Building America
New Code Options for Insulating, Sealing, and Controlling Moisture in Unvented Attics in Residential Buildings

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Course Description

This webinar from the DOE Building America Program will provide an overview of the new unvented attic options in the 2018 IRC/IECC and the additional benefits.

The new code language would require installation of vapor diffusion ports/vents in unvented attics to allow moisture in the attic to be removed by diffusion rather than by air change. This allows the attic assembly to remain airtight while providing a path for moving the moisture to the outside via vapor diffusion. Airtight attics also provide an energy-efficiency benefit.

With the vapor diffusion ports, unvented attics can be insulated with lower-cost alternative insulation material, such as fiberglass batts, blown cellulose, and blown fiberglass, rather than polyurethane spray foam and rigid board insulation. This provides more material choices for designers, builders, and consumers who have issues with expense, the greenhouse gas potential of blowing agents, impacts of fire retardants, and off-gassing of some insulation products. In regions with high wildfire occurrence, elimination of eave vents and air sealing the upper attic vents at ridges significantly decreases entry paths for embers that could start a house fire. In hurricane zones, eliminating roof vents reduces the entry way for rainwater during storms.
Learning Objectives

1. Understand how moisture can be controlled in unvented attics.
2. Learn the proper roof ventilation measures for unvented attics.
3. Learn how to apply the new 2018 IECC/IRC code provisions for unvented attics and unvented enclosed rafter assemblies.
Code Change
R806.5 Unvented attic and unvented attic enclosed rafter assemblies.

- vapor diffusion port
- port area 1:600 of the ceiling area
- vapor permeance greater than 20 perms
- roof slope greater than 3:12
- air supply 50 cfm/1000 ft² ceiling area
- insulation installed directly under the roof deck
- Climate Zones 1, 2 and 3
Vapor Diffusion Port: A passageway for conveying water vapor from and unvented attic to the atmosphere.
Technical Background to the Code Change
Arrhenius Equation
For Every 10 Degree K Rise
Activation Energy Doubles

\[ k = Ae^{-\frac{E_a}{RT}} \]
Damage Functions
Water
Heat
Ultra-violet Radiation
Vapor Pressure and Relative Humidity
Sorption Isotherms
Change in the storage of moisture in a porous building material as the partial pressure of water vapor in the ambient air increases from zero to full saturation value at a given temperature.

**Sorption Curve**
Average sorption isotherm for wood as a function of temperature
From Straube & Burnett, 2005
2nd Law of Thermodynamics
Heat Flow Is From Warm To Cold
Moisture Flow Is From Warm To Cold
Moisture Flow Is From More To Less
Air Flow Is From A Higher Pressure to a Lower Pressure
Gravity Acts Down
Vented Attics Are Climate Dependant
40% to 50% of vented area

50% to 60% of vented area
Houses With Vented Attics Suck
Houses With Vented Attics Suck
Not all the Time…..but......
Infiltration/Exfiltration Controlled Ventilation

Interior sources

Interior sources
Shingles

Roofing paper

Minimum R-50 rigid insulation in two or more layers with horizontal and vertical joints staggered

Nail base for shingles (plywood or OSB) screwed through rigid insulation to wood decking or timber rafters

Air barrier membrane

Wood decking

Timber rafter or exposed joist
Minimum R-50 rigid insulation in two or more layers with horizontal and vertical joints staggered

- Roof sheathing
- Roofing membrane
- Vented space
- Roof sheathing
- Roofing paper
- Shingles
- Air barrier membrane
- Wood decking
- Timber rafter or exposed joist
0°F

70°F

Dewpoint
(50% RH, 70°F)

Location of condensation and frost

Exterior sheathing

Outside

Inside
Simple linearized energy-temperature relation for water
From Straube & Burnett, 2005
The inside face of the exterior sheathing is the condensing surface of interest.

Wood-based siding
Building paper
Exterior sheathing
R-19 cavity insulation in wood frame wall
Gypsum board with any paint or wall covering

Dew point temp.
at 50% R.H., 70°F
Mean monthly outdoor temperature
Dew point temp.
at 35% R.H., 70°F
Dew point temp.
at 20% R.H., 70°F
Potential for condensation

Temperature (°F)

Month
APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY
The inside face of the insulating sheathing is the condensing surface of interest.

