Kohta Ueno

Roof and Attics: The Building Science of 'the Lid'

October 2020

Building Science Corporation

Fine Homebuilding summit

OCTOBER 26-29 | Virtual Online Summit

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About BSC

- Massachusetts-based consulting firm
- Founded by Joseph Lstiburek ("Dr. Joe")
- Forensics
- Design reviews
- Construction admin
- https://buildingscience.com/

Forensic Investigations
BSC began its practice and established its reputation in building science by investigating problems related to the durability and performance of buildings. Forensic investigations of performance problems such as mold, rot, decay, odors, uncontrolled humidity, and poor indoor air quality remain a critical part of our practice, especially with the increasing complexity of architectural designs and the continuous development of more advanced (and often more moisture sensitive) building materials.

Building Performance and Enclosure Consulting
BSC provides whole building design assistance in the preliminary design and design development phases as well as detail review and specific system design through the development of the contract documents. During construction we schedule site visits as needed to observe the installation of mock-ups, specific building systems, and any complicated details, as well as to respond to any unanticipated field conditions or design changes.

Commercial Architecture
BSC's work on commercial projects typically begins with either a forensic investigation of a known problem or with a general building enclosure condition survey to determine the areas of the building that may be deteriorating and in need of repair. The field investigation is followed with the development of prioritized repair recommendations, typically outlining several approaches that clients may select depending on their constraints and preferences.

Residential Architecture
As a full service architecture firm with a prodigious understanding of building science, material science, and energy efficiency, BSC takes a multi-disciplinary team approach to design comfortable, durable, healthy, and energy efficient buildings. Our work includes both new construction and retrofit projects that start with schematic design and are taken through construction documents, bidding, permitting, construction administration and post-construction monitoring.

Education and Training
BSC regularly conducts workshops and seminars that cover both fundamental and advanced building science topics. We are frequently invited to present our research in academic and professional conferences across the country. For recent and upcoming seminars and workshops by the BSC team, visit our Events page.

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Outline of Topics

- Vented attics
- Unvented attics
- “Hybrid” Unvented attics
- Unvented attics… without spray foam?!
- SIPS (Structural Insulated Panels)
- Ice Dams
- Buried Ducts in Vented Attics
- ‘Cut and Cobble’ Unvented Roofs
- Truss Uplift

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Vented Attics

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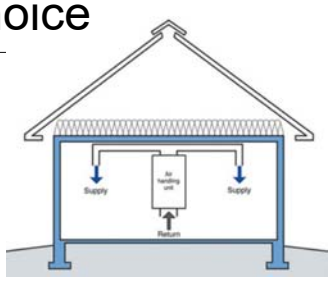
Ventilated Attics—Best Choice

- Rain leaks (bulk water) can be identified from interior
- Roof sheathing dries to ventilated attic-moisture safe
- Interior moisture (air leaks) ventilated away in winter



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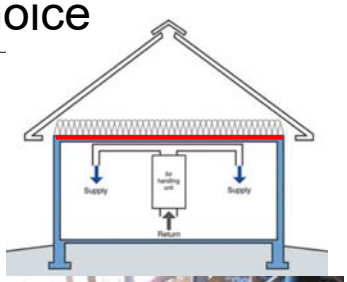
Ventilated Attics—Best Choice

- Rain leaks (bulk water) can be identified from interior
- Roof sheathing dries to ventilated attic-moisture safe
- Interior moisture (air leaks) ventilated away in winter
- Air sealing at ceiling critical for best performance
  - (e.g., spray foam air barrier, detail with sealant)



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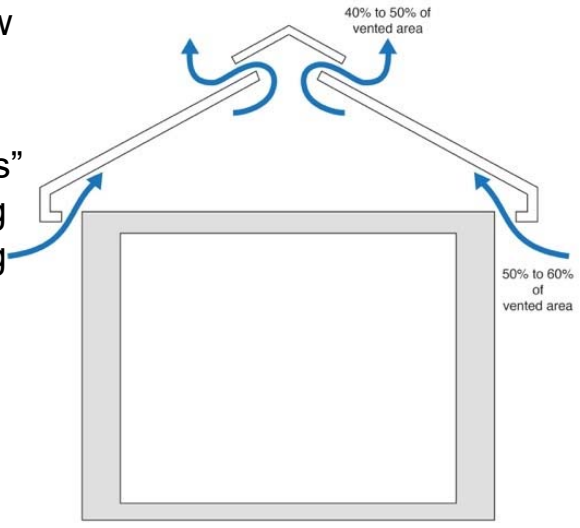
Attic Ventilation: Why?

- Cold Climates (winter):
  - Dilute/ventilate away moisture from interior, avoid condensation
  - Reduction of ice damming ('cold roof' deck)
- Hot Climates:
  - Expels solar heated air—not much cooling effect
  - Adding outside air in summer can add to moisture loads
- 1:150 and 1:300 ventilation ratios
  - 1930's/1940's research—not a very strong case
  - Wet crawl space, balloon frame example
  - But these ventilation ratios basically work

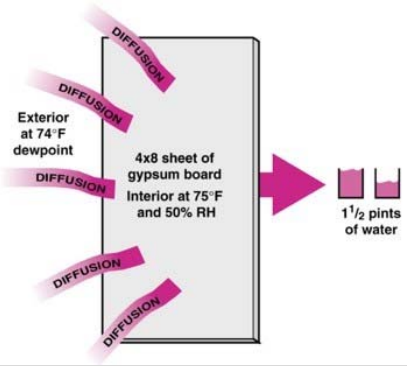
Vented Roof Ventilation Ratios

- "Bias" towards low ventilation (60%/40%)
- "Suck on outdoors" instead of sucking on the attic ceiling



Attic Vapor Barrier (vs. Air Barrier)

- Attic floor air barrier vs. vapor barrier
  - Class I or II only needed in cold climate (CZ 6+)
- Air leakage more important than vapor diffusion (i.e., what a 'vapor barrier' stops)



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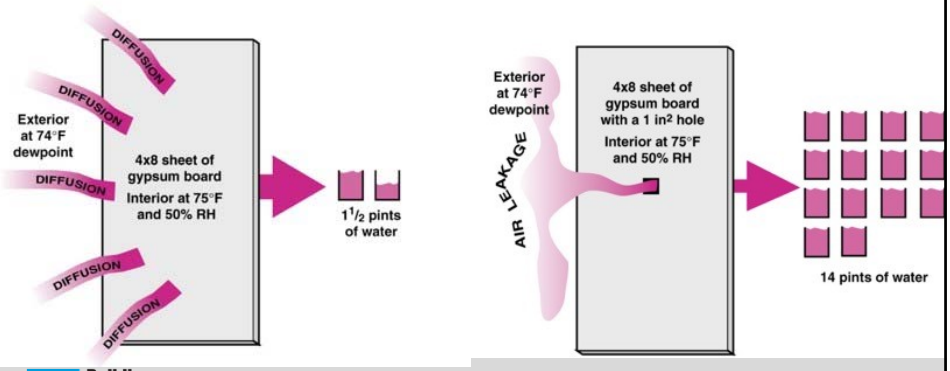
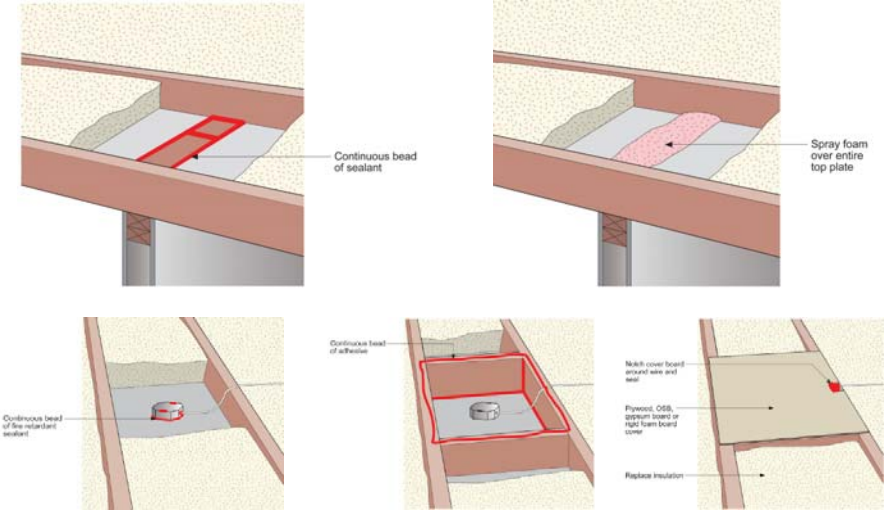


Attic Air Sealing



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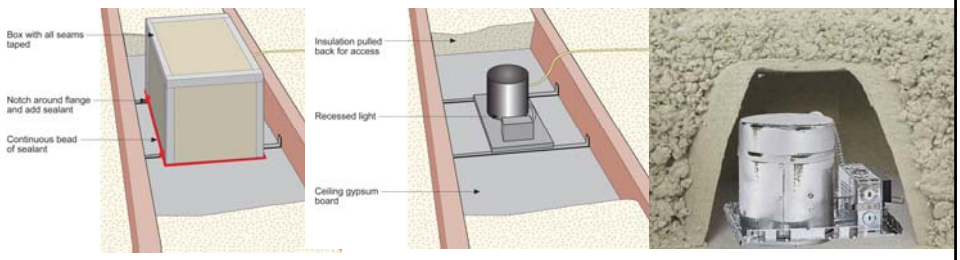
Attic Air Sealing



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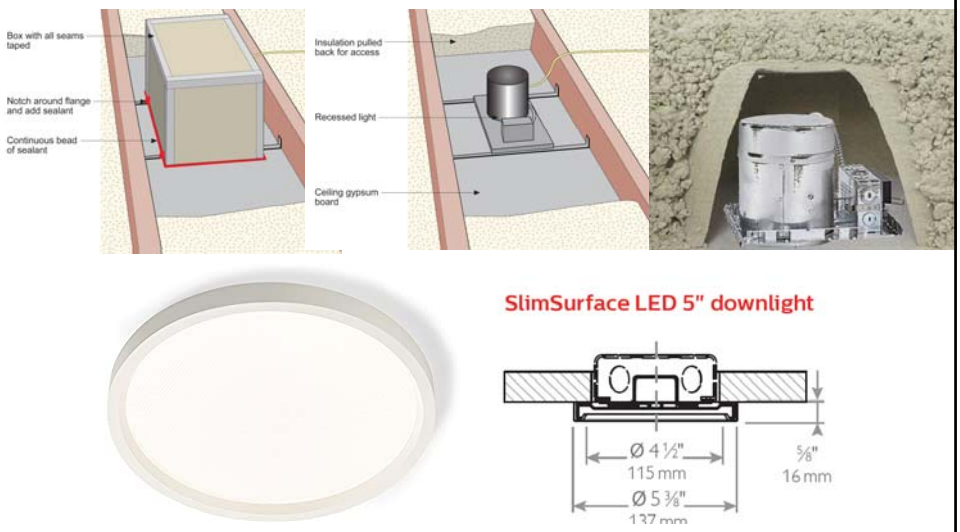
Attic Air Sealing



