

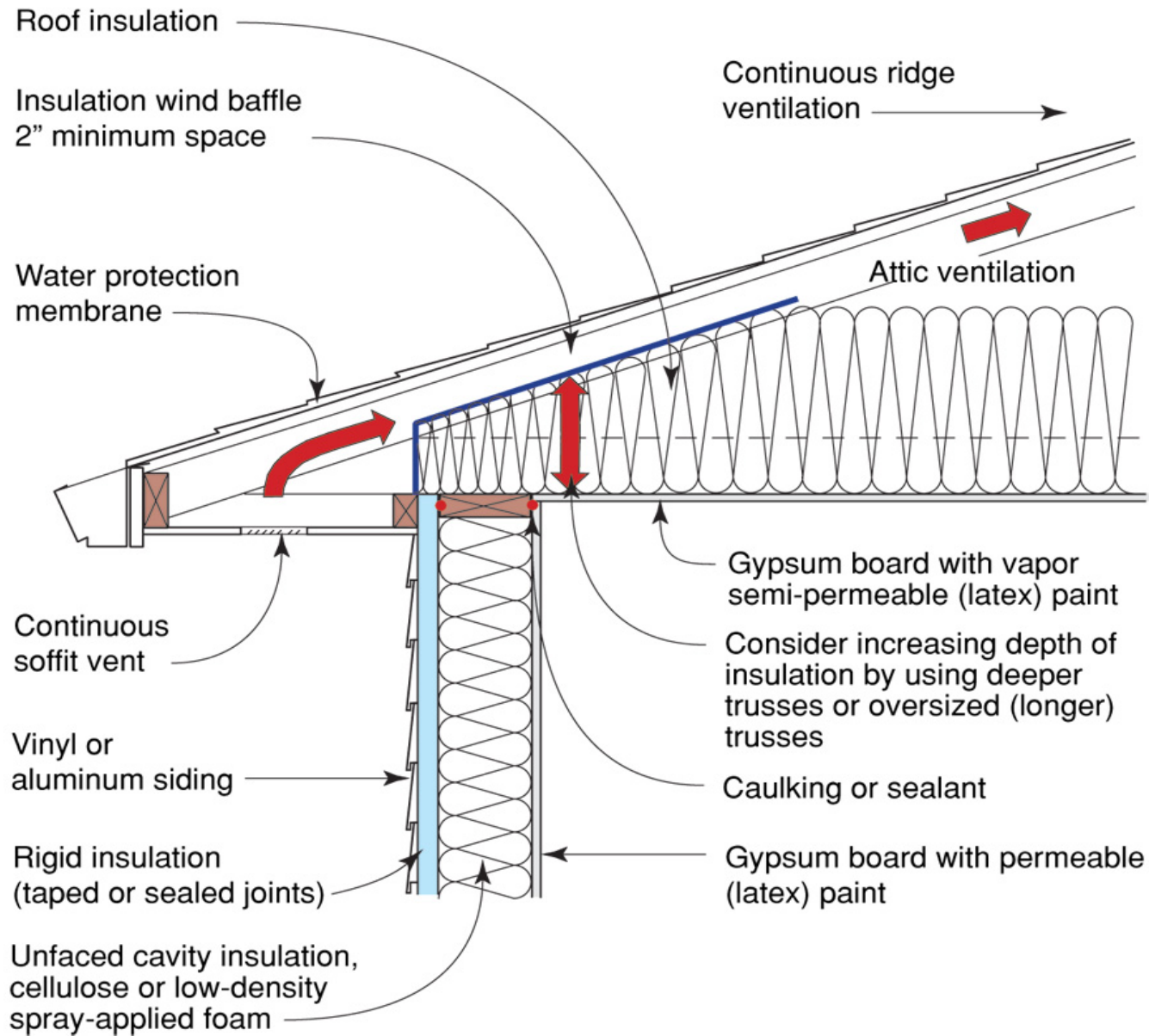
Joseph Lstiburek, Ph.D., P.Eng, ASHRAE Fellow

Building Science

Adventures In Building Science

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Ventilation In Attics



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

Moisture Flow Is From Warm To Cold
Moisture Flow Is From More To Less

Moisture Flow Is From Warm To Cold
Moisture Flow Is From More To Less

Thermal Gradient – Thermal Diffusion
Concentration Gradient – Molecular Diffusion

Moisture Flow Is From Warm To Cold
Moisture Flow Is From More To Less

Thermal Gradient – Thermal Diffusion
Concentration Gradient – Molecular Diffusion

