Building Science

Unvented Roof Assemblies

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Leaky air handling unit and supply ducts

Supply

Return

Supply

Depressurized conditioned space inducing infiltration

Note: Colored shading depicts the building’s thermal barrier and pressure boundary. The thermal barrier and pressure boundary enclose the conditioned space.
Leaky air handling unit and supply ducts

Air handling unit

Supply

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Depressurized conditioned space inducing infiltration
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Equation [4]

\[ k_{\text{eff}} = 0.138 - 1.010 \rho + 3.233 \rho^2 \]

\[ R^2 = 0.79 \]
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.
Outside

70°F

Dewpoint
(50% RH, 70°F)

Location of condensation and frost

0°F

Exterior sheathing

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

Graph showing temperature in degrees Fahrenheit (°F) across different months. The graph illustrates the potential for condensation and dew point temperatures at 50% R.H., 70°F, 35% R.H., 70°F, and 20% R.H., 70°F. The mean monthly outdoor temperature is indicated with a dashed line.
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

Graph:
- Insulation/sheathing interface temperature (R-7.5 sheathing, R-13 cavity insulation as shown in adjacent drawing)
- Mean monthly outdoor temperature
- Potential for condensation
- Dew point temp. at 35% R.H., 70°F

Temperature (°F)

Month

[Graph showing temperature variations by 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

Inside

Dewpoint
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)  
³⁄₈” sheathing over rigid insulation  
Roof sheathing  
Sealant  
Rigid insulation notched around roof trusses and sealed  
Vinyl or aluminum siding  
Rigid insulation  
Building paper drainage plane  
Underside of roof sheathing is typically the “first” condensing surface  
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
Metal cap
OSB sheathing
Scupper
Sealant
Rigid insulation
OSB
Cavity insulation
Sealant
Polymer modified (PM) or traditional cement stucco
Metal lath
Building paper bond break over drainage plane
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)
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
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

Gypsum board with latex paint (acts as thermal barrier separating occupiable space from non-occupiable space)
OSB/plywood sheathing

Drainage plane

9” to 12” cellulose or spray fiberglass
1” HD spray foam
Gypsum board
2x6 frame wall
4½” cellulose or spray fiberglass
1” HD spray foam
1” HD spray foam
2x6 top chord
OSB/plywood sheathing
Drainage plane

Spray fiberglass; 8” nominal
Gypsum board
2x6 frame wall
4½” cellulose or spray fiberglass
1” HD spray foam
Vented vs. unvented shingle temperatures

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

Number of hourly observations

Temperature (F)

unvented S shingle
vented S shingle
Vented vs. unvented attic air temperatures

Low attic air temperatures
Jacksonville, FL 16-Sep to 18-Nov 2000

Number of hourly observations vs. Temperature (F)

- Blue bars: unvented low attic
- Red bars: vented low attic
Average Temperatures
Vented and Unvented Attics, Aug-97

Temperature (F)

Hour of Day (Aug-97)

- Vented attic air
- Unvented attic air
- Vented roof ply
- Unvented roof ply
- Outside
Hourly Maximum Roof Deck Temperature
LV24 and LV22

Temperature (F)

Hour of Day for August 1997

LV24, BAI — LV22, ref — Outside
Roof Shingle Temperature

FSEC 3.0: Orlando, 1-Aug

All black shingle simulations

All white tile simulations

Hour of Day

Temperature (C)

Temperature (F)
New roofing system

Fully adhered membrane

Roof sheathing

Two layers of rigid insulation (joints staggered and offset)

Fully adhered membrane air barrier

Gypsum sheathing

Fluted metal deck
Step 1
- Remove strip of OSB from each side of ridge

Remove 12" 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

Vapor open membrane sheet sealed to OSB with acrylic caulk sealant

Metal strap nailed over top of vapor open membrane sheet (acting as pressure bar)

Continuous bead of sealant between OSB and vapor open membrane sheet

Step 3
- Construct wood ridge vent with 2x2 furring

1/2" OSB

2x2 furring @ 16" o.c.
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

Unfaced batt insulation

Building paper drainage plane

Gypsum board with vapor semi-permeable (latex) paint
Shingles
Dense glass
gold at ridge
Plywood
Roofing membrane
Plywood
2x2 framing
Two layers
2” stone wool
Cavity insulation
Zip (OSB) sheathing
Two 2x14 microlams
Plywood
2x10’s
Bead of adhesive

18"

Bead of adhesive

Continuous bead of drywall adhesive required here

Clips may also be used

Continuous bead of drywall adhesive required here
Leaky air handling unit and supply ducts

Air handling unit

Supply

Return

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Depressurized conditioned space inducing infiltration

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It’s OK to guess. Call it engineering judgement.
“a reasonable degree of engineering and scientific certainty”
Avoid “wag’s”
It’s OK to guess. Call it engineering judgement.
“a reasonable degree of engineering and scientific certainty”
Avoid “wag’s”
Use “swag’s”
Fan pressurizes roof cavity

Ridge vent sealed

Distribution "manifold"

Gypsum board removed

Rigid insulation added

Soffit vent sealed

Soffit vent sealed
Netted cellulose or netted fiberglass or adhesively-sprayed fiberglass

Kraft-faced or foil-faced fiberglass batts

Top chord extension
Low density spray foam insulation

Asphalt shingles

Roofing paper (1 perm or lower vapor retarder as tested by the wet-cup procedure required in some climates)

Roof sheathing

Raised heel truss

Rigid foam, or comparable, as backdam

Fiber cement siding soffit

Roof underlayement sealed to drip edge

Gypsum board with latex paint (acts as thermal barrier separating occupiable space from non-occupiable space)
Netted cellulose; netted fiberglass; un-faced fiberglass batts; kraft-faced fiberglass batts; foil-faced fiberglass batts; adhesively-sprayed fiberglass

Spray polyurethane foam (SPF)

Rigid insulation block/SPF stop

Asphalt shingles
Roofing paper
Roof sheathing
Drip edge
Fascia
Soffit

Cladding
Building paper
Sheathing

Interior gypsum board
Cavity insulation