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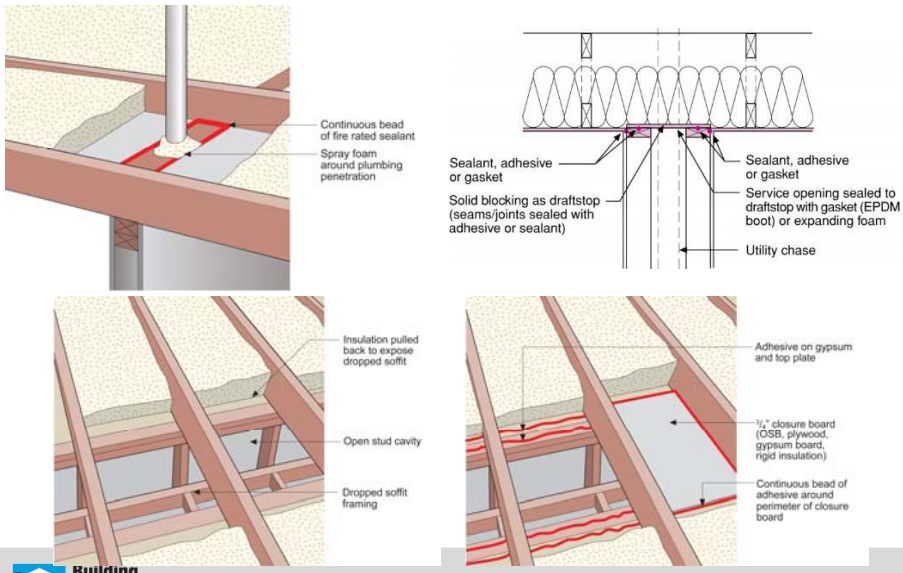
Attic Air Sealing



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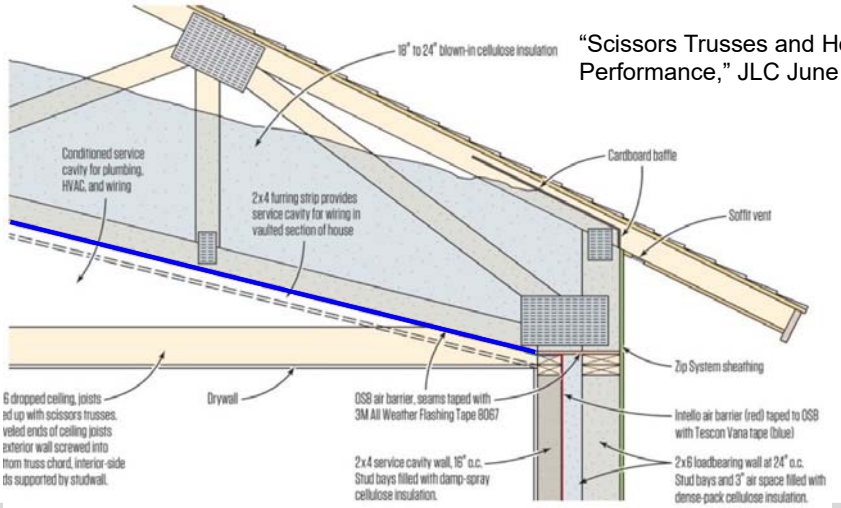
Not Just Flat Ceilings

- Scissor truss with raised energy heel (JLC 2017)



"Scissors Trusses and Home Performance," JLC June 2017

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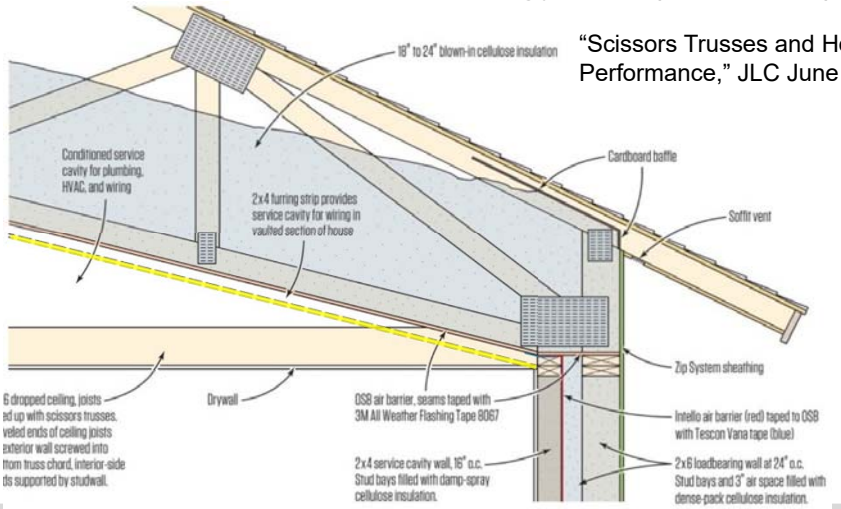

"Scissors Trusses and Home Performance," JLC June 2017

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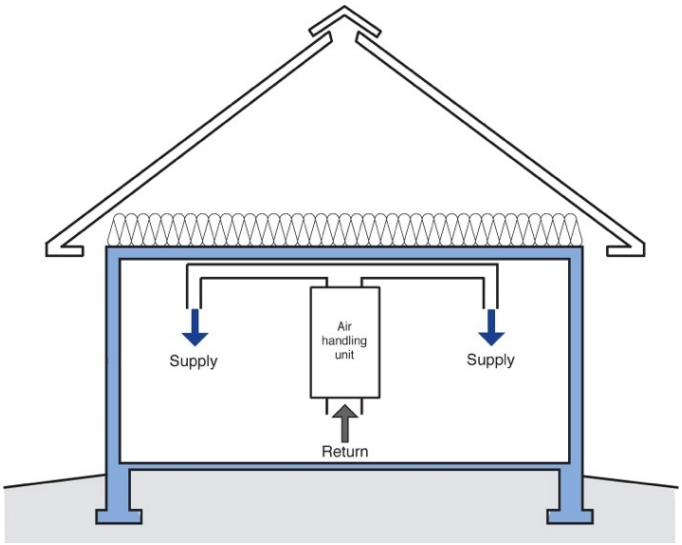
Ductwork in Conditioned Space (Vented)



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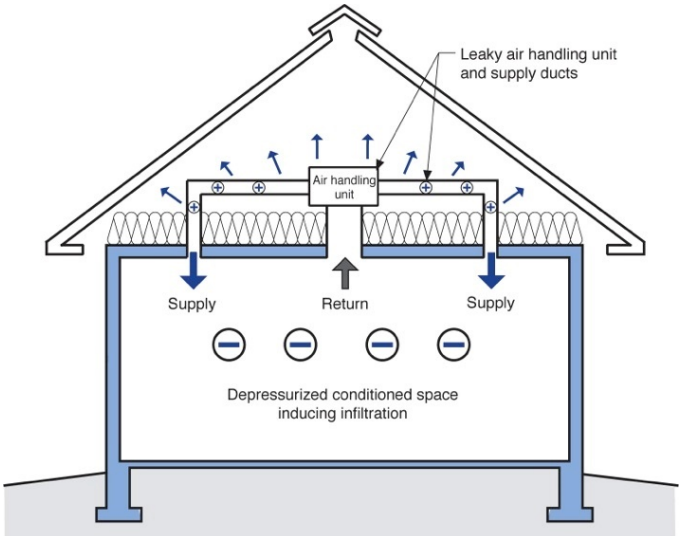
Ductwork in Vented Attic



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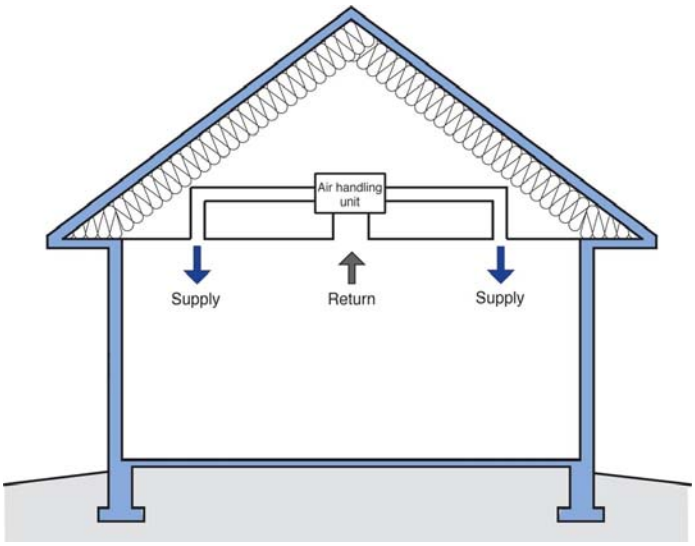
Ductwork in Unvented/Conditioned Attic



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Vented Attic Condensation

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Typical Attic Condensation-Air Leaks


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Typical Attic Condensation-Air Leaks




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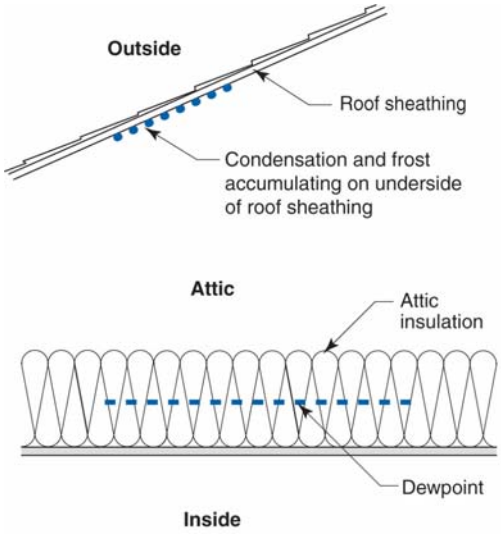
"First Condensation Plane" Frosting



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First Condensation Plane Moisture

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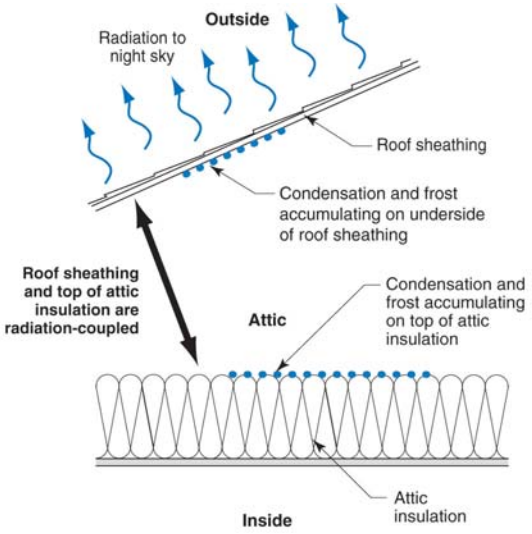
Night Sky Radiation Cooling of Sheathing



Pacific Northwest Research (RDH 2015)

- More projects w. moldy attics not due to air leaks, well ventilated
- Experimental test roofs in Vancouver—grew mold
- Research on fungicide on roof sheathing
- PNW problem?