Vapor Diffusion

Thermodynamic Potential



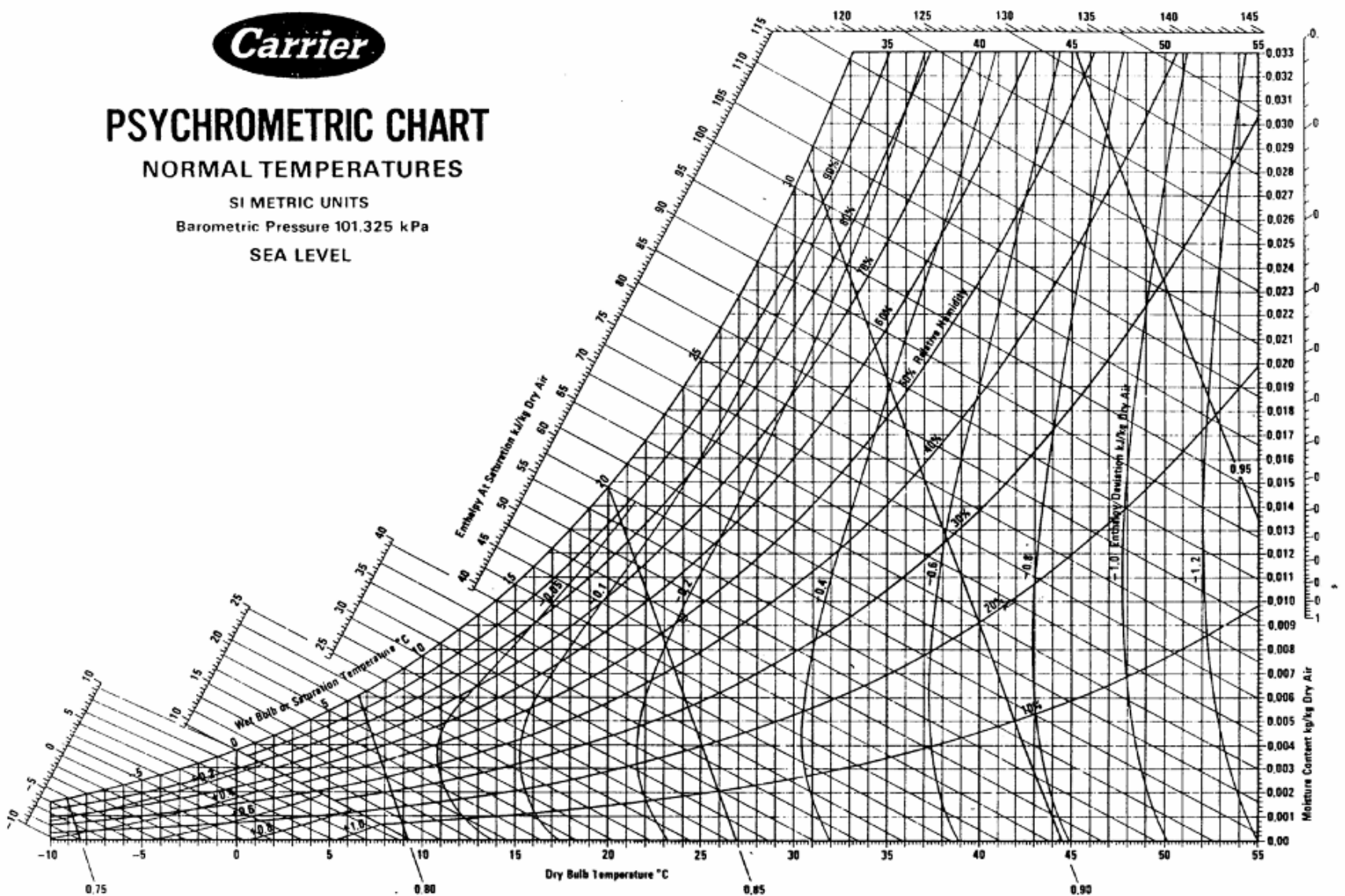
PSYCHROMETRIC CHART

NORMAL TEMPERATURES

SI METRIC UNITS

Barometric Pressure 101.325 kPa

SEA LEVEL



Below 0°C Properties and Enthalpy Deviation Lines Are For Ice

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Most of the time the water ends up on the cold spot...Duh...

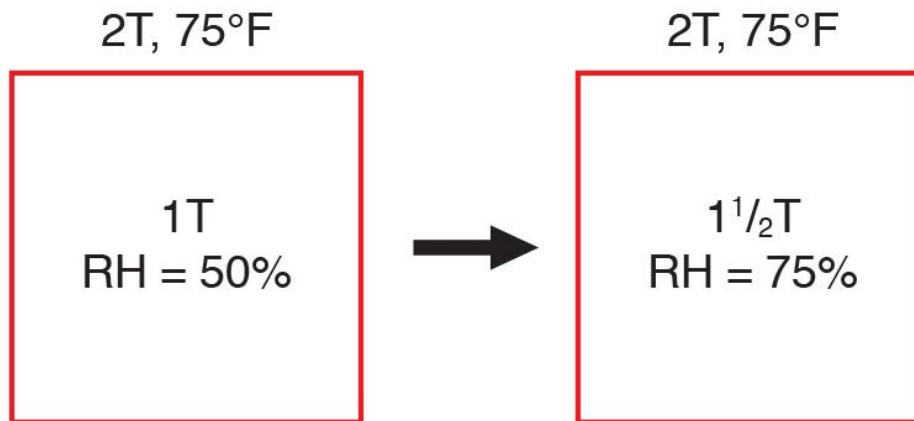
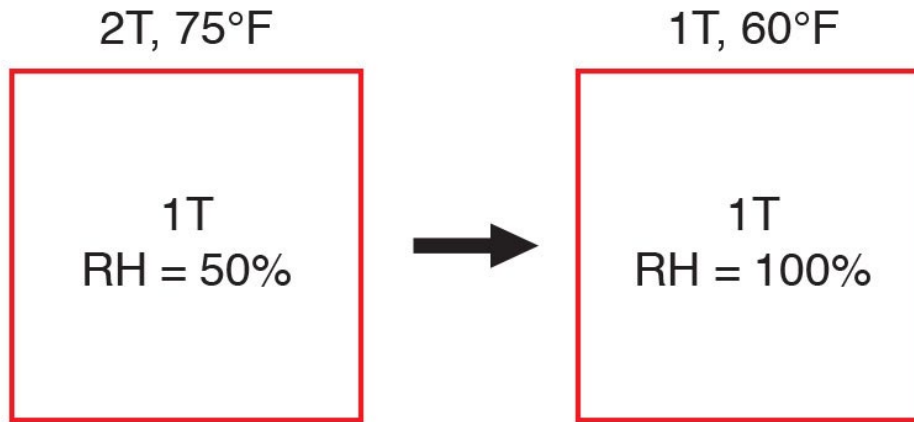


