlighted Regions</b>		



## R402.3.3

### Fenestration Exemption (Prescriptive)



- Prescriptive Table Exemptions\*:
  - Up to 15 SF glazing
  - 1 side-hinged opaque door up to 24 SF
  - R504.2 Repairs-glass only replacements in an existing frame or sash
- New window / replacement window  $U \leq 0.30$  (MA Amendment)

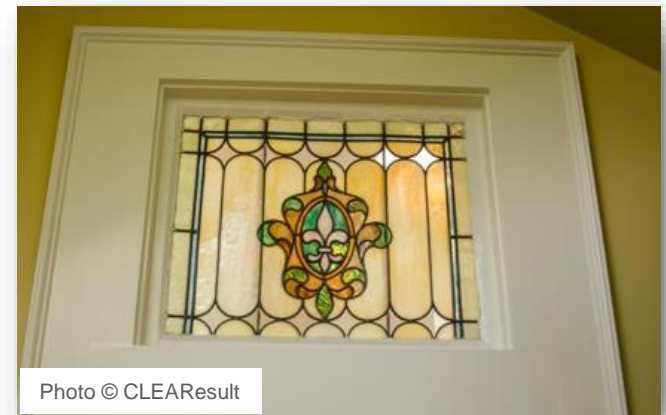
\*Does not apply to U-factor OR Total UA alternatives

# R402.5

## Maximum Fenestration (**Mandatory**)



- Area-weighted average maximum U-factor allowed with tradeoffs:
  - 0.48 for vertical
  - 0.75 for skylights
- Applies to
  - UA Alternative (*REScheck*)
  - Performance path





SCHUCO-SI 82 uPVC System  
Climatop One Triple Glazing, SSG Argon-Fill, SwisSpacer V  
Product Type: SINGLE TILT TURN (3' 3" x 5' 6 1/4")

### ENERGY PERFORMANCE RATINGS

U-Factor (U.S./I-P)

**0.139**

Solar Heat Gain Coefficient

**0.34**

### ADDITIONAL PERFORMANCE RATINGS

Visible Transmittance

**0.58**

Air Leakage (U.S./I-P)

**0.03**

Condensation Resistance

**70**

COG U-Factor (U.S./I-P)

**0.088**

Manufacturer stipulates that these ratings are consistent with the NFRC procedures for determining whole product performance. Consult manufacturer's literature for complete product performance information.