Relevant Resources

- BSD-102: Understanding Attic Ventilation
  https://www.buildingscience.com/documents/digests/bsd-102-understanding-attic-ventilation
- PA-1101: A Crash Course in Roof Venting
  https://www.buildingscience.com/documents/published-articles/pa-crash-course-in-roof-venting/view
- GM-1001: Attic Air Sealing Guide and Details
  https://www.buildingscience.com/documents/guides-and-manuals/gm-attic-air-sealing-guide/view
- "Early History of Attic Ventilation," William B. Rose
  http://docserver.nrca.net/technical/7877.pdf
- "The Problems With and Solutions for Ventilated Attics" RDH 2015
  https://www.slideshare.net/RDHBuildings/the-problems-with-and-solutions-for-ventilated-attics

Unvented Roofs

So Why Unvented Roofs?

- Living space built into roof
- Vented cathedral assemblies—often poor performance
- Complicated rooflines, hip geometries—how to vent?
- Unworkable air barrier at ceiling line
- Blown-in rain (coastal)
- Hurricane tear-off
- HVAC in vented attic

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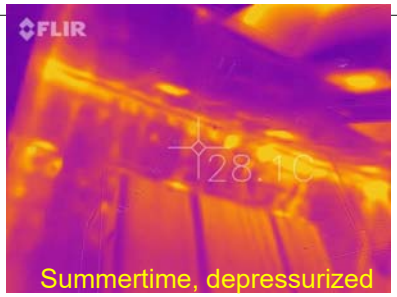
Cathedral Ceilings



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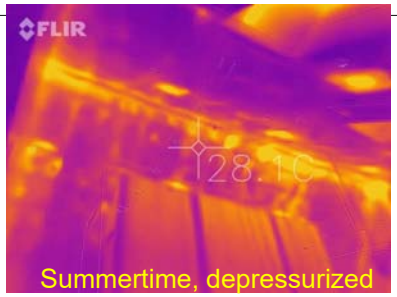
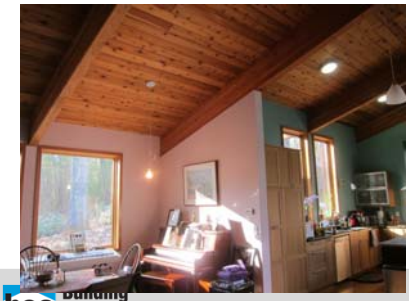
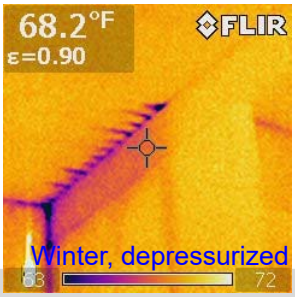
Cathedral Ceilings







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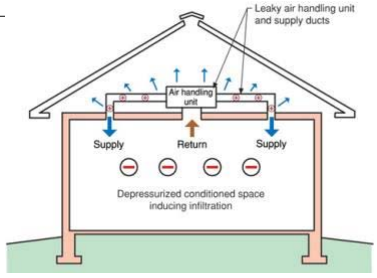
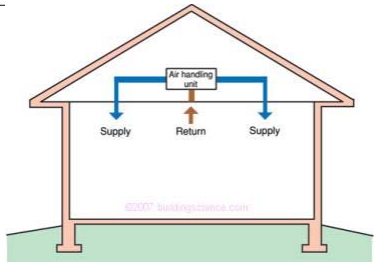
Unvented Roofs & HVAC Placement





- Ducts in unconditioned attic = huge energy losses
  - Industry reluctant to move ducts out of attic
  - Ice dam issues due to duct losses
- Solution: bring ducts into conditioned space
- Unvented/conditioned attic—keeps ductwork in conditioned space, duct leak issues eliminated

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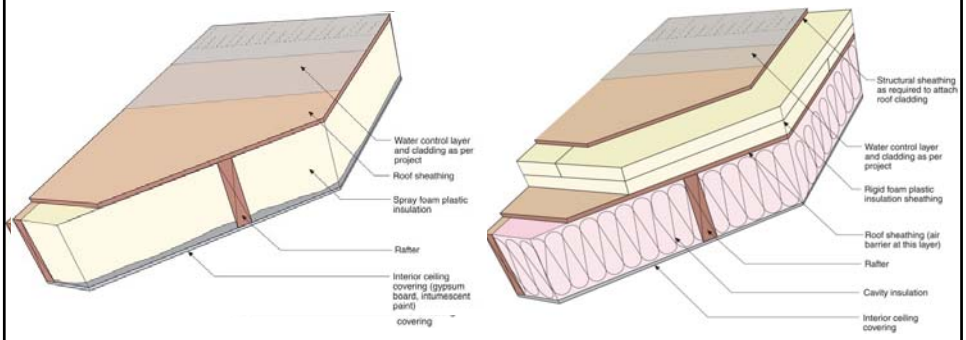
Spray Foam/Exterior Insulation Roofs



- 2009 IRC: R806.4 Unvented attic assemblies
- Minimum R-value of “air impermeable insulation”
  - Actually ratio of R-values (BSI-100 Hybrid Assemblies)
- Nail base needed with rigid foam on roof deck

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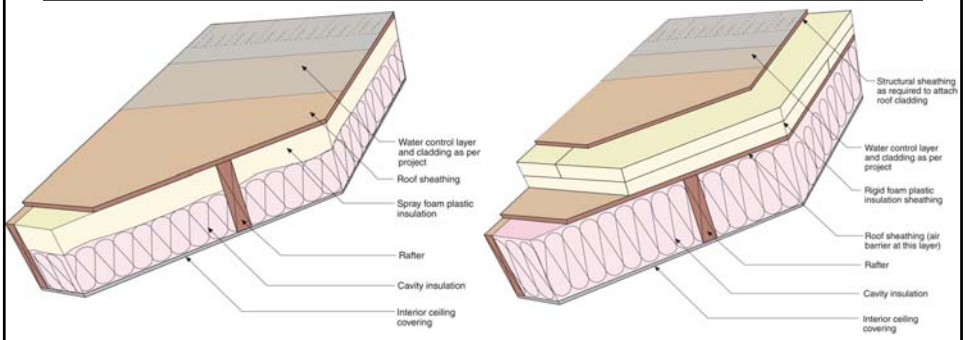
Spray Foam/Exterior Insulation Roofs



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Unvented Hybrid Roofs and Condensation

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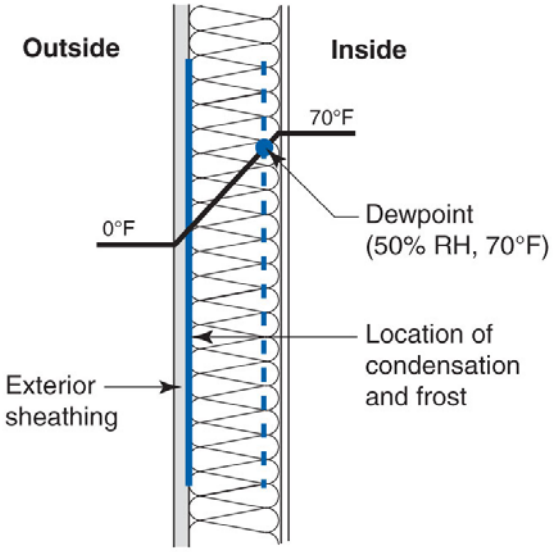
Wintertime Dewpoint Calculations Say…



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But Reality is Different…

- "The dewpoint is inside the wall causing condensation."

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But Reality is Different…

- ~~"The dewpoint is inside the wall causing condensation."~~
- What is the temperature of the condensing surface?

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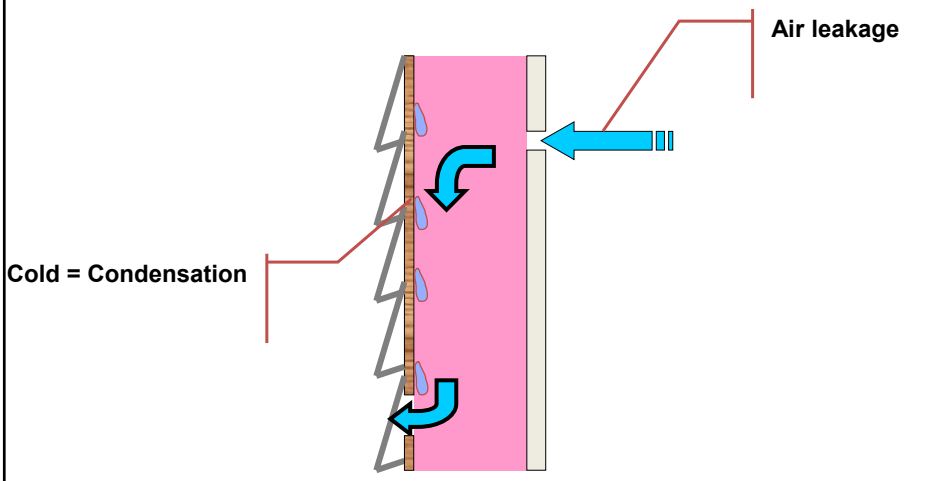
Wall w/o Insulated Sheathing



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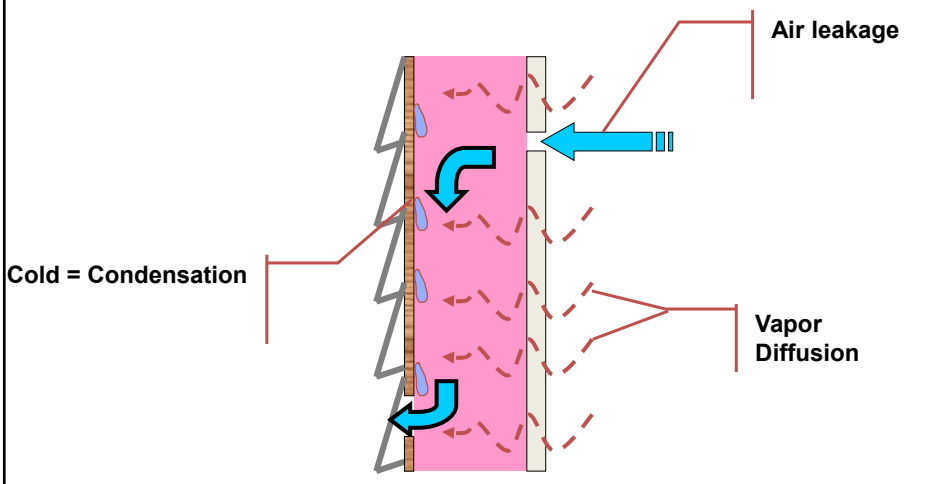
Wall w/o Insulated Sheathing