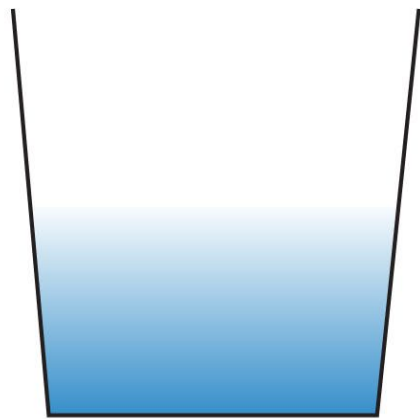




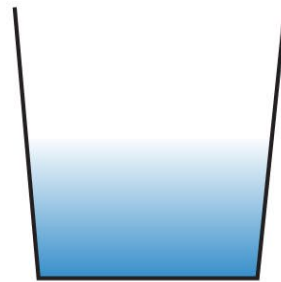


Relative Humidity Vapor Pressure

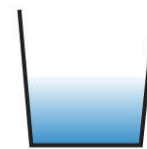




90°F
50% RH



75°F
50% RH



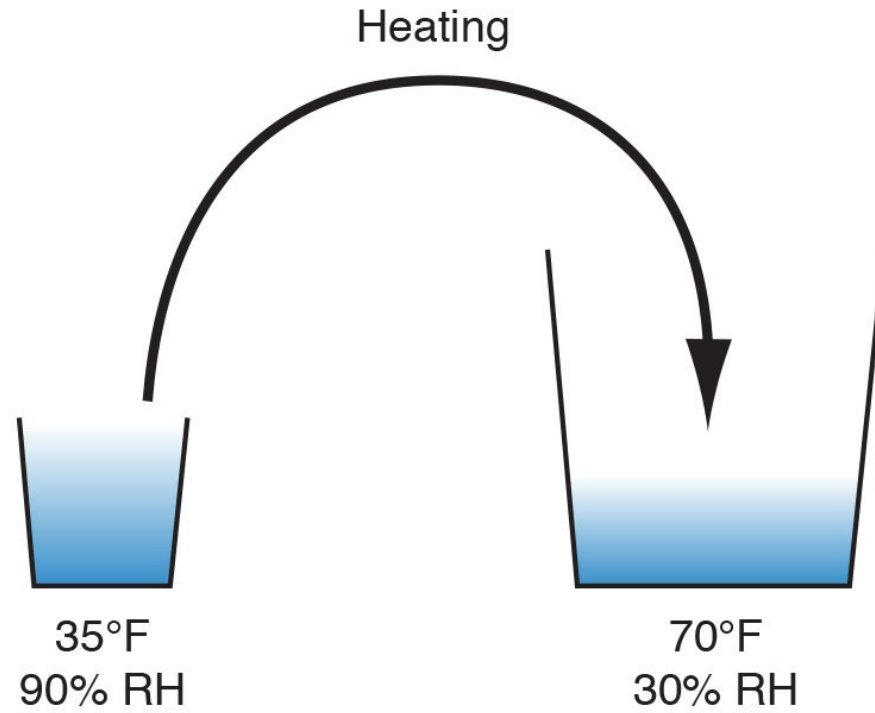
60°F
