

Air Barrier & Insulation Installation

Massachusetts Energy Code Technical Support Program

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.

Presented by:
Performance Systems Development



Mike Turns, Director of Codes & New Construction



Poll 1 – What is your occupation?

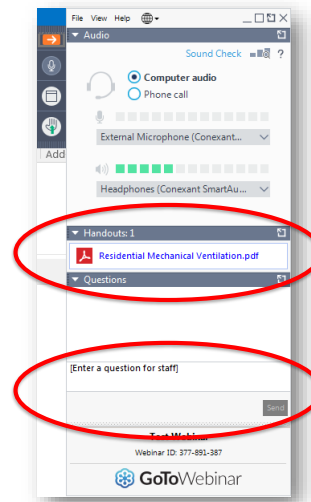


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Logistics

- Questions
- PDF of slides
- Recordings:

<https://www.gotostage.com/channel/3664c313179d4f66944dad38b8f1c58e>



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Continuing Education

- Eligible for Massachusetts Building Officials CEUs
 - One hour for residential & one hour for commercial
 - Attendance record will be submitted to OPSI
- We are not offering AIA LUs at this time
- Not eligible for CSL Credits

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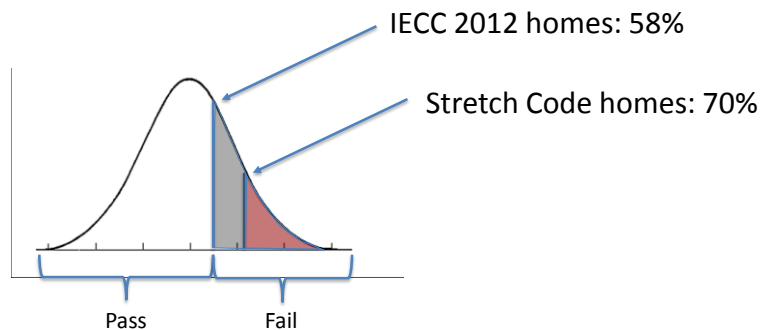
Agenda

- Air barriers and the code
- Advantages of a continuous air barrier
- Advantages of proper insulation installation
- Field inspection tips
- Summary and questions

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MA Code Compliance Residential Baseline Study

Proportion of homes complying with 3 ACH50
building **envelope air leakage** limit:



Source: 2015-16 Massachusetts Single-Family Code Compliance Baseline Study: Volume 2 – Final Report, NMR Group, Inc & Dorothy Conant, October 21, 2016

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What is an air barrier?



- **System** that separates conditioned space from an unconditioned space or the outside
- Resists air pressure differences and controls air infiltration
- Should be continuous over the building thermal envelope
- Should have a lifetime as long as the building

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Why Air Barriers?

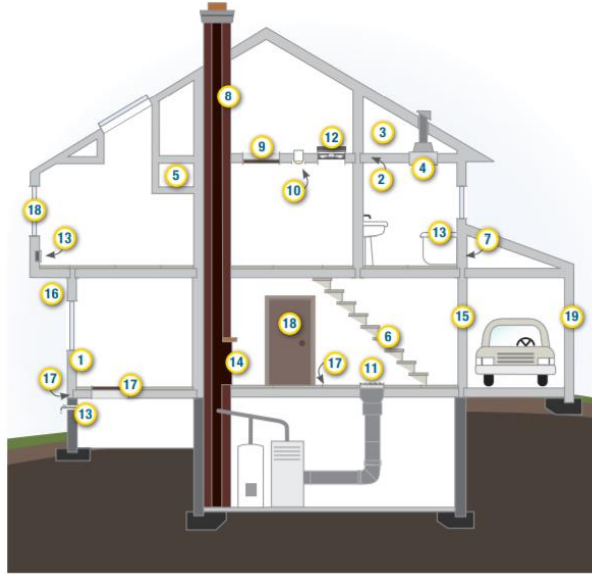


- **Lower energy bills:** Uncontrolled air leakage leads to energy waste
- **Fewer condensation problems:** Prevent warm, moist air from entering building thermal envelope assemblies
- **Improved indoor air quality:**
 - Allows for control of ventilation rate
 - Reduce infiltration of outdoor pollutants, dust and radon
- **Better R-values:** Prevents air movement through air-permeable insulation
- **Improved comfort:** Reduced drafts, moisture, noise