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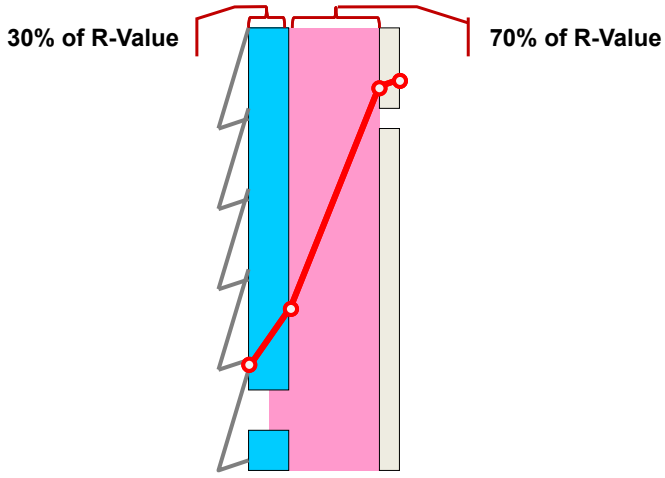
Wall with Insulated Sheathing



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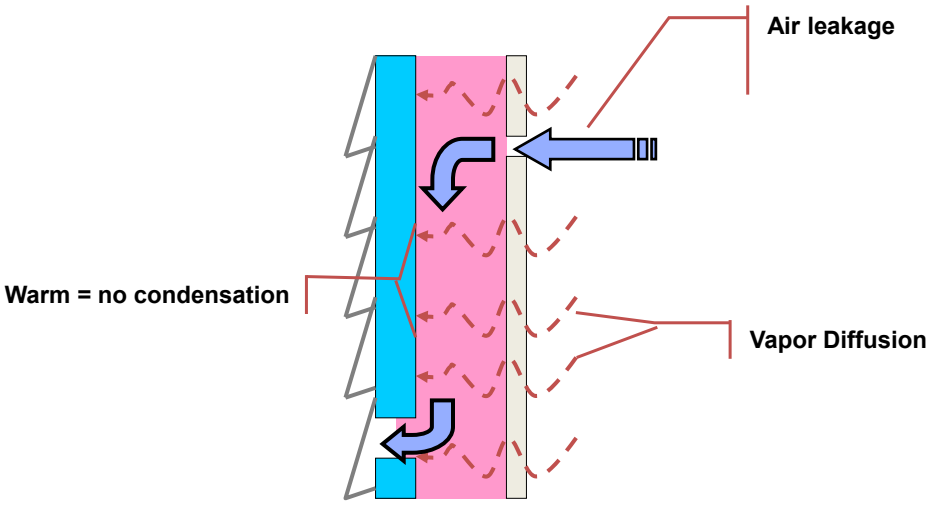
Wall with Insulated Sheathing



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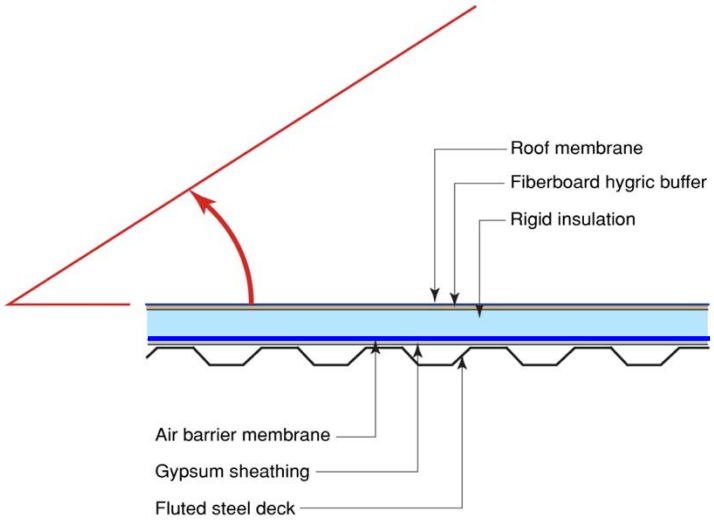
Commercial Low-Slope Roof



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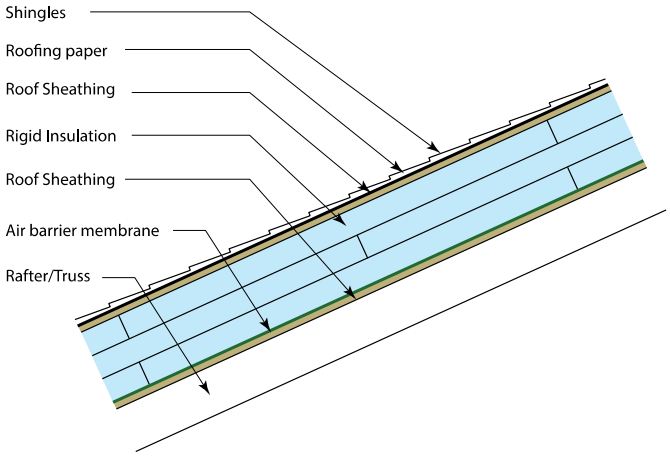
Rigid Exterior Foam Roof



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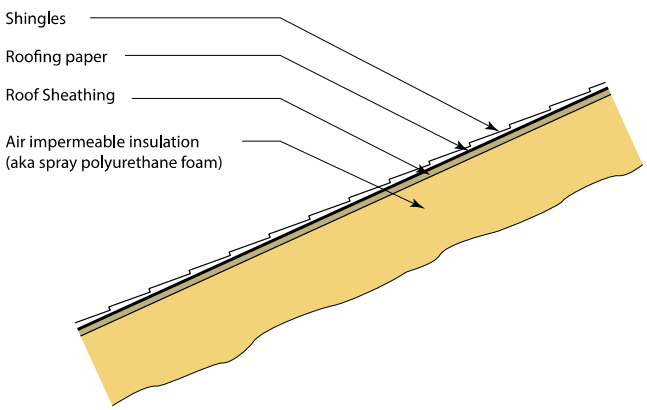
Spray Foam Roofs



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Spray Foam Roofs

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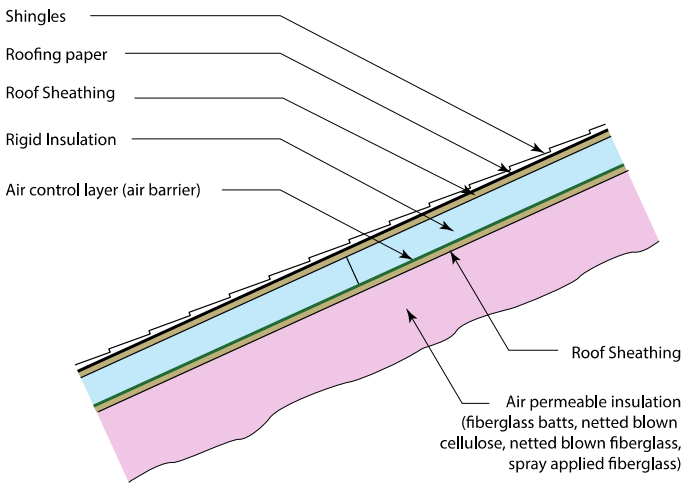
Hybrid Rigid Foam/Air Permeable Roof



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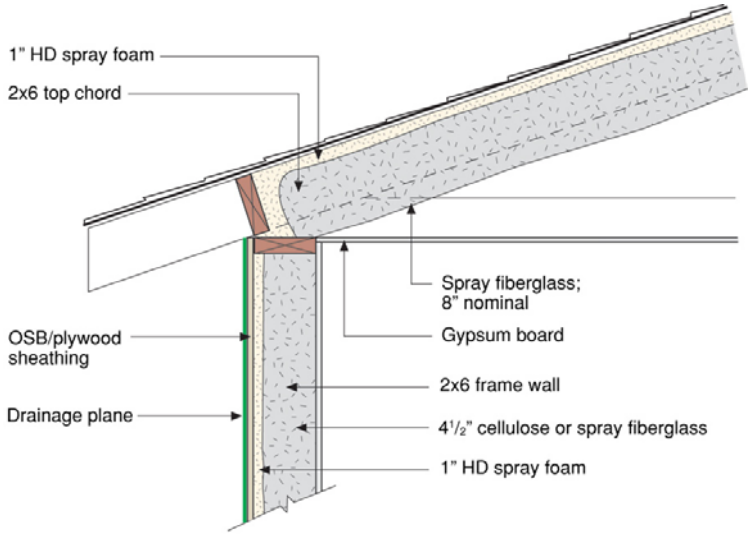
Hybrid Spray Foam/Air Permeable Roof



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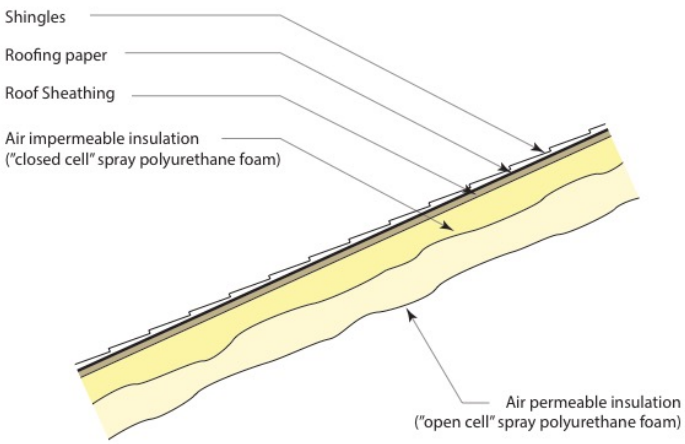
Hybrid Rigid cc Foam/oc Foam Roof



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R806.5 Ratio Requirements

Insulation for Condensation Control*

Climate Zone	Rigid Board or Air Impermeable Insulation	Code Required R-Value	Ratio of Rigid Board Insulation or Air Impermeable R-Value to Total Insulation R-Value
1,2,3	R-5	R-38	10%
4C	R-10	R-49	20%
4A, 4B	R-15	R-49	30%
5	R-20	R-49	40%
6	R-25	R-49	50%
7	R-30	R-49	60%
8	R-35	R-49	70%

*Adapted from Table R 806.5 2015 International Residential Code

Table 1

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8	R-35	R-49	70%

*Adapted from Table R 806.5 2015 International Residential Code

Table 1

5	R-20	R-49	40%

- Climate Zone 5:
  - 40% “air impermeable” (foam) minimum
  - 60% “air permeable” maximum

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Relevant Resources

- GM-0905: IRC FAQ: Conditioned Attics https://www.buildingscience.com/documents/guides-and-manuals/irc-faqs/irc-faq-conditioned-attics
- BA-1312: Application of Spray Foam Insulation Under Plywood and OSB Roof Sheathing https://www.buildingscience.com/documents/bareports/ba-1312-application-of-spray-foam-insulation-under-plywood-and-osb-roof-sheathing/view
- PA-1401: Are You Doing Something Stupid? https://www.buildingscience.com/documents/published-articles/pa-are-you-doing-somethig-stupid/view
- BSI-100: Hybrid Assemblies https://www.buildingscience.com/documents/building-science-insights/bsi-100-hybrid-assemblies
- BSI-049: Confusion About Diffusion https://www.buildingscience.com/documents/insights/bsi-049-confusion-about-diffusion

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Unvented Attic Humidity Problems