**Project: Highland**

**EAS Unit ID: 5 [4 of 4]**

**Architect ID: 5**

**SAFETY GLAZING: [ ] TEMPERED**

# Ceilings



# Nice Finish, but What About the Heat Loss?



Photo © CLEARresult

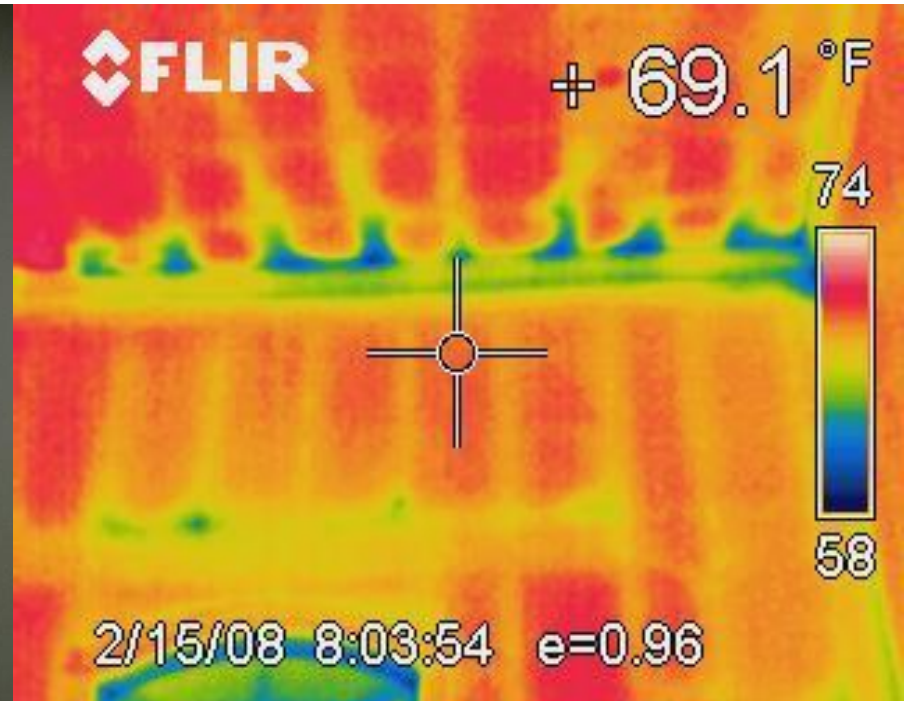


Photo © CLEARresult p



OSB  
3/4" x 4' x 8'  
C194  
2010  
MADE IN THE USA

OSB  
3/4" x 4' x 8'  
C194  
2010  
MADE IN THE USA



# R402.2.3

## Eave Baffles (Prescriptive)



Photo © CLEAResult

## R402.2.4

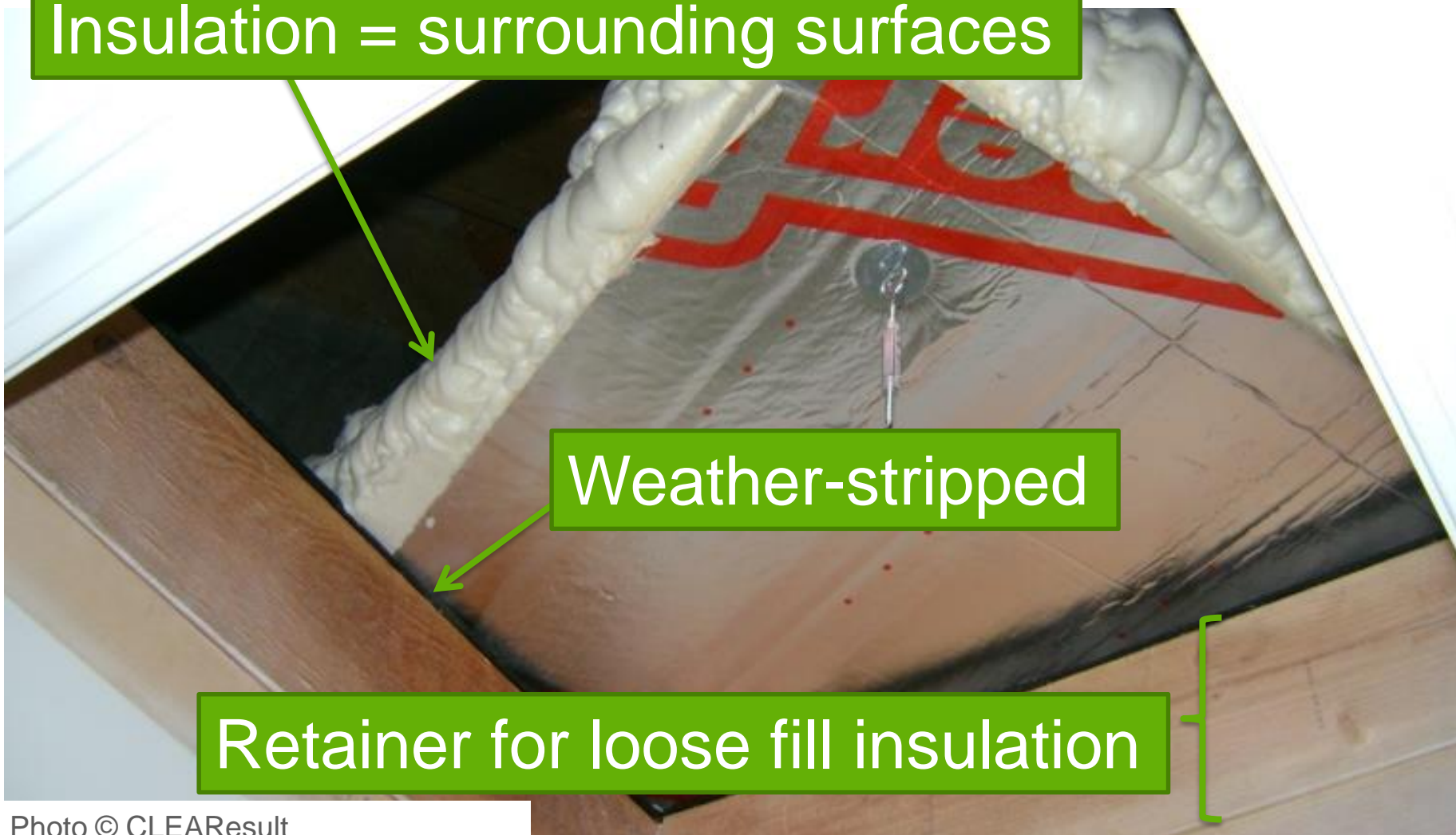
### Access Hatches and Doors (Prescriptive)