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Uncontrolled Air Leakage

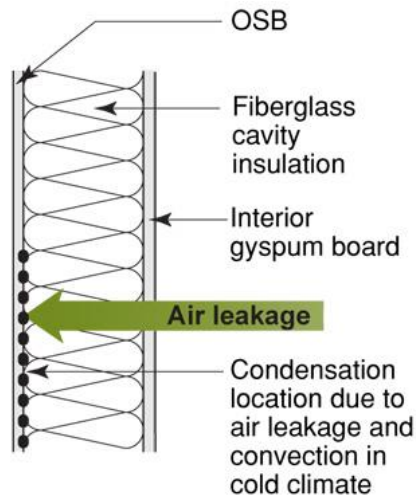
- 1 Air Barrier and Thermal Barrier Alignment
- 2 Attic Air Sealing
- 3 Attic Kneewalls
- 4 Shafts for Piping or Ducts
- 5 Dropped Ceiling/Soffit
- 6 Staircase Framing at Exterior Wall
- 7 Porch-Wall Juncture
- 8 Flue or Chimney Shaft
- 9 Attic Hatch
- 10 Recessed Lighting
- 11 Ducts
- 12 Whole-House Fan
- 13 Exterior Wall Penetrations
- 14 Fireplace Wall
- 15 Garage/Living Space Walls
- 16 Cantilevered Floor
- 17 Rim Joists, Sill Plate, Foundation, Floor
- 18 Windows & Doors
- 19 Common Walls between Attached Dwelling Units



Source: <https://www1.eere.energy.gov>

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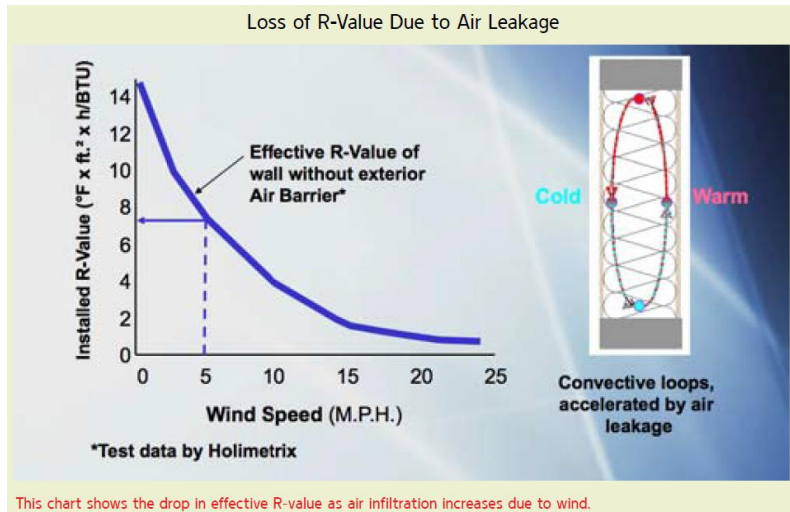
Condensation Due to Air Leakage



basc.pnnl.gov

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Loss of R-Value Due to Air Leakage



Source: Easley, S., *Hybrid Insulation Systems*, Green Builder Magazine, Sept/Oct 2009

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What is NOT an air barrier

Air Barrier \neq Vapor Barrier

Air Barrier \neq Water Resistive Barrier

- Vapor barrier* slows **vapor diffusion**
- Water Resistive Barrier prevents **liquid water intrusion**

*More appropriately called a vapor *retarder*

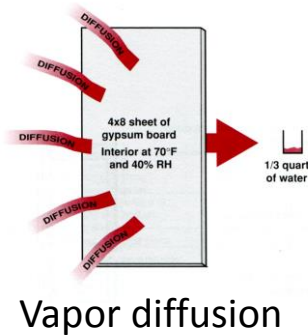
15

What is NOT an air barrier?

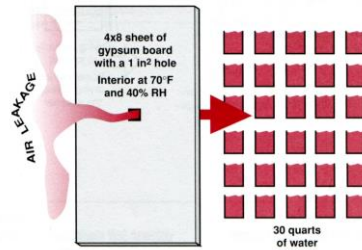
Air Barrier \neq Vapor Barrier (Retarder)



Air Barrier vs. Vapor Barrier



90X more moisture transfer from air leakage



What is an air barrier?

Air Barrier \neq Water Resistive Barrier



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AIR BARRIERS AND THE CODE

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Air Barrier Definition



- IECC R202
 - 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**.

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Related Code Sections



Section R402.4.1.1: The components of the building thermal envelope shall be installed in accordance with manufacturer's instructions and the criteria listed in Table 402.4.1.1

Table R402.4.1.1
AIR BARRIER AND INSULATION INSTALLATION

Component	Air Barrier Criteria	Insulation Installation Criteria

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Air Barrier & Insulation Installation Checklist