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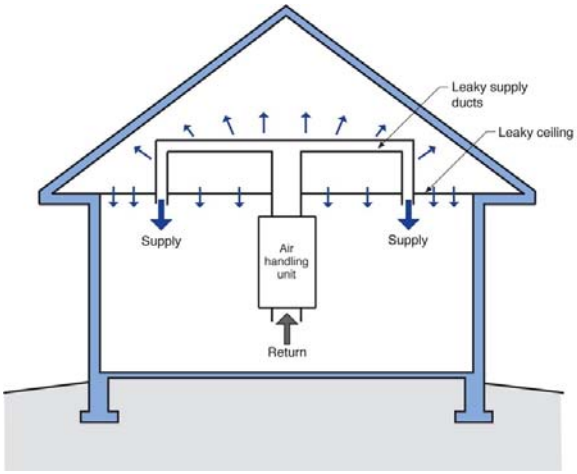
Unvented Attic: That Was Then…

- Inadvertent dehumidification from duct leakage



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Unvented Attic Humidity Problems

- Summertime problem, typically with ocSPF attics
- Modern well-sealed ductwork
- Interior RH gets very high—70%+ RH; attic is highest portion of house
- 'Ping-pong' moisture from roof sheathing, heated and cooled—temperature extremes
- Solutions:
  - Add conditioning @ 50 cfm/1000 ft^2 ceiling area
  - Add dehumidification
  - Use ccSPF or exterior foam—roof sheathing no longer 'moisture connected' to interior conditions or hi/lo T's

Relevant Resources

- BSI-077: Cool Hand Luke Meets Attics
  https://www.buildingscience.com/documents/insights/bsi-077-cool-hand-luke-meets-attics
- BSI-016: Ping Pong Water and The Chemical Engineer
  https://www.buildingscience.com/documents/building-science-insights-newsletters/bsi-016-ping-pong-water-and-chemical-engineer
- High Humidity in Unvented Conditioned Attics: What's going on in these damp attics insulated with open-cell spray foam?
  https://www.greenbuildingadvisor.com/article/high-humidity-in-unvented-conditioned-attics

Fibrous Insulation Unvented Roofs

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Fibrous Insulation Unvented Roofs

- Dense pack insulation of unvented roofs common in cold-climate retrofits
  - Moisture risks (see BSI-043 "Don't Be Dense—Cellulose and Dense-Pack Insulation")—2 in 10 failure?
  - Violates I-codes (see IRC § R806.4/R806.5)
  - "Ridge rot"—localized problems (SIPS same problem)

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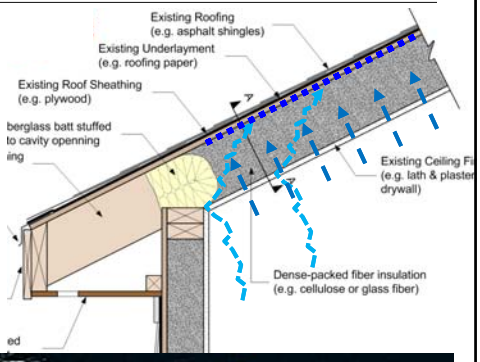
Why Unvented + Fibrous Risky?

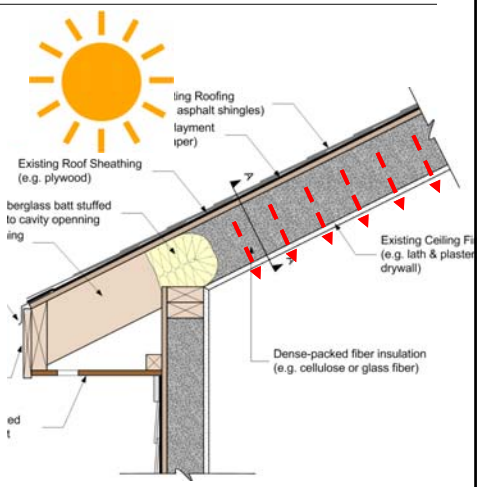
- Different than walls?
- Moisture risks at sheathing
  - Interior-sourced air leakage
  - Vapor contributing too?
  - Zero-perm exterior ("wrong side perfect vapor barrier")
  - Night sky radiation cooling
  - Stack effect in winter
  - "Ridge rot" (thermal and moisture buoyancy)



59

Why Unvented + Loose Fill Risky?

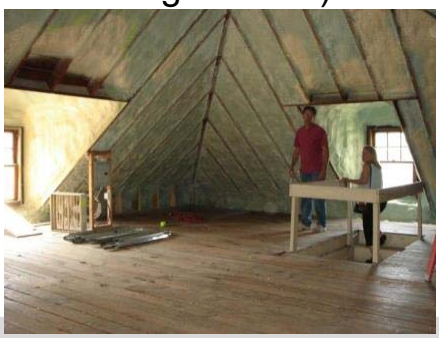
- Risk reduced by:
  - Airtightness of ceiling
  - Dense insulations-less airflow
  - Solar drive
    - But white roofs, shading
  - Lower interior RH (winter)
    - Why many of them work?
  - Lower permeance interior
    - Assumes good airtightness—vapor retarder not bypassed
- Moisture accumulation: what gets in vs. gets out



60

Why Fibrous Fill Unvented Roofs?

- Unvented roofs without spray/board foams could reduce costs and increase market penetration… IF moisture damage risks are addressed
- Retrofit opportunities (existing uninsulated living space at roof line, without removing finishes)



"Ridge Rot" and Moisture Buoyancy

Houston and Jacksonville (CZ 2A) 2001



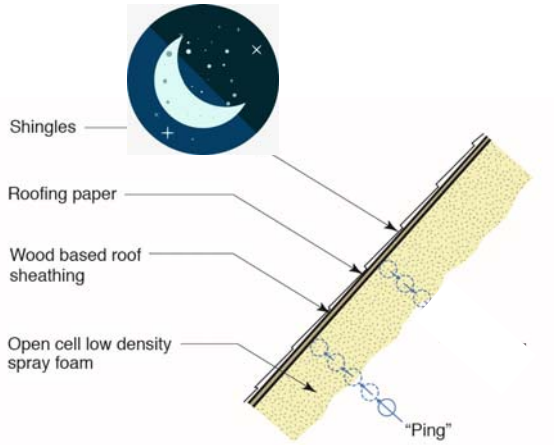

63

Moisture Buoyancy

- Moisture concentrated at highest point in conditioned attic (ridge)
- Not a simple one-dimensional problem
- Not a straight-up air leakage problem
- Problem with open-cell spray foam (ocSPF) unvented roofs (high RHs in attic)-many climates
  - But not ccSPF—lower vapor permeance
- Concentration of interior-sourced moisture
- Moist air is lower density ("lighter") than dry air
- Others: "system in equilibrium has same dewpoint in connected air space"

64

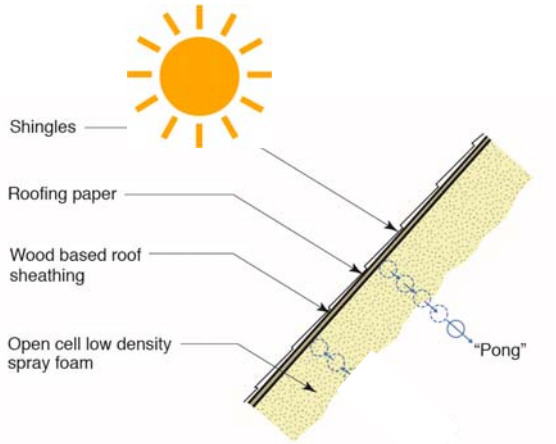
“Ping Pong” Water



- See BSI-016: Ping Pong Water and The Chemical Engineer

65

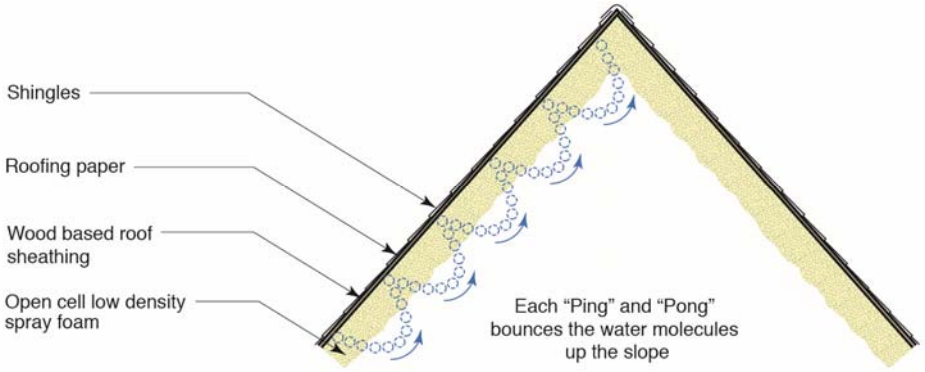
“Ping Pong” Water



- See BSI-016: Ping Pong Water and The Chemical Engineer

66

“Ping Pong” Water



- “Gas separation process similar to pressure swing adsorption”
- Solar-powered moisture concentration machine

Relevant Resources

- BSI-016: Ping Pong Water and The Chemical Engineer https://www.buildingscience.com/documents/building-science-insights-newsletters/bsi-016-ping-pong-water-and-chemical-engineer
- BSI-043: Don't Be Dense—Cellulose and Dense-Pack Insulation https://www.buildingscience.com/documents/insights/bsi-043-dont-be-dense

Previous Building America Research

69

Previous Building America Research

- Chicago (CZ 5A):
  - One winter, 50% RH
  - Unvented roofs-high risk
  - Cellulose lower risk than FG batt
  - Vented compact roof (chute) safe-but poor air leakage

70

Previous Building America Research

- Chicago (CZ 5A):
  - One winter, 50% RH
  - Unvented roofs-high risk
  - Cellulose lower risk than FG batt
  - Vented compact roof (chute) safe-but poor air leakage
- Houston/Orlando (CZ 2A):
  - 2 attics, multiple seasons
  - Diffusion vents allow greater drying, avoid moisture problems

Chicago roof disassembly


Houston roof w. diffusion vent

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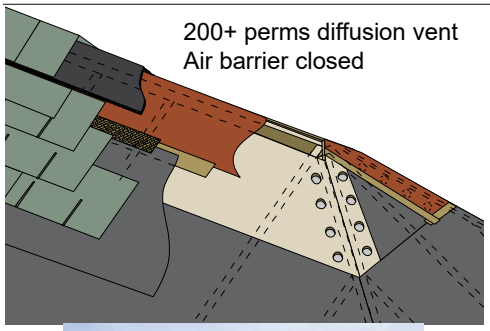
Diffusion Vent Prototype (Houston)



bsc Science Corporation

Fine Homebuilding Summit 2020
The Building Science of 'the Lid'

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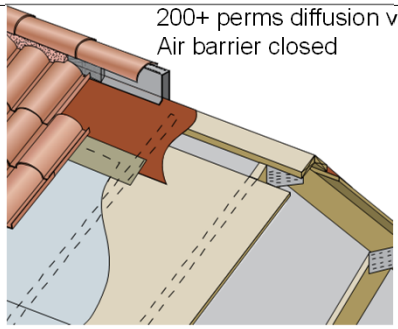
72

Diffusion Vent Prototype (Orlando-Tile)