50% RH

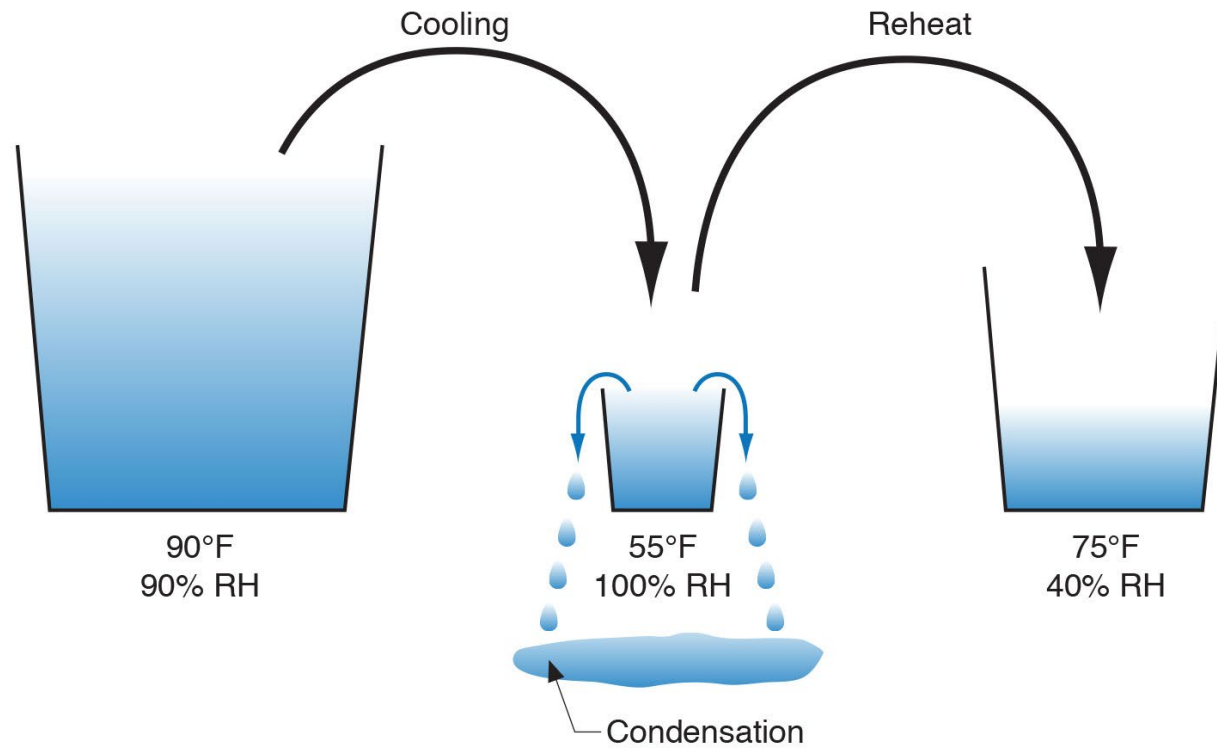


45°F
50% RH

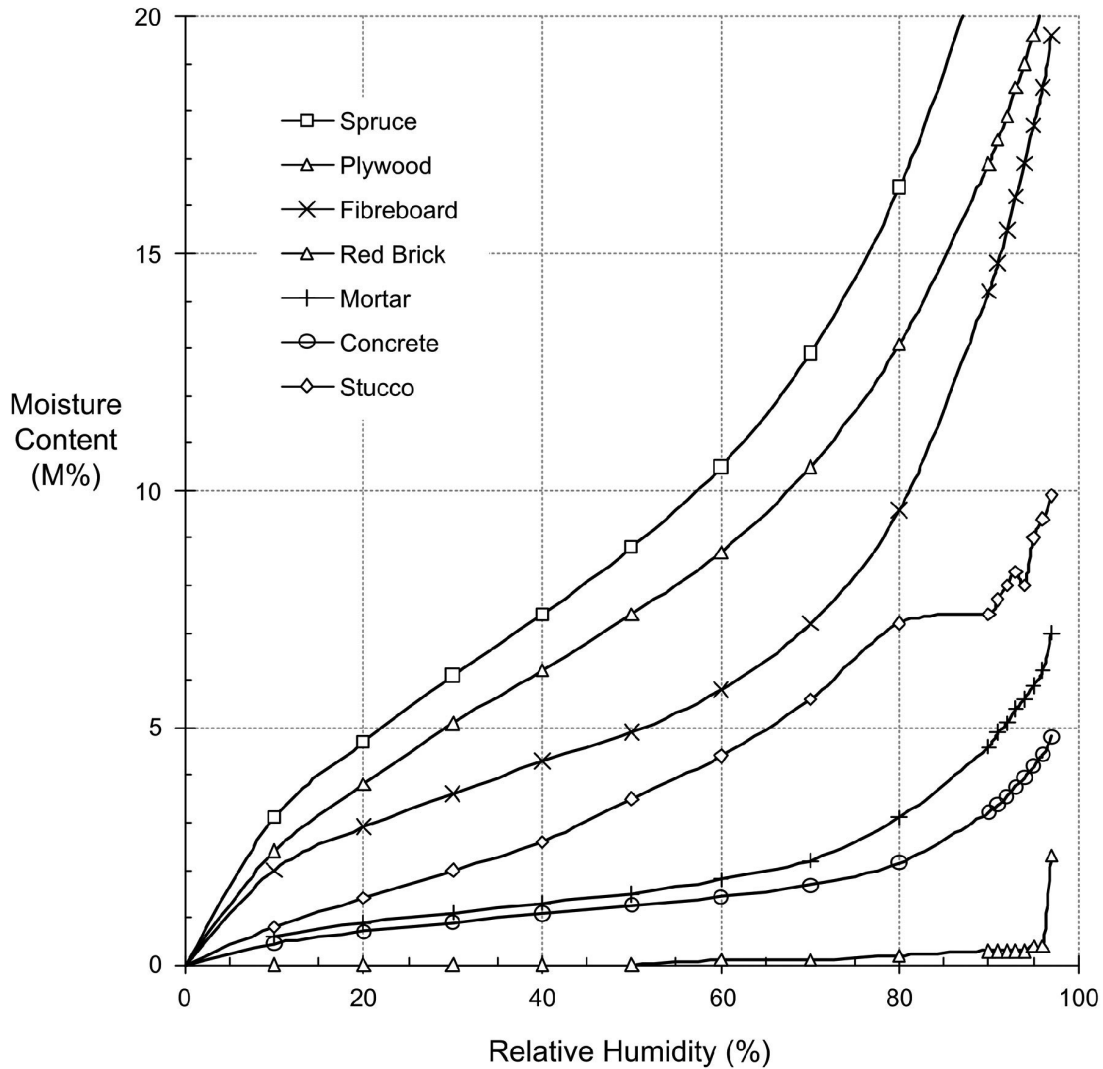


30°F
50% RH



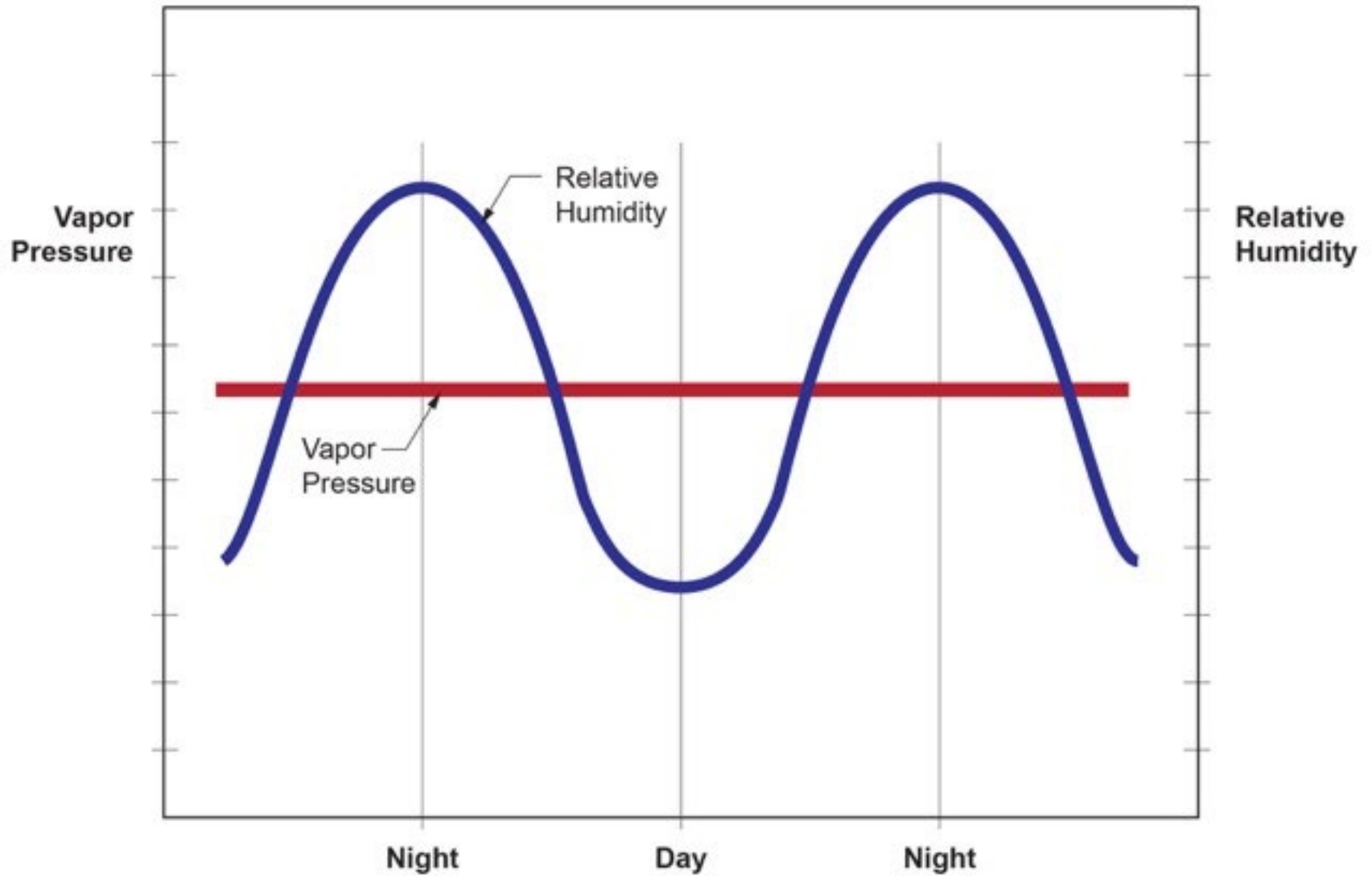


Sorption



Sorption isotherm for several building materials [Kumaran 2002]