Wood-based siding

R-7.5 rigid insulation

R-13 cavity insulation in wood frame wall

Gypsum board with any paint or wall covering

Mean monthly outdoor temperature

Insulation/sheathing interface temperature (R-7.5 sheathing, R-13 cavity insulation as shown in adjacent drawing)

Dew point temp. at 35% R.H., 70°F

Potential for condensation

Month
Figure 8-7. Outside vapour pressure, saturated vapour pressure and inside vapour pressure for Winnipeg.
Outside

- Roof sheathing
- Condensation and frost accumulating on underside of roof sheathing

Attic

- Attic insulation
- Dewpoint

Inside
Outside

Radiation to night sky

Roof sheathing

Condensation and frost accumulating on underside of roof sheathing

Attic

Condensation and frost accumulating on top of attic insulation

Inside

Attic insulation

Roof sheathing and top of attic insulation are radiation-coupled
The inside face of the roof sheathing forming the cavity is the first condensing surface.

OSB or plywood nail base for shingles

R-30 unfaced batt ceiling insulation compressed to fit within 2x8 rafters or damp spray cellulose or “netted” dry blown cellulose or fiberglass

R-5 rigid insulation (vertical and horizontal joints offset from roof sheathing)

Sealant

Rigid insulation notched around roof rafters and sealed

Vinyl or aluminum siding

Rigid insulation (taped, shiplapped or sealed joints)

Unfaced batt insulation

OSB or plywood roof sheathing

Gypsum board ceiling with semi-vapor permeable (latex) paint

Caulking or sealant

Gypsum board with semi-vapor permeable (latex) paint
Shingles

Roofing paper

R-19 batt insulation installed with wire stays or twine or netted cellulose

R-5 rigid insulation (vertical and horizontal joints offset from roof sheathing)

\(\frac{3}{8}\)” sheathing over rigid insulation

Roof sheathing

Sealant

Rigid insulation notched around roof trusses and sealed

Underside of roof sheathing is typically the “first” condensing surface

Vinyl or aluminum siding

Rigid insulation

Building paper drainage plane

Unfaced batt insulation

Gypsum board with vapor semi-permeable (latex) paint
Roofing tile

Roofing paper

Netted cellulose insulation or batt insulation installed with wire stays or twine

Roof sheathing

Underside of roof sheathing is typically the “first” condensing surface

Stucco

Unfaced batt insulation

Rigid insulation

Gypsum board with vapor semi-permeable (latex) paint

Building paper drainage plane
Truss Uplift
Top chord lengthens

Truss bows upward

Bottom chord shrinks

Top chord lengthens
18" wide membrane strip under parapet folded down over exterior rigid insulation
Coping wedge
OSB
Rubber roofing membrane
Rigid insulation
Air barrier membrane (membrane roofing in very cold and cold climates; housewraps, building paper in all other climates)

Sealant
Rigid insulation
OSB
Cavity insulation
Sealant
Polymer modified (PM) or traditional cement stucco
Metal lath
Building paper bond break over drainage plane
Gypsum board with semi-permeable (latex) paint
Sealant, adhesive or gasket at top plate
Cavity insulation
Metal cap
18" wide membrane strip under parapet folded down over exterior OSB
Coping wedge
OSB
Rubber roofing membrane

OSB sheathing
Scupper
Two layers OSB
High density spray foam insulation

Polymer modified (PM) or traditional cement stucco
Metal lath
Building paper bond break over drainage plane

Gypsum board with semi-permeable (latex) paint
Cavity insulation
Sealant, adhesive or gasket at top plate
Caulking or sealant
Cavity insulation

1/4" cant/ft
1" HD spray foam
2x6 top chord
OSB/plywood sheathing
Drainage plane

Spray fiberglass; 8" nominal
Gypsum board
2x6 frame wall
4 1/2" cellulose or spray fiberglass
1" HD spray foam
Roof cladding

Roof underlayment

3” HD spray foam (R-19.5)

6\(\frac{1}{4}\)” spray fiberglass (R-21)
Low density spray foam insulation

Asphalt shingles

Roofing paper

Roof sheathing

Raised heel truss

Rigid foam, or comparable, as backdam

Soffit

Roof underlayment sealed to drip edge

Non-occupiable space

Gypsum board with latex paint (acts as thermal barrier separating occupiable space from non-occupiable space)
Conditioned Attics Not Unvented Attics
Conditioned Attics Not Unvented Attics
Need Supply Air
Conditioned Attics Not Unvented Attics
Need Supply Air
50 cfm/1000 ft² of Attic
FRF Data: June 1 - September 30, 1989

15-minute averages

Temperature (F)

Standard Time (h)

White Shingles

Black Shingles
Vented vs. unvented shingle temperatures

South-facing shingle temperatures
Jacksonville, FL  16-Sep to 18-Nov 2000

Temperature (F)

- unvented S shingle
- vented S shingle

Number of hourly observations
Hourly Maximum Roof Deck Temperature
LV24 and LV22

Temperature (°F)