Massachusetts Energy Code 9 th Edition Air Barrier and Insulation Checklist (Based on IECC 2015 Table R402.4.1.1)	
GENERAL REQUIREMENTS	
<input type="checkbox"/> A continuous air barrier shall be installed in the building envelope. <input type="checkbox"/> The exterior thermal envelope contains a continuous air barrier. <input type="checkbox"/> Breaks or joints in the air barrier shall be sealed. <input type="checkbox"/> Air-permeable insulation shall not be used as a sealing material.	
FRAMING INSPECTION	
<input type="checkbox"/> Ceiling/attic	<ul style="list-style-type: none"> The air barrier in any dropped ceiling/soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed.
<input type="checkbox"/> Walls	<ul style="list-style-type: none"> 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. Walls are framed to allow the corner to be insulated.
<input type="checkbox"/> Windows, skylights and doors	<ul style="list-style-type: none"> The space between window/door jambs and framing, and skylights and framing shall be sealed.
<input type="checkbox"/> Rim joists	<ul style="list-style-type: none"> Rim joists shall include the air barrier.
<input type="checkbox"/> Floors (including above garage and cantilevered floors)	<ul style="list-style-type: none"> The air barrier shall be installed at any exposed edge of insulation.
<input type="checkbox"/> Crawl space walls	<ul style="list-style-type: none"> Exposed earth in inverted crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped.
<input type="checkbox"/> Garage separation	<ul style="list-style-type: none"> Air sealing shall be provided between the garage and conditioned spaces.
<input type="checkbox"/> Shower/tub on exterior wall	<ul style="list-style-type: none"> The air barrier installed at exterior walls adjacent showers and tubs shall separate them from the showers and tubs.
<input type="checkbox"/> Electrical/phone box on exterior walls	<ul style="list-style-type: none"> The air barrier shall be installed behind electrical or communication boxes or air-sealed boxes shall be installed.
<input type="checkbox"/> Concealed sprinklers	<ul style="list-style-type: none"> 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 ceiling.

INSULATION INSPECTION	
<input type="checkbox"/> Ceiling/attic	<ul style="list-style-type: none"> The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.
<input type="checkbox"/> Walls	<ul style="list-style-type: none"> 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.
<input type="checkbox"/> Rim joists	<ul style="list-style-type: none"> Rim joists shall be insulated.
<input type="checkbox"/> Floors (including above garage and cantilevered floors)	<ul style="list-style-type: none"> 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.
<input type="checkbox"/> Crawl space walls	<ul style="list-style-type: none"> Where provided instead of floor insulation, insulation shall be permanently attached to the crawlspace walls.
<input type="checkbox"/> Narrow cavities	<ul style="list-style-type: none"> 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.
<input type="checkbox"/> Shower/tub on exterior wall	<ul style="list-style-type: none"> Exterior walls adjacent to showers and tubs shall be insulated.
<input type="checkbox"/> Recessed lighting	<ul style="list-style-type: none"> Recessed lighting fixtures installed in the building thermal envelope shall be air tight and IC rated.
PLUMBING ROUGH-IN INSPECTION	
<input type="checkbox"/> Plumbing and wiring	<ul style="list-style-type: none"> 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.
MECHANICAL ROUGH-IN INSPECTION	
<input type="checkbox"/> Shafts, penetrations	<ul style="list-style-type: none"> Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed.
<input type="checkbox"/> HVAC register boots	<ul style="list-style-type: none"> HVAC register boots that penetrate building thermal envelope shall be sealed to the subfloor or drywall.
FINAL INSPECTION	
<input type="checkbox"/> Recessed lighting	<ul style="list-style-type: none"> Recessed light fixtures installed in the building thermal envelope shall be sealed to the drywall.
<input type="checkbox"/> Ceiling/Attic	<ul style="list-style-type: none"> Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.

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Poll 2

True or False:

Ninety-nine percent of new homes in Massachusetts are tested with a blower door and pass at less than 3 ACH50.



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GENERAL AIR BARRIER CRITERIA

General Requirements

Table R402.4.1.1

Massachusetts Energy Code 9th Edition

Air Barrier and Insulation Checklist

(Based on IECC 2015 Table R402.4.1.1)

GENERAL REQUIREMENTS

- A continuous air barrier shall be installed in the building envelope.
-
- 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.

Common air barrier strategies



- House wrap with attention to details
- Sheathing w/ self-adhered membrane & tape
- Drywall sealed to framing
- Sheathing (OSB, plywood, foam) sealed at joints
- Spray foam

Combined with caulk, foam sealant, liquid air barriers

These are NOT necessarily complete air barrier systems by themselves.