Insulation = surrounding surfaces

Weather-stripped

Retainer for loose fill insulation





## R402.2.4

### Access Hatches and Doors (Prescriptive)



Access shall be provided to all equipment that prevents damaging or compressing the insulation.



Photo © CLEAResult

## R402.2.4 Access Hatches and Doors (Prescriptive)



Photo © CLEAResult

# Ice Dams

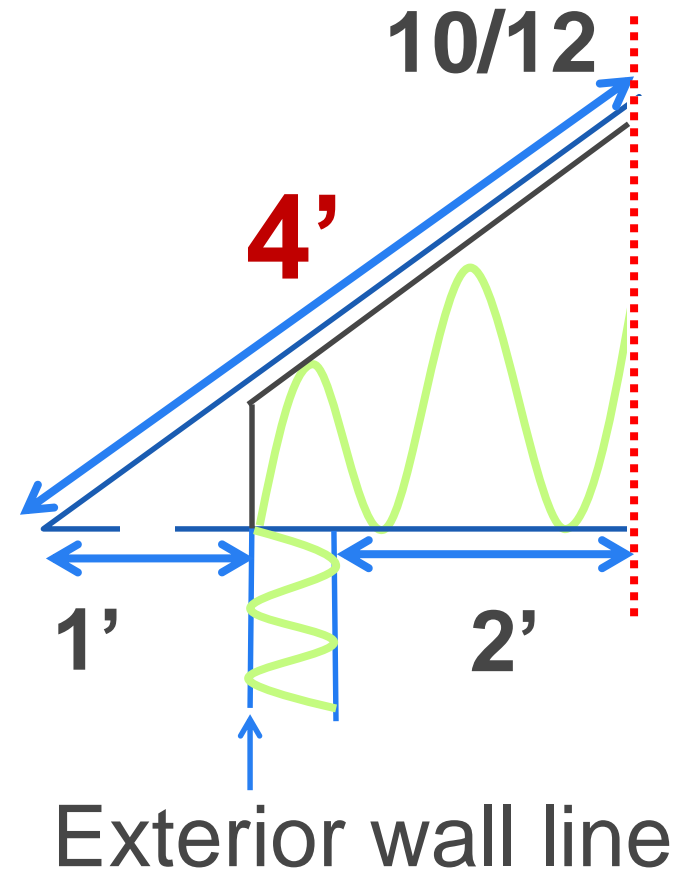


# 2015 IRC R905.4.3.1

## Ice Protection



Ice barrier shall extend from the eave's edge to a point at least 24 inches inside the exterior wall line of the building





# R303.2 Installed to Manufacturer's Specifications...



- Strapped Ceilings?  
Blown is Best...



courtesy of CLEARResult



courtesy of CLEARResult

# R303.2 Manufacturer's Specifications Insulation Must Contact Surface...



- If You Must Strap, You Could...