Hour of Day for August 1997

LV24, BA
LV22, ref
Outside
Roof Shingle Temperature

FSEC 3.0: Orlando, 1-Aug

- All black shingle simulations
- All white tile simulations

Temperature (°C) vs. Hour of Day

Temperature (°F)
Roofing tile

Roofing paper

Netted cellulose insulation or batt insulation installed with wire stays or twine

Roof sheathing

Underside of roof sheathing is typically the “first” condensing surface

Stucco

Rigid insulation

Building paper drainage plane

Unfaced batt insulation

Gypsum board with vapor semi-permeable (latex) paint
Step 1
- Remove strip of OSB from each side of ridge

Step 2
- Create air seal with strip of vapor open membrane (tape seams)
- Vapor open membrane sheet sealed to OSB with acrylic caulk sealant
- Hold vapor open membrane sheet in place with metal strapping

Step 3
- Construct wood ridge vent with 2x2 furring
Sweating Ducts
Sweating Ducts
Light Colored Roofs
Cool Roofs
Radiant Barriers
ACCA Manual J, S and D
Ductwork Attic Dehumidification System
Burying Ducts
Ridge vent

Air change

Soffit vents

Classic vented attic

Vapor diffusion port

Vapor diffusion

Unvented attic with vapor diffusion port
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Water Managed Existing Sill Beams and Sill Plates
Guide describing how to insulate the sill beam or sill plate on the exterior side in a way that allows drying to the exterior, as part of an exterior wall upgrade.

Water Managed Existing Wall Penetrations
Guide with information about how to install flashing integrated with air and water control layers around piping, vents, and other wall penetrations as part of an exterior wall retrofit.

Water Managed Roof – Re-roofing and Adding Insulation over a Flat Roof
Guide describing an approach to re-roofing an existing flat roof to improve thermal, water, and air control performance.

Water Managed Roof – Re-roofing – Sloped Roof
Guide describing how to re-roof an existing home with a sloped roof.

Water Managed Roof-Wall Intersections in Existing Homes
Guide describing how to install and properly integrate flashing at the intersection of an existing wall and an existing intersecting roof

Water Management of Existing Basement Floor
Guide describing how to retrofit an existing basement floor or slab to reduce moisture issues.

Water Management of Existing Crawlspace Floor
Guide providing information about treating bulk water drainage issues and moisture control measures in existing basements and crawl spaces.

Whole-Building Delivered Ventilation
This guide describes how to install a whole-building ventilation system to provide adequate dilution of indoor air contaminants.

Whole-House Dehumidification
Guide describing additional requirements for HVAC systems in warm-humid climates to operate in a dehumidification mode to maintain indoor relative humidity at or below 60 percent.

Wind Washing
Guide describing wind washing and how to prevent it.
# Unvented Attic Insulation

## Scope

Install insulation along the underside of the roof deck of an unvented attic rather than on the ceiling deck of a vented attic for either of two reasons: to provide an unvented, conditioned space for locating HVAC equipment in the attic, and/or to provide a continuous thermal barrier for designs that have complex coffered ceiling planes and/or numerous penetrations for lights, speakers, vents, soffits, etc., which make it difficult to achieve an airtight ceiling plane.

Install insulation to levels that meet or exceed code or energy-efficiency program requirements.

The insulation components for an unvented attic assembly can be successfully designed and installed, based on recommendations from this Guide and the requirements of the 2012 International Residential Code (IRC) Section R806.5 “Unvented attic and unvented enclosed rafter assemblies.” The intent of Section R806.5 is to require unvented attic assembly designs that keep the roof deck – the principle condensing surface in roof assemblies – sufficiently warm throughout the year, or to prevent interior moisture-laden air from accessing the roof deck. This is done by using what is referred to as “air-impermeable insulation” such as rigid foam board above the roof deck or spray foam on the underside of the roof deck.

### DOE Zero Energy Ready Home Notes

The U.S. Department of Energy [Zero Energy Ready Home National Program Requirements](https://www1.eere.energy.gov/buildings/zero_energy/ready/home) specify as a mandatory requirement (Exhibit 1, §2.2) that, for all labeled homes, whether prescriptive or performance path, ceiling, wall, floor, and slab insulation shall meet or exceed 2012 IECC levels. See the guide [2012 IECC Code Level Insulation - DOE Zero Energy Ready Home Requirements](https://www1.eere.energy.gov/buildings/zero_energy/ready/home) for more details.
Unvented Attic Insulation

Compliance

The Compliance tab contains both program and code information. Exact code language is copyrighted and may require purchase from the publisher. While we continually update our database, links may have changed since posting. Please contact our webmaster if you find broken links.