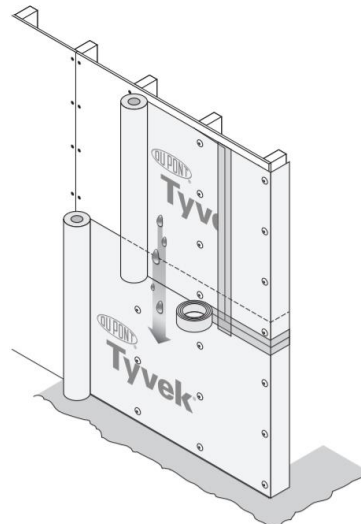
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House Wrap installation



Installation as an air barrier:

1. Install shingle-fashion (start at the bottom)
2. Fasten with broad crown staples (or equiv.)
3. Clean surface of debris before taping
4. Tape all seams – vertical AND horizontal



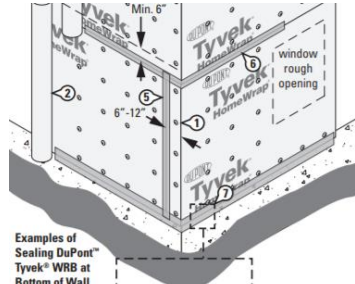
DuPont Tyvek Water-Resistive and Air Barrier Installation Guidelines

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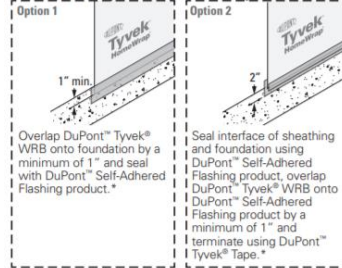
House Wrap installation



- 4. Overlap house wrap onto foundation
- 5. Seal wrap to foundation



Examples of Sealing DuPont™ Tyvek® WRB at Bottom of Wall



Option 1
Overlap DuPont™ Tyvek® WRB onto foundation by a minimum of 1" and seal with DuPont™ Self-Adhered Flashing product.*

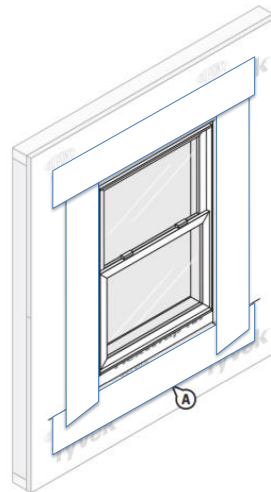
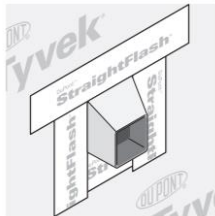
Option 2
Seal interface of sheathing and foundation using DuPont™ Self-Adhered Flashing product, overlap DuPont™ Tyvek® WRB onto DuPont™ Self-Adhered Flashing product by a minimum of 1" and terminate using DuPont™ Tyvek® Tape.

DuPont Tyvek Water-Resistive and Air Barrier Installation Guidelines

House Wrap Installation



- 6. Flash/seal all penetrations



DuPont Tyvek Water-Resistive and Air Barrier Installation Guidelines

Self-adhered Membrane



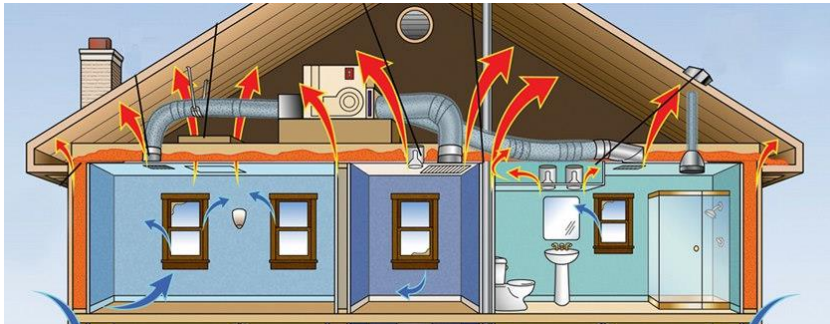
Courtesy of the Department of Energy's Building America Solution Center (<http://bascc.energy.gov>)

WRB as Air Barrier is Only Part of a complete air barrier...

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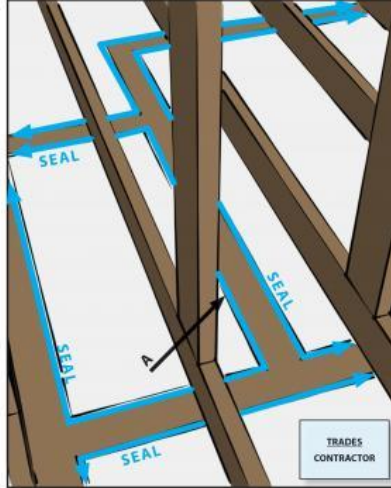
General Requirements

Continuous Air Barrier



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Continuous Air Barrier Ceiling/Attic Plane



Courtesy of the Department of Energy's Building America Solution Center (<http://bascc.energy.gov>)

General Requirements Air-Permeable Insulation



Courtesy of the Department of Energy's Building America Solution Center (<http://bascc.energy.gov>)

Not used as a sealing material

General Requirements

Air-Permeable Insulation



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Poll 2

True or False:

A home's air barrier is typically comprised of a single air barrier product.