courtesy of CLEARResult



courtesy of CLEARResult



# Table R402.4.1.1 Insulation Levels in Full Contact with the Air Barrier (drywall)

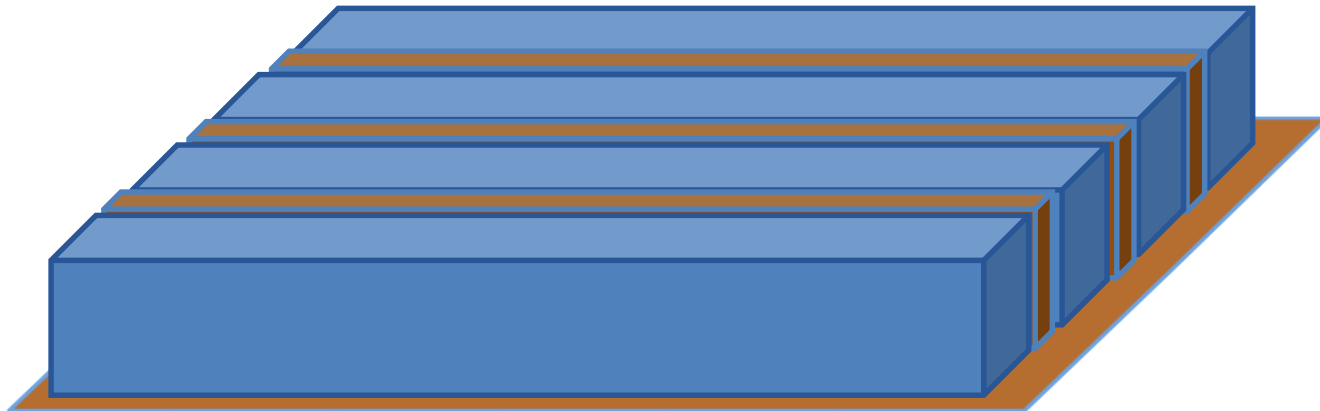


courtesy of CLEAResult

# Ceiling Assembly R-value



- R-49 attic insulation with 10" ceiling joists
- *10% framing factor*
- *Joists R-9.5*



**Assembly R-value = 35**



# Cold Surfaces Condense Water Vapor

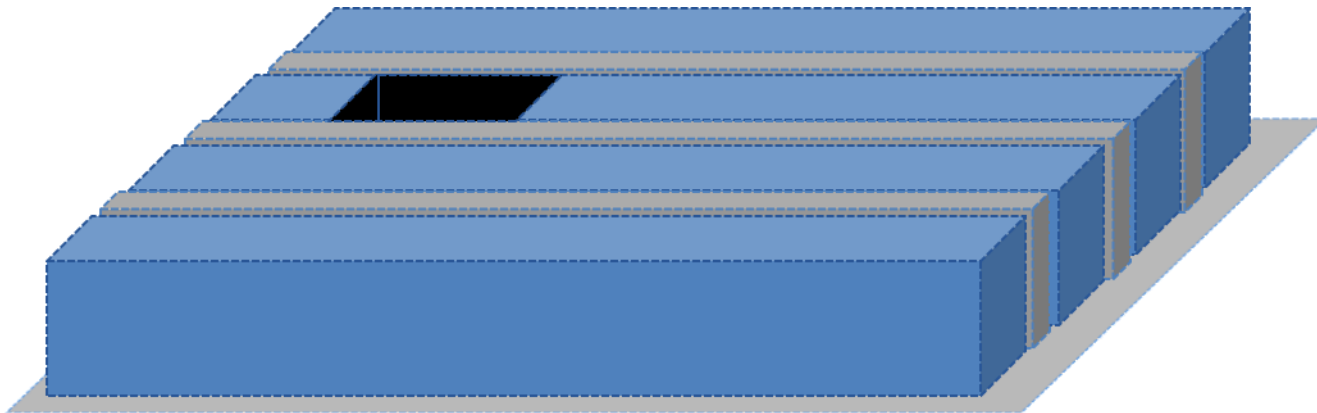


courtesy of CLEAResult

# Ceiling Assembly R-value



- Add an uninsulated attic hatch (R-1)
- *10 square feet*



**Overall R-value = 26**

# Lighting

# R404.1

## Lighting Equipment (**Mandatory**)



Minimum **75%** high-efficacy lamps in permanent fixtures





# R404.1

## Lighting Equipment (**Mandatory**)



# Energy Use Due to Non-Compliance



Building System	2012 IECC	Stretch Code
Lighting	3%	1%
Ducts	4%	1%
Air Leakage	3%	<1%
Above Grade Walls	2%	1%
Frame Floors	2%	1%
Foundation Walls	1%	<1%
Ceilings	1%	<1%
Windows	1%	<1%
Slabs	<1%	<1%
<b>Overall</b>	<b>18%</b>	<b>5%</b>

# Mass Save® Energy Code Technical Support



## Project Specific Code Assistance

- MA code officials
- Design professionals
- Contractors
- Sub contractors
- Material suppliers



Free energy code support

**855-757-9717**

Phone assistance

Office visits

Project site visits

# Thank you!

## Massachusetts Code Compliance Support Initiative

**CLEAResult**