2009 and 2012 IRC

The 2009 and 2012 IRC Section R202 defines vapor retarders class information. A vapor retarder is defined as “a measure of the ability of a material or assembly to limit the amount of moisture that passes through that material or assembly.” Vapor retarder classes are defined by the IRC using the desiccant method with Procedure A of ASTM E96. These classes are:

Class I: 0.1 perm or less
Class II: 0.1 perm to 1.0 perm
Class III: 1 perm to 10 perms

The IRC has had information on unvented attics for several editions. The 2012 IRC Section R806 contains the following requirements, with slight modifications from the 2009 edition, with the most notable addition being identification of vapor retarders by class in R806.5 items 2 and 4.

R806.5 Unvented attic and unvented enclosed rafter assemblies. Unvented attic assemblies and unvented enclosed rafter assemblies are permitted if all the following conditions are met:

1. The unvented attic space is completely contained within the building thermal envelope.
Code Briefs

The intent of Building America's Code Compliance Briefs are to provide code-related information about Building America's research, best practices, and new innovations to help ensure that the measures will be accepted as being in compliance with the code. Providing notes for code officials on how to plan review and conduct field inspections can help builders or remodelers with proposed designs and provide jurisdictional officials with information for acceptance. Providing the same information to all interested parties (e.g., code officials, builders, designers, etc.) is expected to result in increased compliance and fewer innovations being questioned at the time of plan review and/or field inspection.

Air Sealing and Insulating Attic Knee Walls - Code Compliance Brief
Air sealing and insulating attic knee walls to code.

Air Sealing and Insulating Common Walls (Party Walls) in Multi-Family Buildings - Code Compliance Brief
Publication Date: May, 2016
The intent of this brief is to provide code-specific information about air sealing and insulating common walls in multi-family buildings to help ensure that the measures will be accepted as being in compliance with the code. Providing the same information to all interested parties (e.g., code officials, builders, designers, etc.) is expected to result in increased compliance and fewer innovations being questioned at the time of plan review and/or field inspection.

Air Sealing and Insulating Garage Walls - Code Compliance Brief
This brief provides an overview of the 2009 through 2015 IRC/IECC code requirements related to air sealing and insulating attached garage walls.

Bathroom Fan Ratings - Code Compliance Brief
If the bathroom fan is part of the whole-house mechanical ventilation system (WHMV), there are code provisions that should be verified during plan review and field inspection depending upon codes enforced in your jurisdiction.

Buried Ducts in Vented Attics in Hot-humid and Mixed-humid Climate Zones - Code Compliance Brief
Publication Date: May, 2016
The intent of this brief is to provide code-related information about buried ducts in vented attics to
Overview:
The intent of this brief is to provide code-related information about controlling moisture in unvented attics by installing a vapor diffusion port/vent that would convey water vapor from an unvented attic to the outside when air-permeable insulation materials are installed and can be verified as being in compliance with the related codes and standards for residential construction. Providing consistent information to document compliance (e.g., code officials, builders, contractors, is challenging and more uniform plan review and field inspections are necessary. The following sections provide the details and explanations necessary to verify compliance with the requirements of the codes related to the installation of vapor diffusion port/vents in unvented attics. The implementation of the revised code provisions for unvented attics involves understanding the requirements and guidelines outlined in the codes and their companion documents. The following sections provide the details and explanations necessary to verify compliance with the requirements of the codes related to the installation of vapor diffusion port/vents in unvented attics. The implementation of the revised code provisions for unvented attics involves understanding the requirements and guidelines outlined in the codes and their companion documents.

Plan Review:

Field Inspection:

Technical Validation:

This section provides details on the specific provisions for the installation of vapor diffusion port/vents, including the required materials, methods of installation, and specific requirements for compliance. The information presented in this section is intended to assist code officials, builders, contractors, and inspectors in verifying compliance with the revised code provisions for unvented attics. The implementation of the revised code provisions for unvented attics involves understanding the requirements and guidelines outlined in the codes and their companion documents. The following sections provide the details and explanations necessary to verify compliance with the requirements of the codes related to the installation of vapor diffusion port/vents in unvented attics. The implementation of the revised code provisions for unvented attics involves understanding the requirements and guidelines outlined in the codes and their companion documents.

The research supporting this code change is an outgrowth of the original research conducted under the Department of Energy’s Building America Program. The same technical team and the same technical approach that supported the original code changes for unvented attics in the early 2000s is the basis for this proposed code change.
Additional Resources

Building America Website:
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PDF of the presentation of this webinar available at:
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Additional Resources

Building America Solution Center
https://basc.energy.gov

Code Compliance Brief
• Controlling Moisture in Unvented Attics

Building Science Corporation
• Venting Vapor