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FRAMING INSPECTION

Framing Inspection

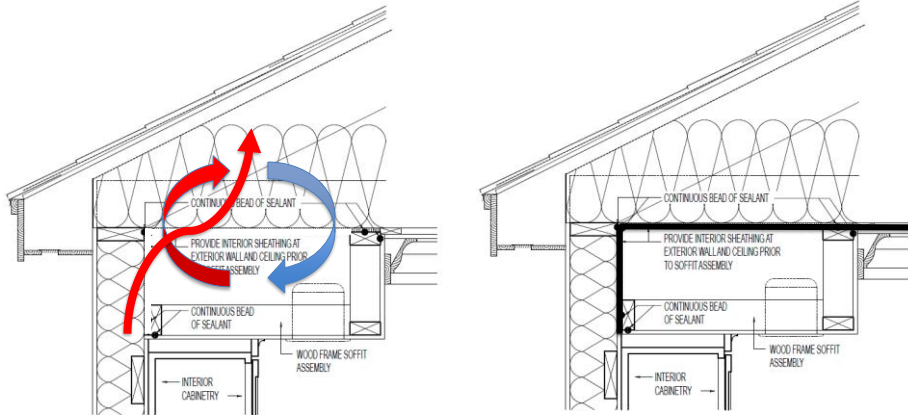
FRAMING INSPECTION		
<input type="checkbox"/>	Ceiling/attic	<ul style="list-style-type: none"> The air barrier in any dropped ceiling/soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed.
<input type="checkbox"/>	Walls	<ul style="list-style-type: none"> The junction 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. Walls are framed to allow the corner to be insulated or continuous insulation is/will be installed.
<input type="checkbox"/>	Windows, skylights and doors	<ul style="list-style-type: none"> The space between window/door jambs and framing, and skylights and framing shall be sealed.
<input type="checkbox"/>	Rim joists	<ul style="list-style-type: none"> Rim joists shall include the air barrier.
<input type="checkbox"/>	Floors (including above garage and cantilevered floors)	<ul style="list-style-type: none"> The air barrier shall be installed at any exposed edge of insulation.
<input type="checkbox"/>	Crawl space walls	<ul style="list-style-type: none"> Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped.
<input type="checkbox"/>	Garage separation	<ul style="list-style-type: none"> Air sealing shall be provided between the garage and conditioned spaces.
<input type="checkbox"/>	Shower/tub on exterior wall	<ul style="list-style-type: none"> Exterior walls adjacent to showers and tubs shall be insulated The air barrier installed at exterior walls adjacent showers and tubs shall separate them from the showers and tubs.
<input type="checkbox"/>	Electrical/phone box on exterior walls	<ul style="list-style-type: none"> The air barrier shall be installed behind electrical or communication boxes or air-sealed boxes shall be installed.
<input type="checkbox"/>	Concealed sprinklers	<ul style="list-style-type: none"> 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.

Framing Inspection

Ceiling/attic plane



☐	Ceiling/attic	<ul style="list-style-type: none"> The air barrier in any dropped ceiling/soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed.
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CAD details Courtesy of the Department of Energy's Building America Solution Center (<http://bas.energy.gov>)

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Framing Inspection

Ceiling/attic – Soffit spaces



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



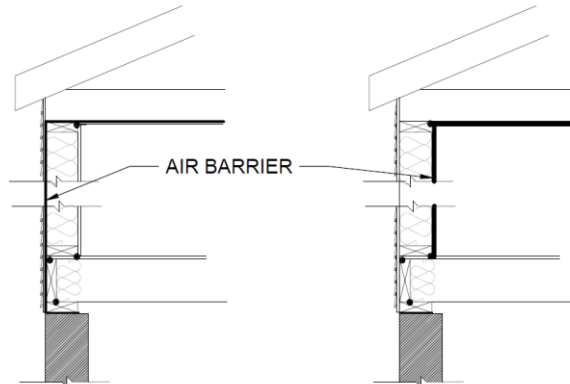
Courtesy of the Department of Energy's Building America Solution Center (<http://bas.energy.gov>)

Framing Inspection

Walls – Air Barrier Options



<input type="checkbox"/>	Walls	<ul style="list-style-type: none"> 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. Walls are framed to allow the corner to be insulated or continuous insulation is/will be installed.
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© Performance Systems Development