200+ perms diffusion vent
Air barrier closed



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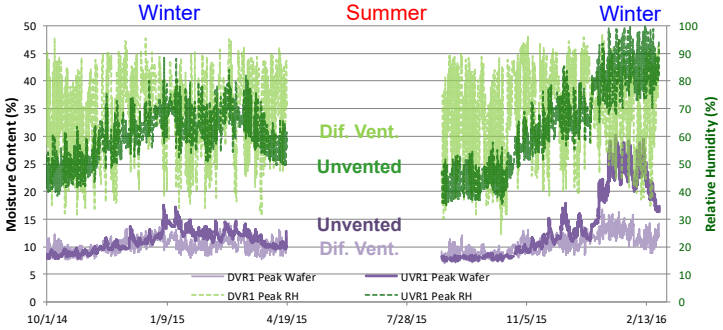
Houston/Orlando Results

- Diffusion vent avoids wintertime ridge accumulation problems (ridge peak RHs/MCs)
- No failures at low interior RH, bigger difference at higher RH (interior humidification)
- Airtightness disappointing in some cases-no SPF
- Unvented + fibrous + DV: in 2018 IRC, CZ 1, 2, 3



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Unvented Roofs w Diffusion Ports in Code

2018 IBC 1202.3/IRC 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
- Insulation installed directly under the roof deck or at the ceiling (attic floor)
- Air supply 50 cfm/1000 ft^2 ceiling area where insulation installed directly under the roof deck
- ***Climate Zones 1, 2 and 3***

Relevant Resources

- BSI-088: Venting Vapor https://www.buildingscience.com/documents/insights/bsi-088-venting-vapor
- BA-1409: Field Testing Unvented Roofs with Asphalt Shingles in Cold and Hot-Humid Climates https://www.buildingscience.com/documents/building-america-reports/ba-1409-field-testing-unvented-roofs-asphalt-shingles-cold-and
- BA-1511: Field Testing of an Unvented Roof with Fibrous Insulation, Tiles, and Vapor Diffusion Venting https://www.buildingscience.com/documents/building-america-reports/ba-1511-field-testing-unvented-roof-fibrous-insulation-tiles-and

Westford Test Hut Experiment

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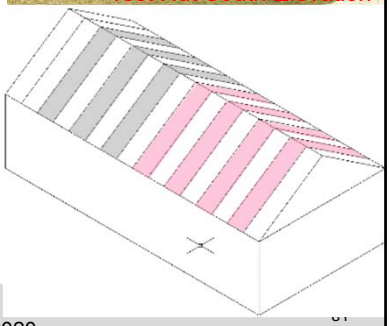
Test Hut Experimental Approach

- Climate Zone 5A test hut
- Eight north-south roof bays; guard bays
- ±R-50 (14-¾" framing, 2012 IECC)
- Test variables (changed year-to-year):
  - Vapor retarder: variable perm vs. fixed perm, various permeance curves
  - Diffusion vent at ridge: full size, none, "small," or "tight"
  - Fiberglass vs. cellulose
  - "Control" comparison § R806.4 spray foam + fibrous
- Varying interior boundary conditions
  - Winter 1: "Normal" interior conditions
  - Winter 2: Elevated RH (50% constant)
  - Winter 3: Air leakage into rafter bays

Test Hut South Elevation



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Diffusion Vent

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Test Hut Construction

- Instrumentation completion

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Test Hut Construction

- Interior air/vapor control installed

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Westford Test Hut Research Findings

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Year 1 Findings (“Normal” Conditions)

- Roofs with diffusion vent & variable-perm vapor retarder safest
- Non-diffusion vent roofs worst; high moisture levels at ridge
- Viitanen mold index values below risk thresholds (3.0 MI); meets ASHRAE Standard 160
- Visible settling of insulation (when cutting new ridge openings from above)
- Summertime inward drive at fixed-perm VR roofs
- Eliminated non-diffusion vent roofs (“small”, “tight”) for following research

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Ridge Retrofits, Insulation Settling

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Ridge Retrofits, Insulation Settling

Cellulose settling along entire roof length only occurred on north side

Roofs left as-is for Winter 2: realistic settling of insulation? Also, damage to instruments when retrofitting insulation

88

Year 2 Findings (50% RH Constant)

- Interior at 50% RH creates much more challenging conditions: many pushing edge of risk
- Many MCs over 20% to 30%, sustained high RH
- Mold Index #s remain below 3.0
- Mold growth occurred on framing & sheathing
- "Tight" diffusion vent did not work acceptably
- Code-compliant ccSPF roof acceptable
- Repacked insulation after disassembly; filling all voids
- Replaced all ridge sensors (data failures)

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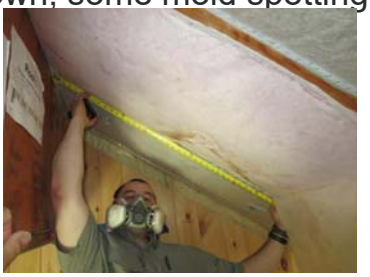
Summer 2 Ridge Disassembly Work

- Fiberglass: staining, rundown, some mold spotting

90

Summer 2 Ridge Disassembly Work

- Cellulose: worst mold, settling (greater at north)

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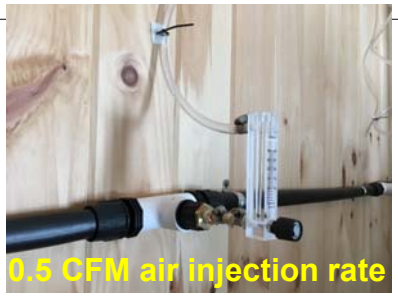
Year 3 Setup & Findings (Air Injection)

- Early winter 50% RH, no air leak
- February onward-add air leak
- Air injection system
  - Interior-to-interior leak
  - Very small air leak, 0.5 CFM per bay
  - Comparable to very airtight construction
- Before air injection: much drier than Year 2
  - Repacking insulation suppresses convection?
- Air injection: severe spike in sheathing MC
  - Localized to injection site
  - Disassembly in summer: no visible damage

Air Injection System



Disassembly

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Westford Test Hut Recommendations

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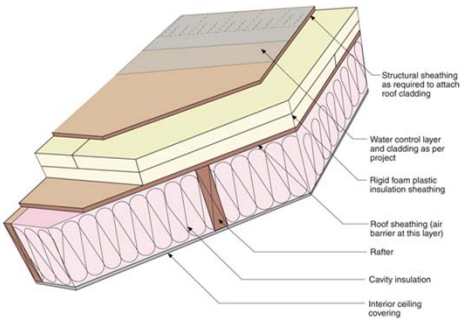
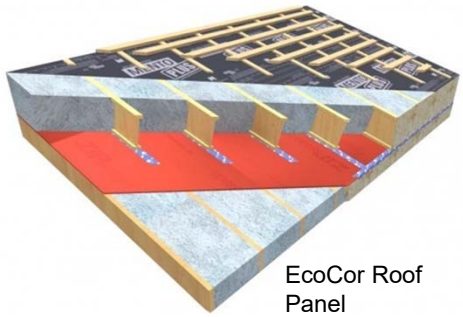
Recommendations and Further Work

- Unvented fibrous insulation roofs **can** work, **BUT**
  - Ensure complete packing of insulation
  - Still vulnerable to small (0.5 CFM) air leaks
- Mold found after Winter 2, despite mold index < 3.0
  - Vulnerability to moisture damage at ridge
- Difficult to recommend for widespread use and acceptance in building codes
  - High indoor RHs more likely w. tighter construction and high occupant density/multifamily
- Retrofit solution for failing assemblies?
  - Demolition + spray foam not possible?
  - No place in code to allow

Recommendations and Further Work

- Foam-free unvented roof options
  - Fibrous + continuous exterior insulation outside air barrier, per § R806.5
  - Ventilated cavity outboard of vapor-permeable air/water control membrane





EcoCor Roof Panel

Recommendations and Further Work

- If implementing unvented fibrous insulation roofs
  - Keep interior RH low for life of building
  - Airtightness of interior air/vapor control layer
  - Variable-perm vapor retarder (allows downward drying)
  - Large 300 perm diffusion vent recommended
  - Fibrous insulation without voids or empty cavities
  - Light colored roofs & shading increase risks
- Future work?
  - Moisture risks demonstrated; not sure if additional research useful
  - "Story and a Half Geometry" (Cape Cod short slope)

98

Relevant Resources

- BA-2001: Monitoring of Unvented Roofs with Fibrous Insulation, Diffusion Vents, and Interior Vapor Control in a Cold Climate https://www.buildingscience.com/documents/building-america-reports/ba-2001-monitoring-unvented-roofs-fibrous-insulation-diffusion
- NESEA Building Energy Boston, August 12, 2020 https://www.buildingscience.com/sites/default/files/2020-08-14_nesea_be18_ueno_unvented_roofs_for_pdf.pdf

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SIPS Roofs

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Juneau AK SIPS Failures

- ~8600 HDD, Climate Zone 7

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Juneau AK SIPS Failures

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Juneau AK SIPS Failures

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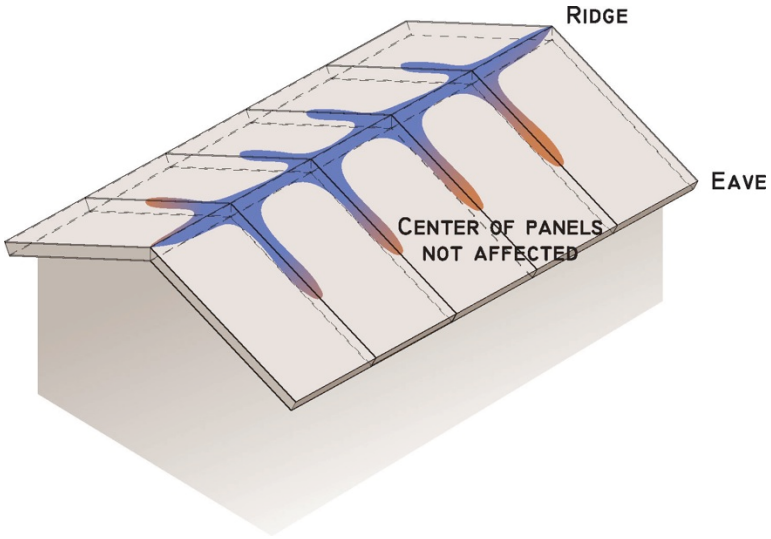
SIPS "Ridge Rot" Patterns



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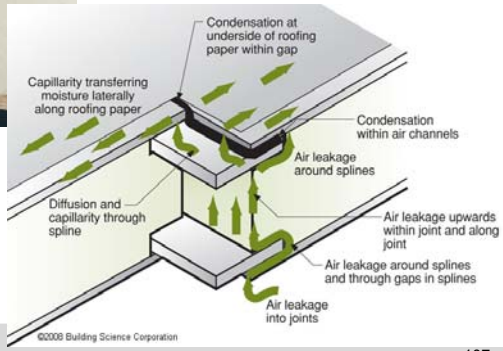
SIPS Spline Joints (Field Sealed)