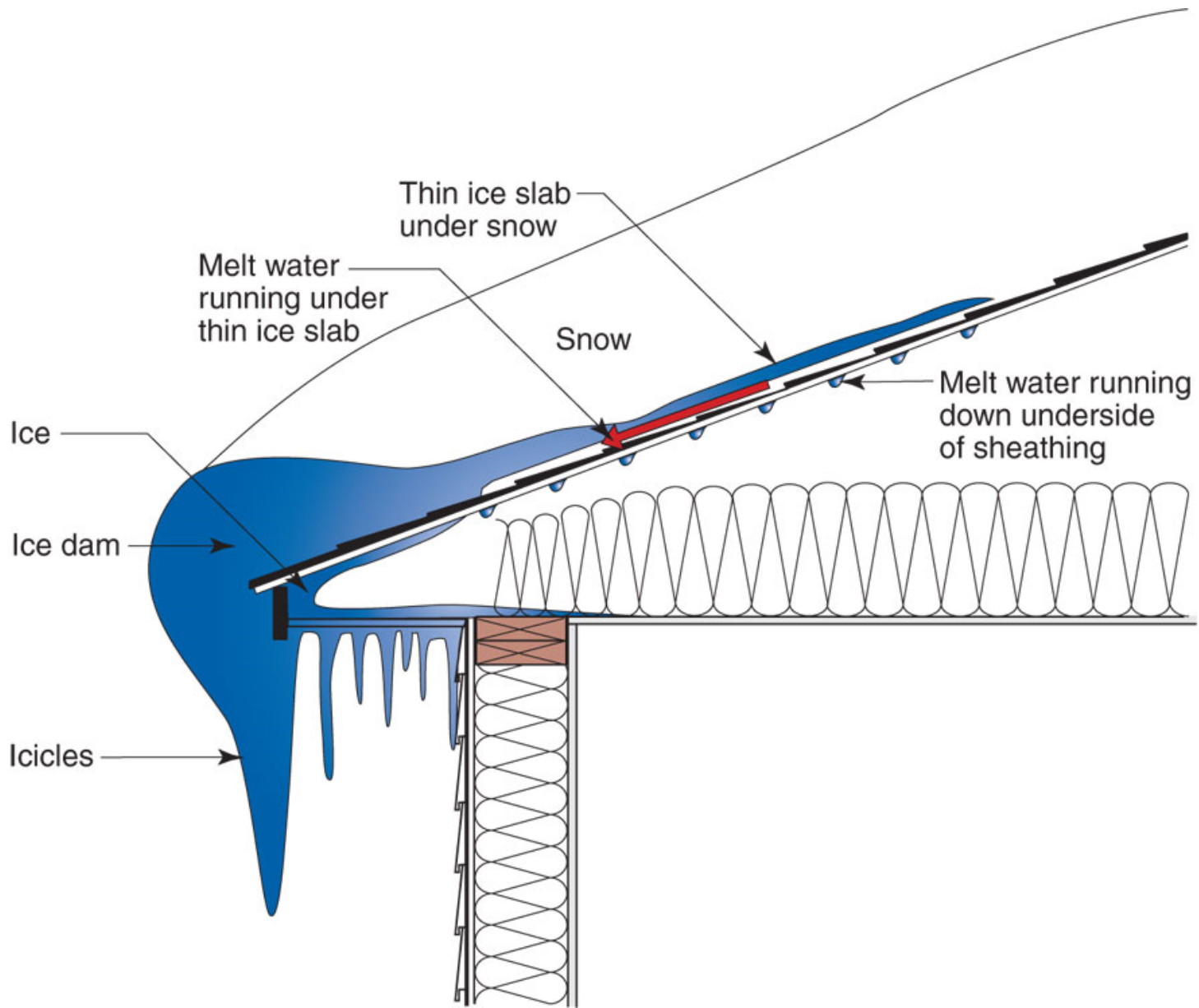
From Straube & Burnett, 2005



Ice Dams





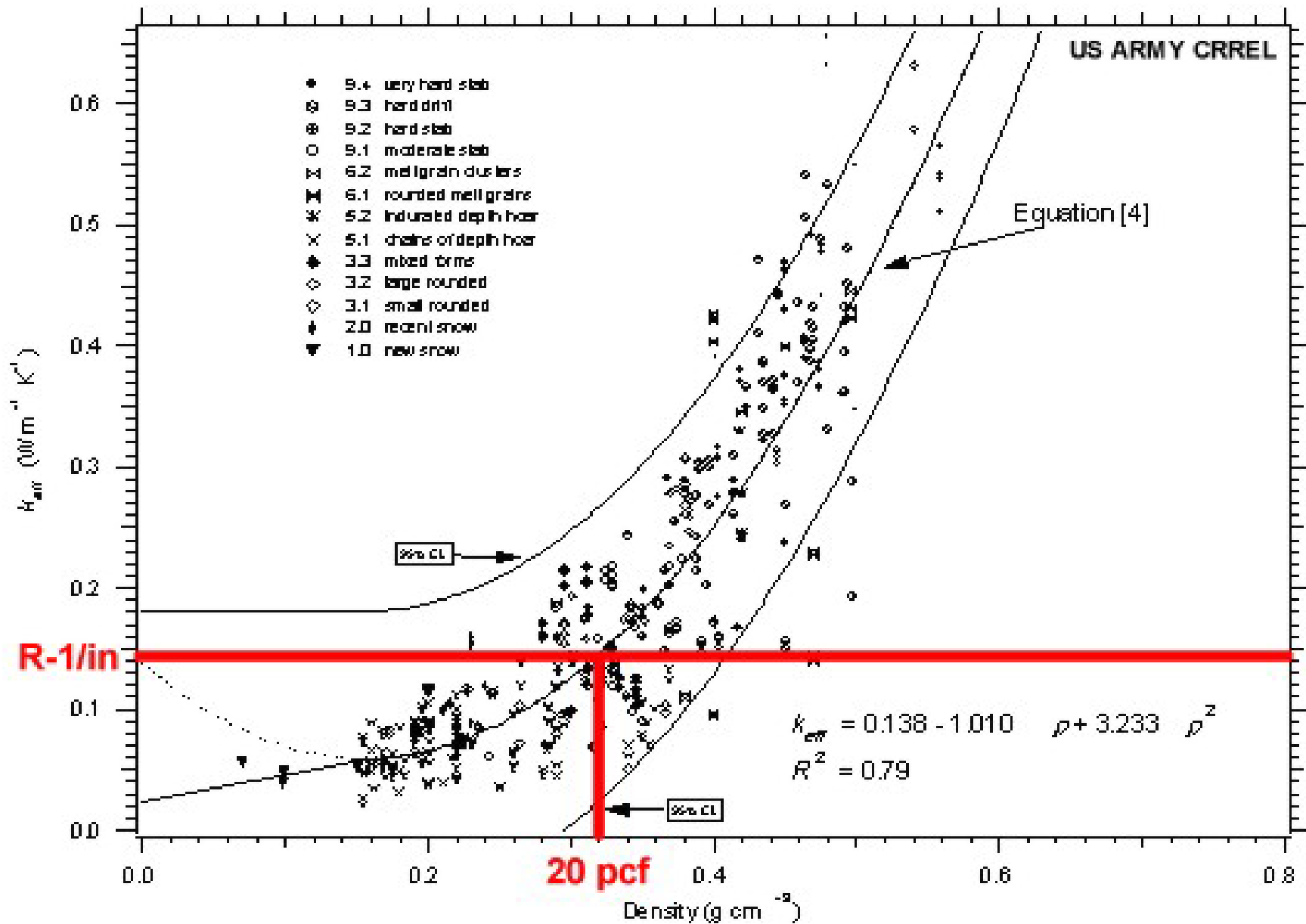






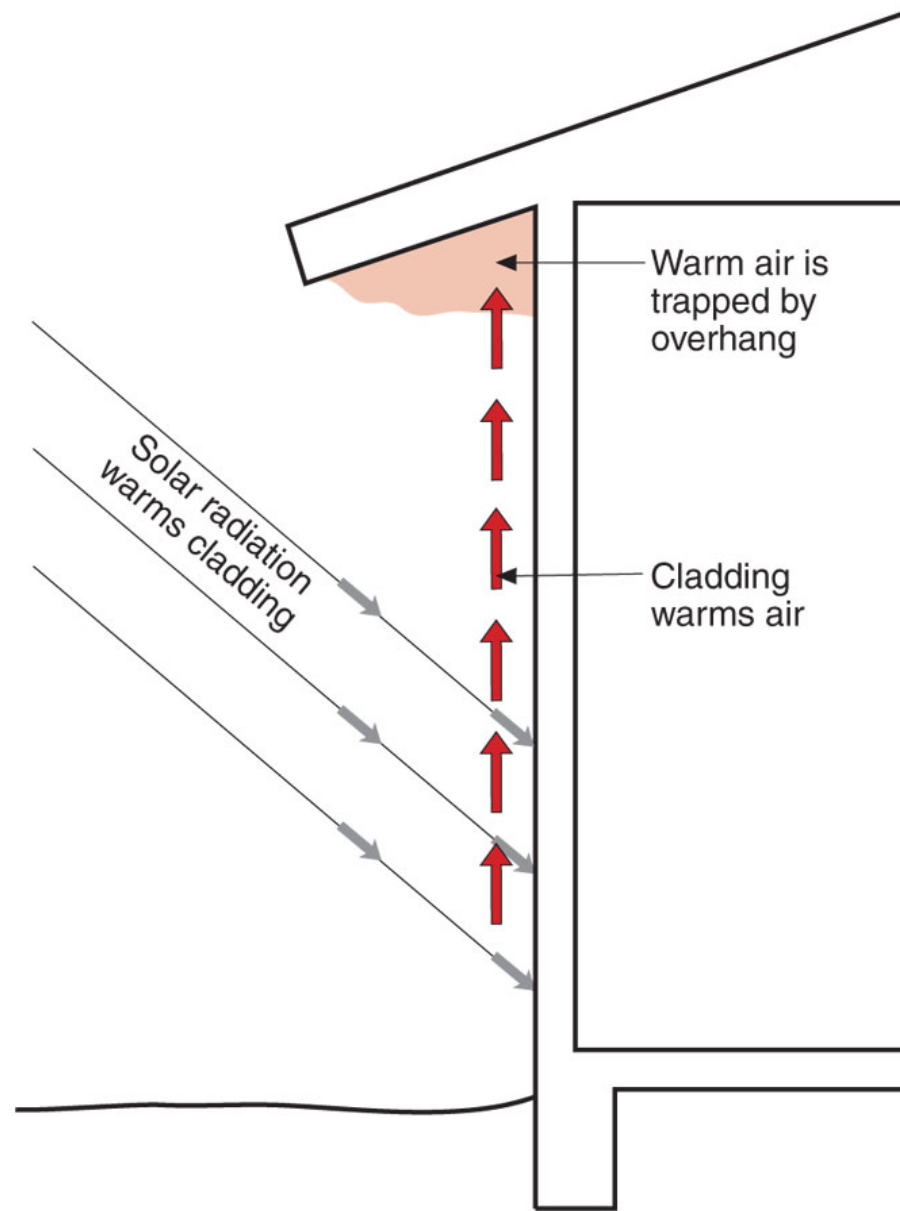








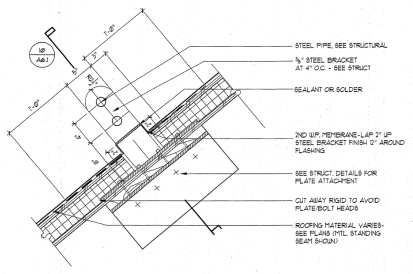




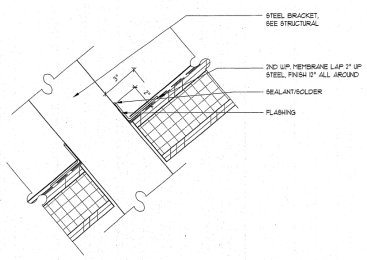




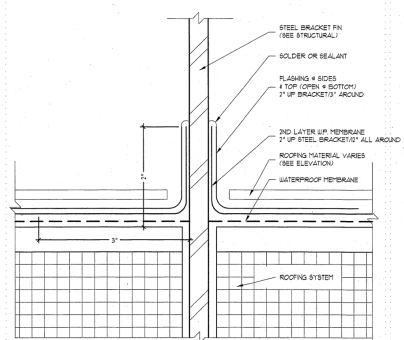




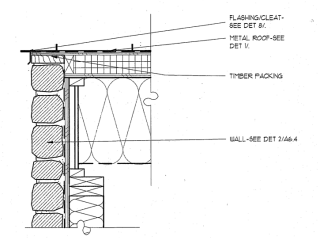
12 DETAIL @ SNOW GUARD
SCALE: 1-1/2"=1'-0"



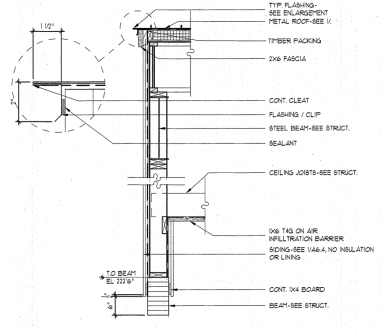