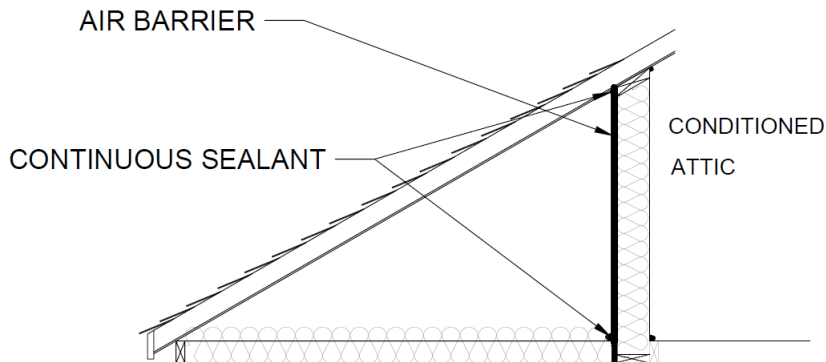
42

Framing Inspection

Walls – Air Barrier Options



<input type="checkbox"/>	Walls	<ul style="list-style-type: none"> 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. Walls are framed to allow the corner to be insulated or continuous insulation is/will be installed.
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Framing Inspection

Knee Walls

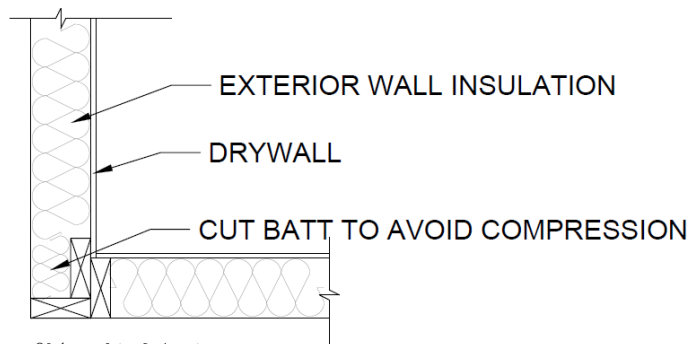


Courtesy of the Department of Energy's Building America Solution Center (<http://bascc.energy.gov>)

Framing Inspection

Walls – Insulated corner

<input type="checkbox"/>	Walls	<ul style="list-style-type: none"> • 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. • Walls are framed to allow the corner to be insulated or continuous insulation is/will be installed.
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Framing Inspection

Walls – Insulated corner



Courtesy of the Department of Energy's Building America Solution Center (<http://basoc.energy.gov>)

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Framing Inspection

Windows & Doors

<input type="checkbox"/> Windows, skylights and doors	<ul style="list-style-type: none"> The space between window/door jambs and framing, and skylights and framing shall be sealed.
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Use low-expanding foam or backer rod and caulk

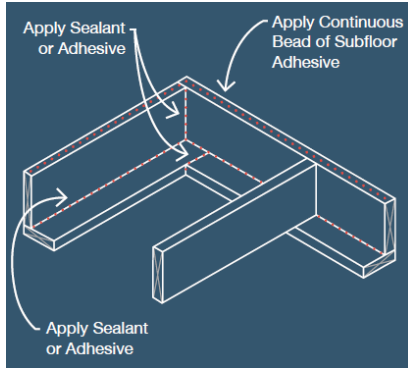
48

Framing Inspection

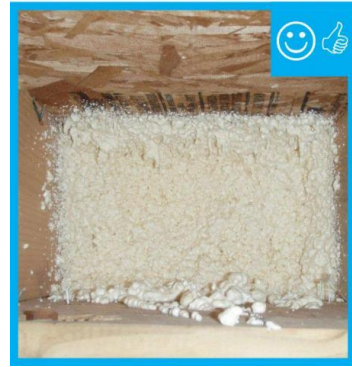
Rim Joists



<input type="checkbox"/> Rim joists	<ul style="list-style-type: none"> Rim joists shall include the air barrier.
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Priority Air Sealing Locations for New Homes, Insulation Institute.



Courtesy of the Department of Energy's Building America Solution Center (<http://best.energy.gov>)

Framing Inspection

Garage separation



<input type="checkbox"/> Floors (including above garage and cantilevered floors)	<ul style="list-style-type: none"> The air barrier shall be installed at any exposed edge of insulation.
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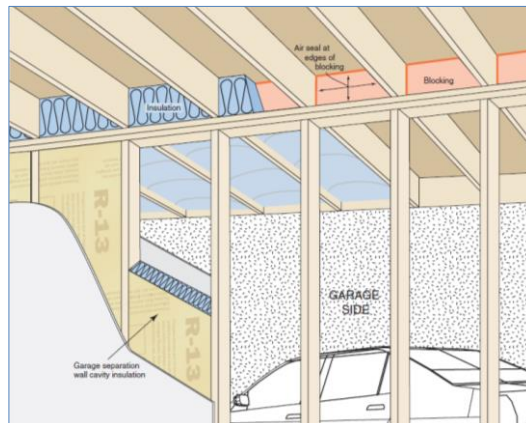