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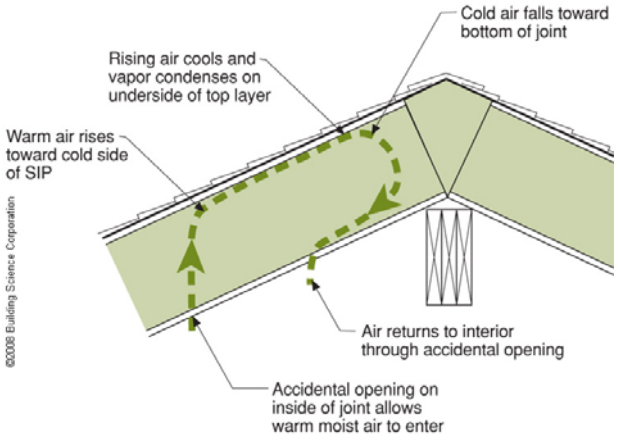
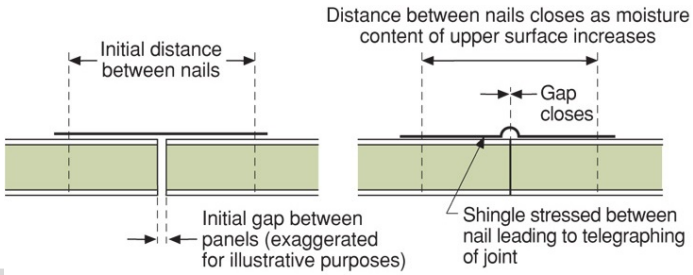
SIPS Interior-to-Interior Air Leak

- Can pass a blower door test, but…



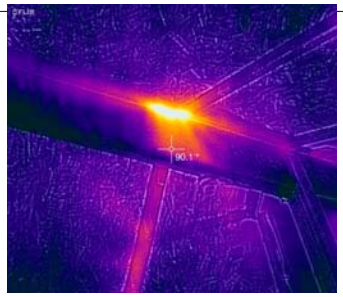
108

SIPS Shingle Ridging



109

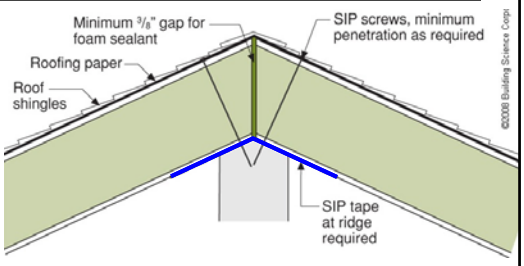
SIPS Air Leakage Testing



110

SIPS Solutions

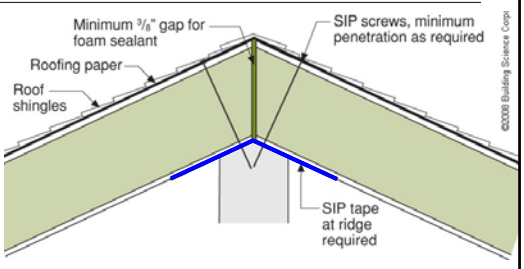
- New construction: tape over beams/ purlins for robust & inspectable air seal between panels

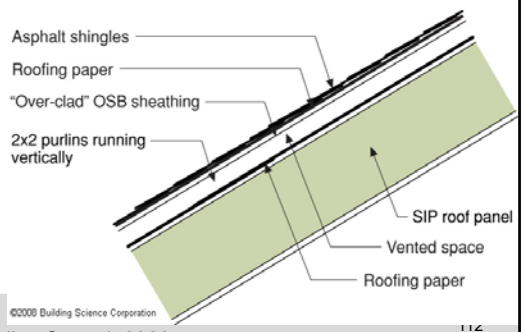


111

SIPS Solutions

- New construction: tape over beams/ purlins for robust & inspectable air seal between panels
- Retrofit: vented over-roof with permeable underlayment to allow drying. Reduces ice dam risks





112

Relevant Resources

- BSI-036: Complex Three Dimensional Airflow Networks https://www.buildingscience.com/documents/insights/bsi-036-complex-three-dimensional-air-flow-networks
- Builder's Guide to Structural Insulated Panels (SIPs) https://www.buildingscience.com/files/builders-guide-structural-insulated-panels-sips

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Ice Dams

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Ice Dams

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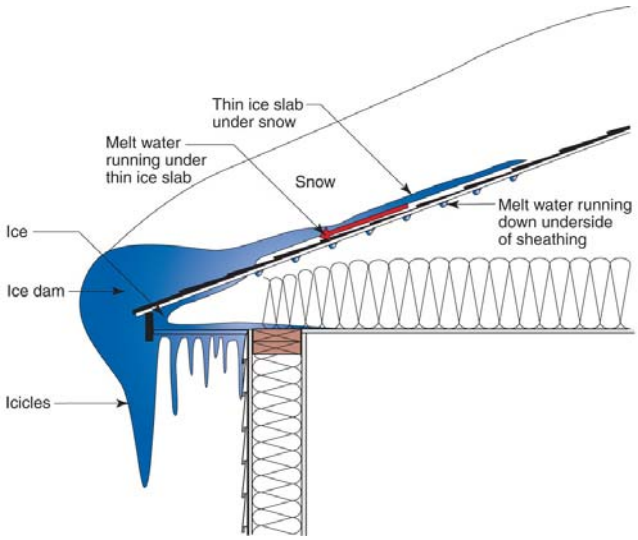
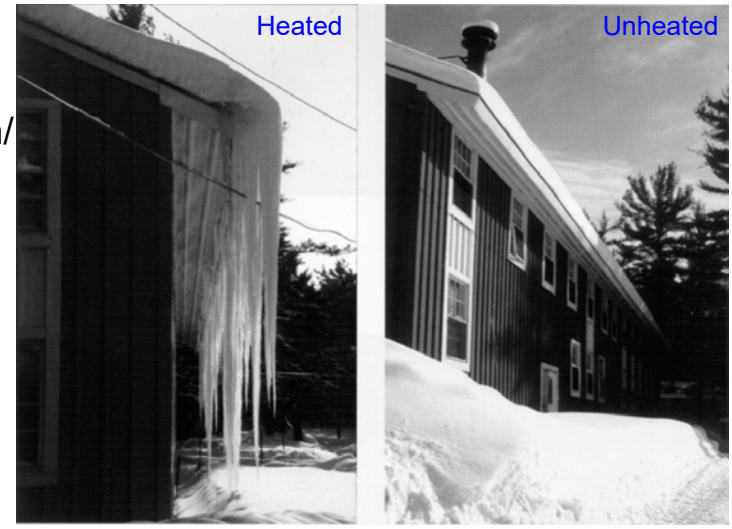
Ice Dam Mechanisms



116

Heated vs. Unheated Buildings

- Upstate NY
- Tobiasson/ CRREL



117

Ice Dam Solutions: Edge Metal

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Ice Dam Solutions: Heat Tape, Membrane

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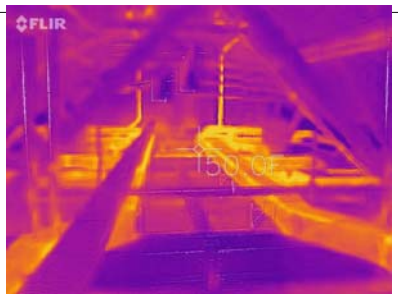
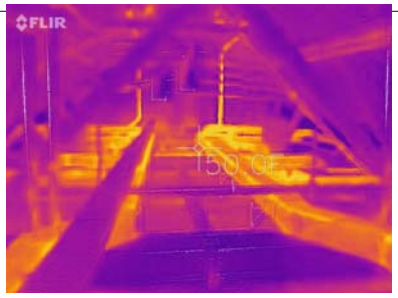
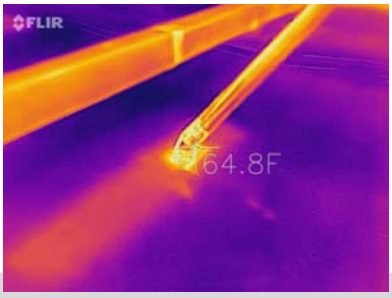
Ice Dams: Control Heat from Interior



120

Ice Dams: Control Heat from Interior





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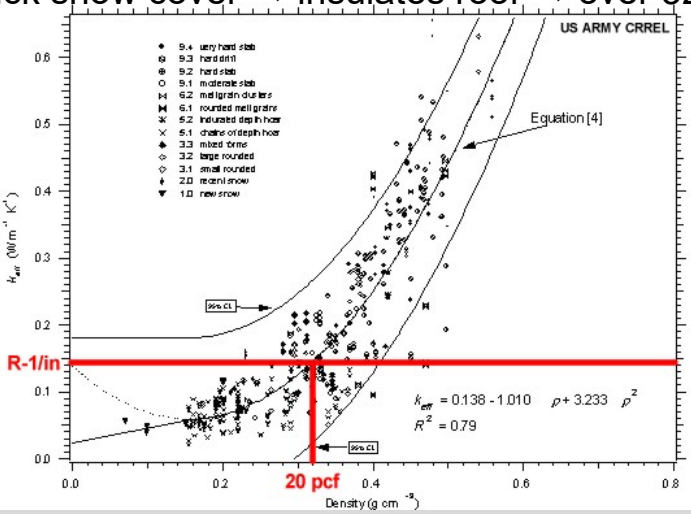
Unvented Roof Ice Damming

- Unvented roofs typically control ice dams
- Problems occur with high snow loads

122

Snow R-Value ~R-1 per inch

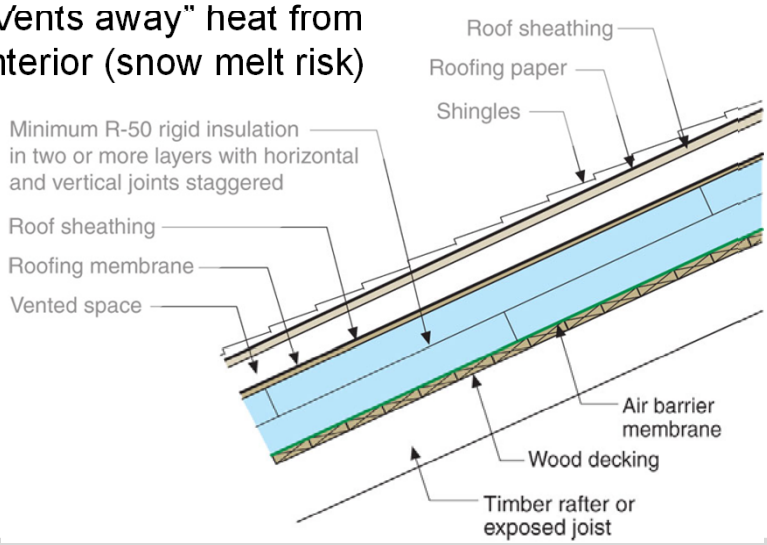
- Thick snow cover → insulates roof → over 32° F



123

Vented 'Over Roof' at Unvented Roof

- "Vents away" heat from interior (snow melt risk)