11 FLASHING DETAIL @ SNOW GUARD
SCALE: 3/4"=1'-0"



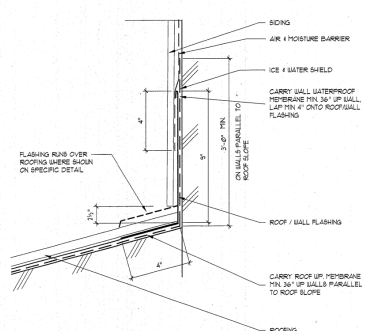
10 WATERPROOFING @ SNOW GUARD
SCALE: FULL SIZE



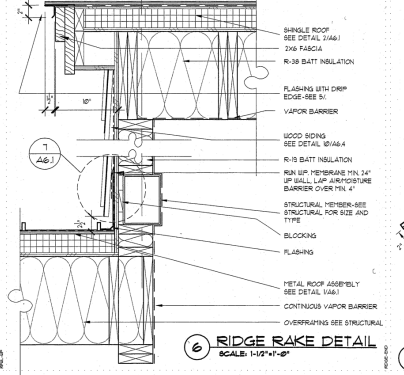
9 CLUB BAR RAKE DETAIL-NORTH END
SCALE: 1-1/2"=1'-0"



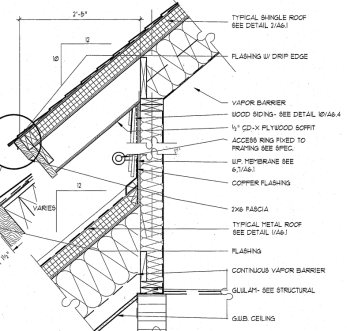
8 RAKE/SOFFIT @ OUTDOOR GRILLE/CLUB
SCALE: 3/4"=1'-0"



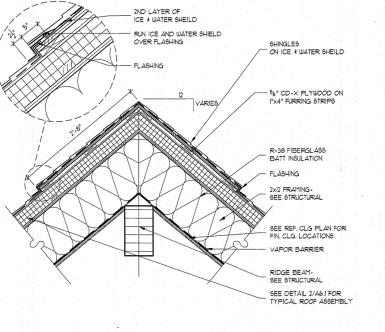
7 MINIMUM W.P. @ ROOF/WALL
SCALE: N.T.S.