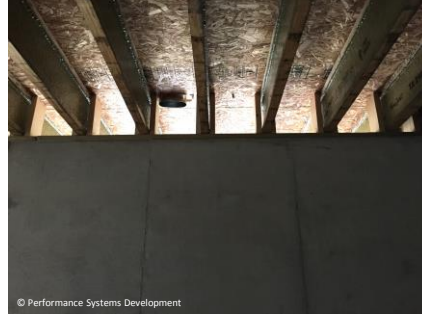
Image courtesy of Southface - southface.org

Framing Inspection

Garage separation



From the garage



From the conditioned basement

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Framing Inspection

Garage separation



energy.gov

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Framing Inspection

Shower/tub on exterior wall



<input type="checkbox"/>	Shower/tub on exterior wall	<ul style="list-style-type: none"> • Exterior walls adjacent to showers and tubs shall be insulated • The air barrier installed at exterior walls adjacent showers and tubs shall separate them from the showers and tubs.
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Insulation Installation

Shower/tub on exterior walls



Air barrier and insulation installed

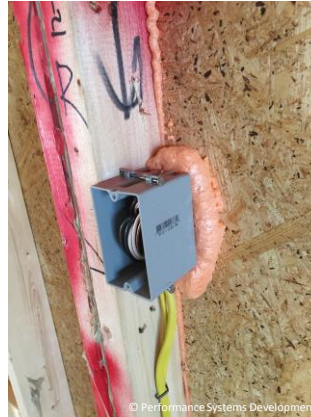


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Framing Inspection

Electrical/phone boxes on exterior walls

<input type="checkbox"/>	<p>Electrical/phone box on exterior walls</p> <ul style="list-style-type: none"> The air barrier shall be installed behind electrical or communication boxes or air-sealed boxes shall be installed.
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Poll 4

Which of the following is NOT an intended outcome of installing a continuous air barrier?

- Avoid decreasing the effective R-value of insulation
- Improve comfort
- Slow vapor diffusion
- Reduce condensation risk

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INSULATION INSPECTION

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Insulation Installation Manufacturer's Instructions

Per NAIMA:

- Cavity spaces in which the insulation is being placed should be completely filled – top to bottom, side to side and front to back.

[NOTE: Even in cases where the code required R-value is met with a product of thickness less than the cavity depth, the cavity space should be completely filled.]

- Insulation should not be compressed when the full thickness space is available, as this results in a reduction of R-value.

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Insulation Installation

Walls Per Manufacturer's Instructions



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Insulation Installation

Walls Per Manufacturer's Instructions



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Insulation Installation

Walls Per Manufacturer's Instructions



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Insulation Installation

Walls with Compression



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Insulation Installation

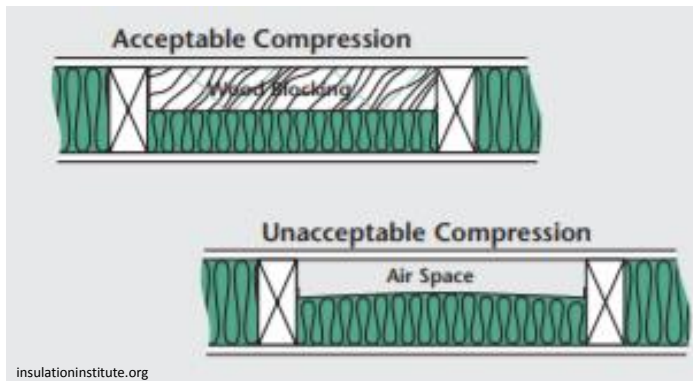
Walls – Poor Installation



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Insulation Installation

Walls



Plan View

66

Insulation Installation

Walls

<input type="checkbox"/>	Walls	<ul style="list-style-type: none"> • 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.
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Rigid foam in header



© Performance Systems Development

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Insulation Installation

Rim Joists

<input type="checkbox"/>	Rim joists	<ul style="list-style-type: none"> • Rim joists shall be insulated.
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Courtesy of the Department of Energy's Building America Solution Center (<http://bas.energy.gov>)

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Insulation Installation

Floors



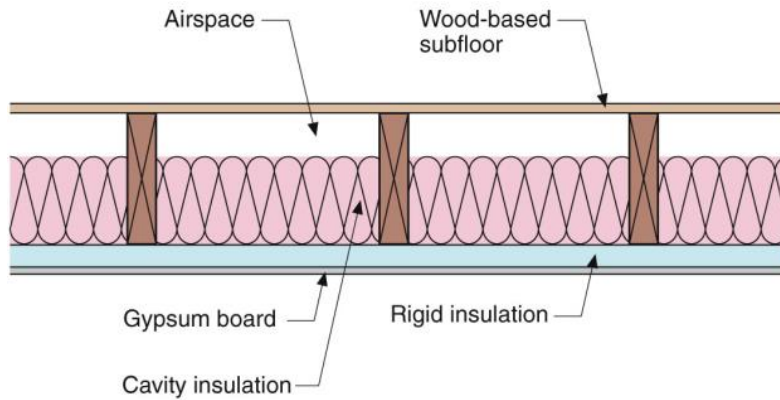
<input type="checkbox"/> Floors (including above garage and cantilevered floors)	<ul style="list-style-type: none"> • Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of subfloor decking, or floor framing cavity insulation shall be permitted to be in 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.
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Courtesy of the Department of Energy's Building America Solution Center (<http://bascc.energy.gov>)