124

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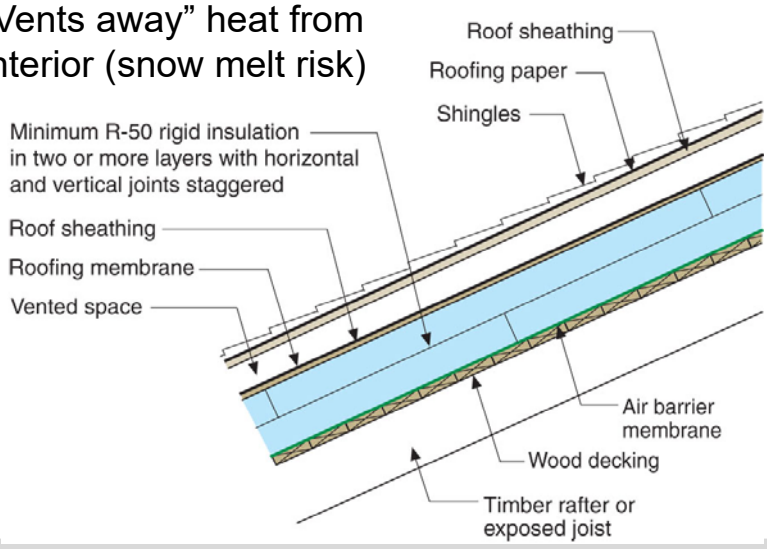
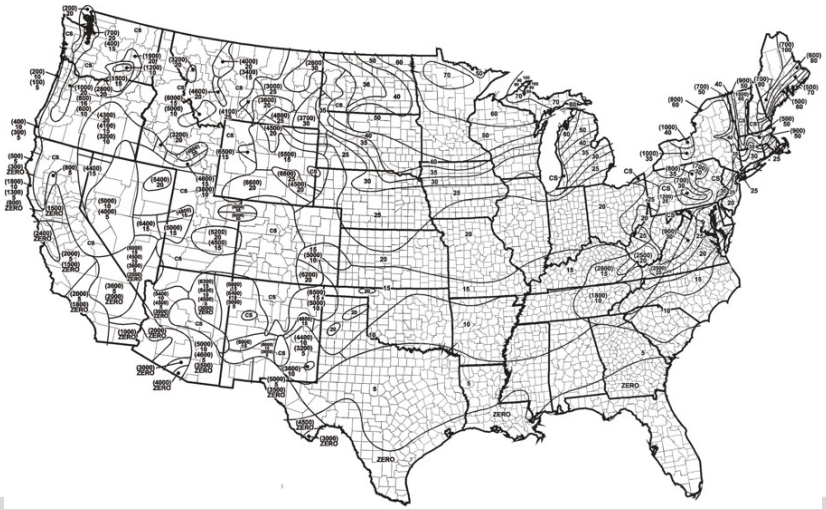


125

Ground Snow Load Map

- Ground snow load 60 lbs./ft^2 → vented over roof



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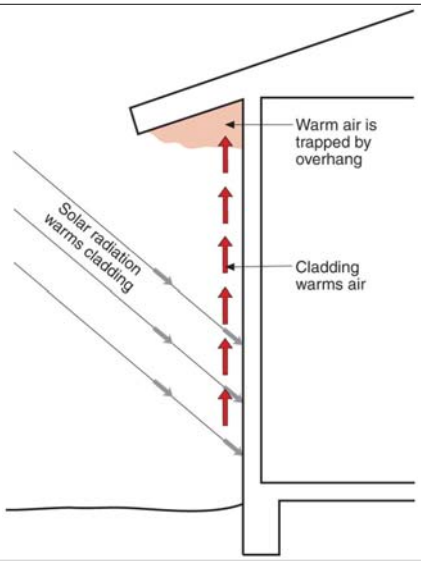
Snow Country Solar "Plume"



127

South-Facing Overhang Thermal 'Plume'

- "Captures" heat rising off sunlit wall, melts snow

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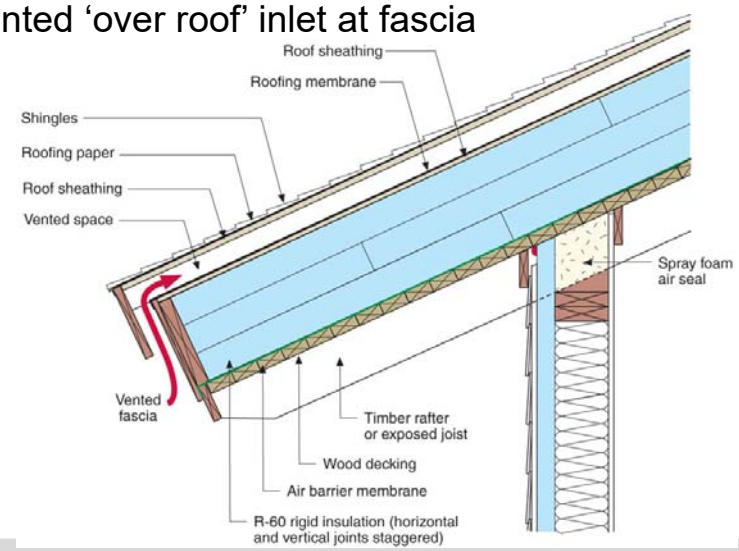
Insulated Overhang (Snow Country)

- Vented 'over roof' inlet at fascia



129

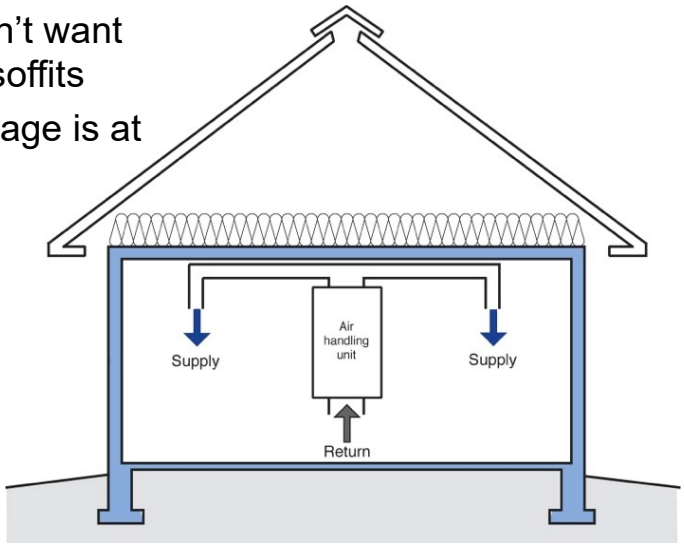
Relevant Resources

- BSI-046: Dam Ice Dam
  https://www.buildingscience.com/documents/insights/bsi-046-dam-ice-dam
- BSD-135: Ice Dams
  https://www.buildingscience.com/documents/digests/bsd-135-ice-dams
- BSI-097: De-Icing Ice Dams
  https://www.buildingscience.com/documents/building-science-insights/bsi-097-de-icing-ice-dams

Buried Ducts in Attics

Ductwork in Conditioned Space (Vented)

- Builders don't want bulkheads/soffits
- Square footage is at premium



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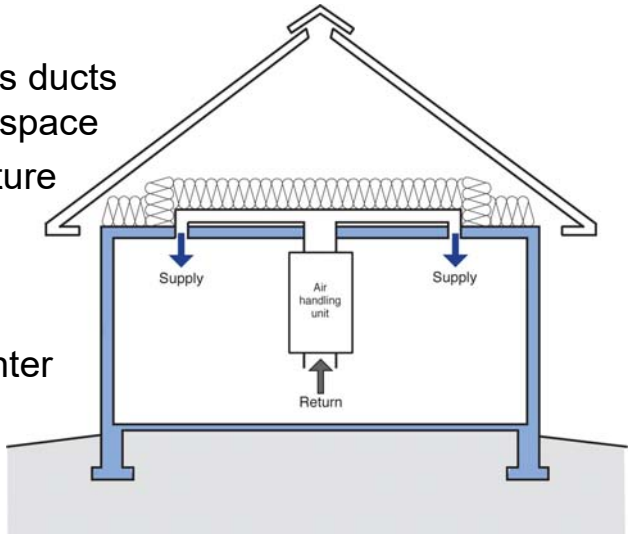
Ductwork in Conditioned Space (Vented)

- Builders don't want bulkheads/soffits
- 'Pre-rock' step (similar to commercial construction)

133

Buried Ducts in Vented Attic

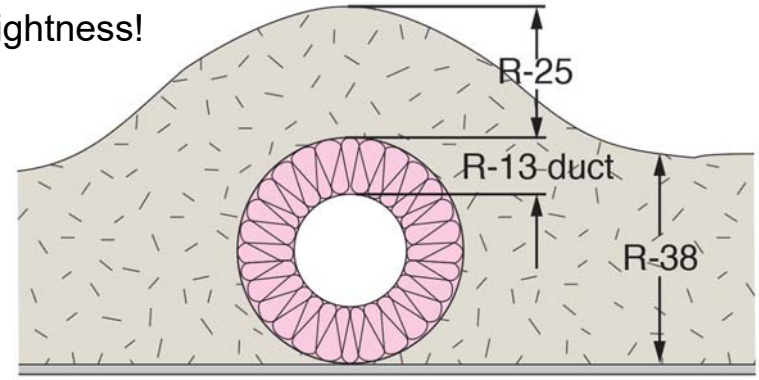
- Almost same performance as ducts in conditioned space
- Potential moisture risks
- Steven Winter, CARB, NAHB Innovation Center research



Vented Attic Ductwork Sweating

Buried Ductwork Under Insulation

- Climate Zones 1A, 2A, 3A and 4A: R-13 'wrap' (hot and humid climates)
- All other CZs: R-8 wrap
- Duct tightness!



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ccSPF to create R-13 Ductwork

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Relevant Resources

- BSI-094: No Sweat
  https://www.buildingscience.com/documents/building-science-insights-newsletters/bsi-094-no-sweat

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Cut & Cobble Unvented Roof (Diffusion Vent)

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Cut & Cobble Roof, Central MA




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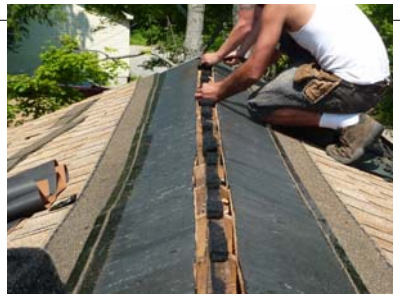
Diffusion Vent Retrofit

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Monitoring Results

- Not ideal experiment (with & w/o DV comparison)
  - (Trying to fix friends' houses, not rot them)
- Still worrying high wood MCs ~30% peaks
- But disassembly—no damage
- Peaks occur in spring (May), not winter—???
- What goes in vs. what comes out
  - In via air leakage/out via vapor diffusion → hard
  - Airtightness was ~6 ACH 50; air leaks to roof evident
  - Trapped moisture—foil-faced polyiso below?
- Still OK-no condensation/dripping

Relevant Resources

- Cut-and-Cobble Insulation: Does it ever make sense to cut rigid foam into strips and insert the strips between your studs or rafters? https://www.greenbuildingadvisor.com/article/cut-and-cobble-insulation

Questions?

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Presentation will be available at:
https://buildingscience.com/past-events