Insulation Installation

Floors



Courtesy of the Department of Energy's Building America Solution Center (<http://bascc.energy.gov>)

Optional detail

Insulation Installation

Narrow cavities

<input type="checkbox"/>	Narrow cavities	<ul style="list-style-type: none"> 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.
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Insulation Installation

Recessed lighting

<input type="checkbox"/>	Recessed lighting	<ul style="list-style-type: none"> Recessed lighting fixtures installed in the building thermal envelope shall be air tight and IC rated.
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Plumbing & Electrical Wiring

PLUMBING ROUGH-IN INSPECTION

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Plumbing Rough-in Inspection

Plumbing and Wiring

<input type="checkbox"/> Plumbing and wiring	<ul style="list-style-type: none">• 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.
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Plumbing Inspection

Plumbing & Electrical Wiring



Compression



MECHANICAL ROUGH-IN INSPECTION

Mechanical Inspection

Shafts & Penetrations



<input type="checkbox"/> Shafts, penetrations	<ul style="list-style-type: none"> • Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed.
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© Performance Systems Development

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Mechanical Inspection

HVAC Register Boots



<input type="checkbox"/> HVAC register boots	<ul style="list-style-type: none"> • HVAC register boots that penetrate building thermal envelope shall be sealed to the subfloor or drywall.
--	--



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FINAL INSPECTION

Final inspection Recessed Lighting

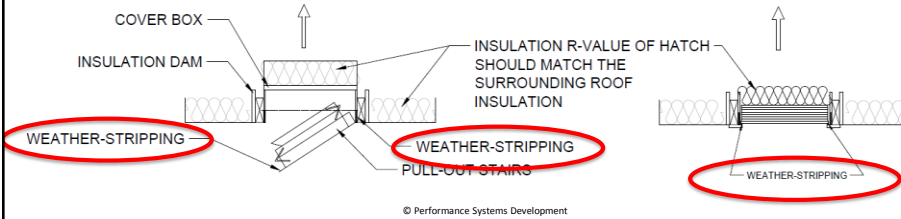
- | | | |
|--------------------------|--------------------------|--|
| <input type="checkbox"/> | Recessed lighting | <ul style="list-style-type: none">Recessed light fixtures installed in the building thermal envelope shall be sealed to the drywall. |
|--------------------------|--------------------------|--|



Final inspection

Attic access hatch

<input type="checkbox"/> Ceiling/Attic	<ul style="list-style-type: none"> Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.
--	---



Final inspection

Attic access hatch



Summary



- Air barriers:
 - Eliminate energy waste from uncontrolled infiltration
 - Protect insulation from R-value degradation
 - Reduce condensation risk
 - Improve indoor air quality
- Download and use the checklist!

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Energy Code Support



Questions about the energy code?

Energy Code Support Hotline:

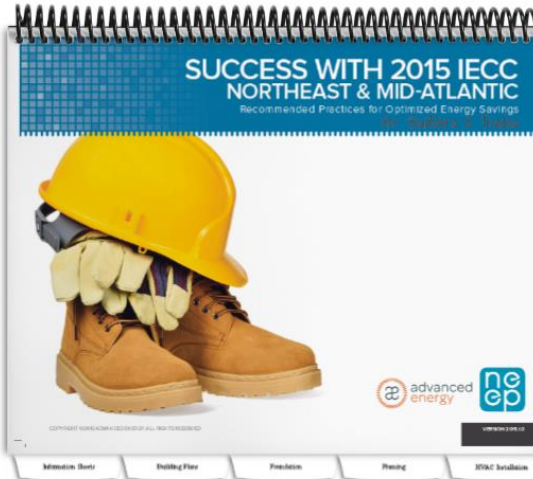
855-757-9717

Energy Code Support Email:

energycodesma@psdconsulting.com

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Energy Code Field Guides



Field Guides for
Code Officials and
Builders/Trades at:

SuccessWithEnergyCode.com

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Residential New Construction

Incentives for energy efficient building and renovating



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

Incentives also offered for existing buildings.
Visit www.MassSave.com for the details.

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Residential New Construction – Incentives



Blended Savings Approach (BSA)

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

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Thanks!

Massachusetts Energy Code Technical Support Program