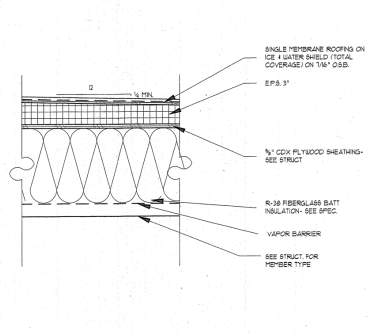
6 RIDGE RAKE DETAIL
SCALE: 1-1/2"=1'-0"



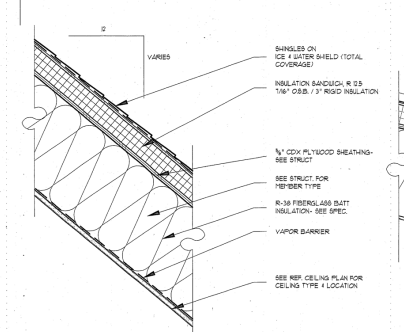
5 RIDGE EAVE @ MTL. ROOF @ WALL
SCALE: 1-1/2"=1'-0"



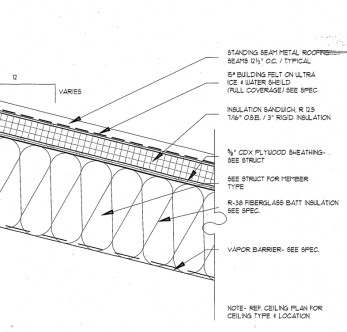
4 RIDGE CAP DETAIL
SCALE: 1-1/2"=1'-0"




3 FLAT ROOF @ MECH. DORMER
SCALE: 1-1/2"=1'-0"



2 TYPICAL ASPHALT SHINGLE ROOF
SCALE: 1-1/2"=1'-0"



1 TYPICAL METAL ROOF
SCALE: 1-1/2"=1'-0"



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ISSUE: 3/8/18

REVISIONS:

100% CONSTRUCTION DOCUMENTS

ROOF DETAILS

DRAWN BY:

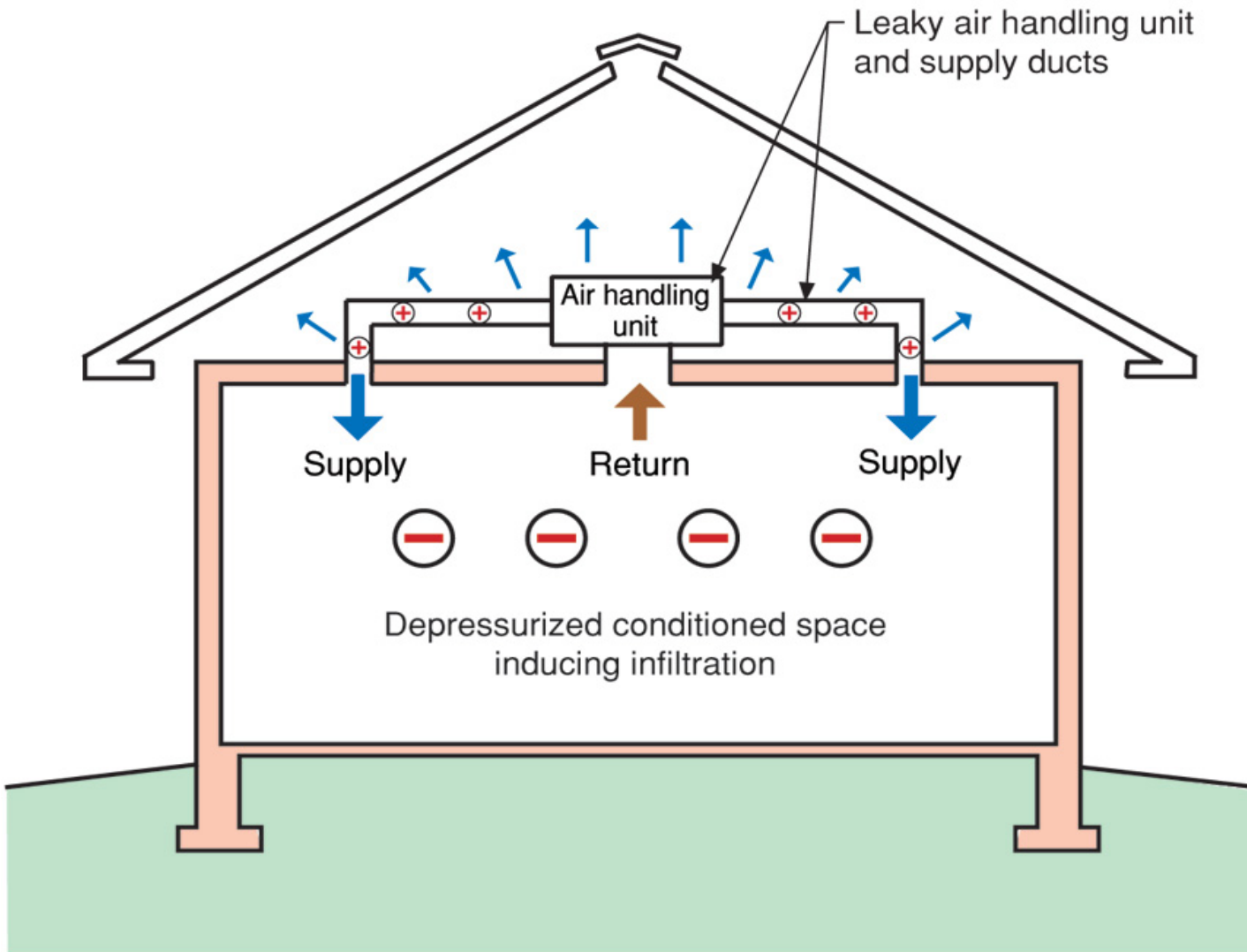
CHECKED BY:

A6.1

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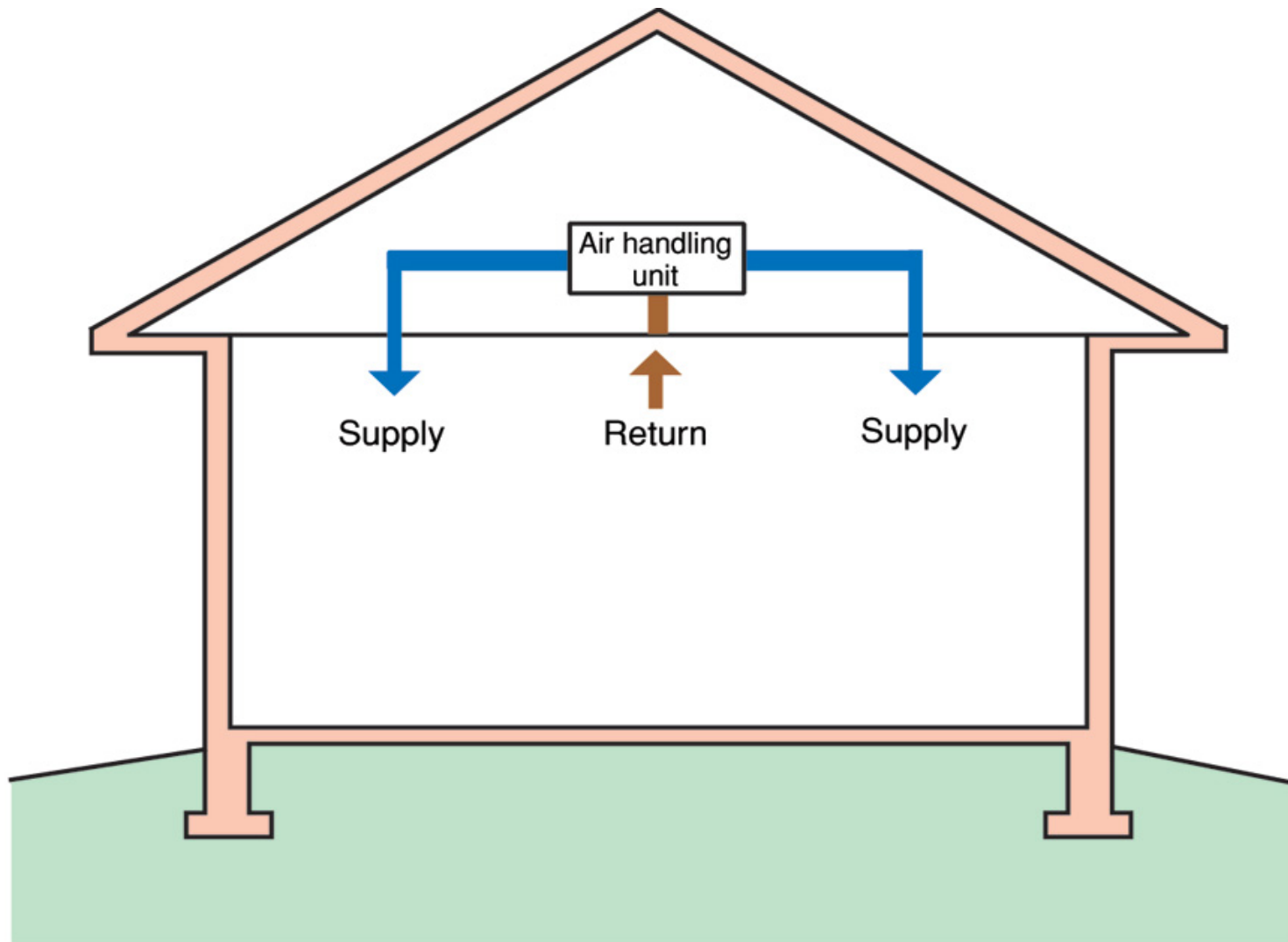




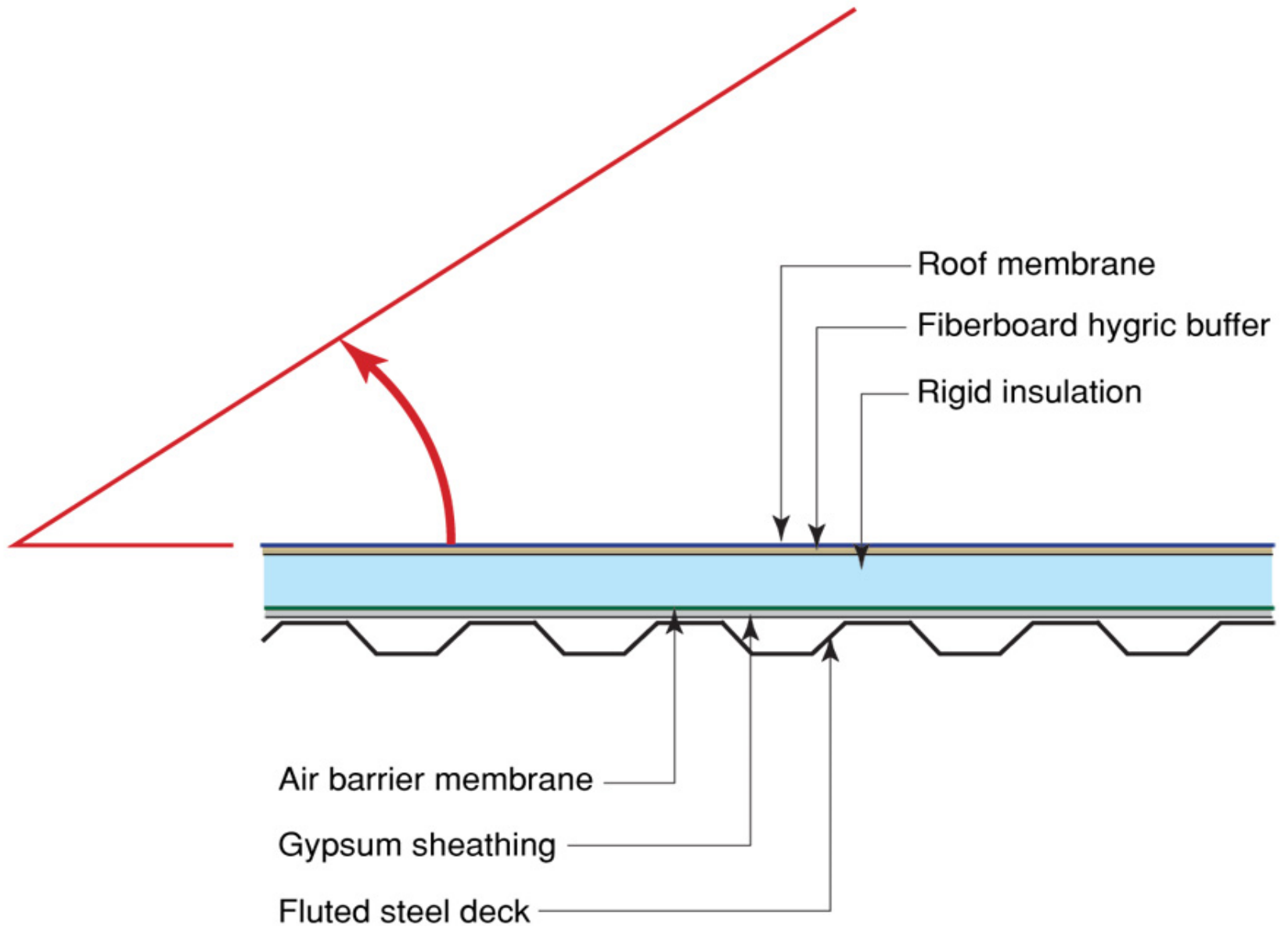
Note: Colored shading depicts the building's thermal barrier and pressure boundary. The thermal barrier and pressure boundary enclose the conditioned space.

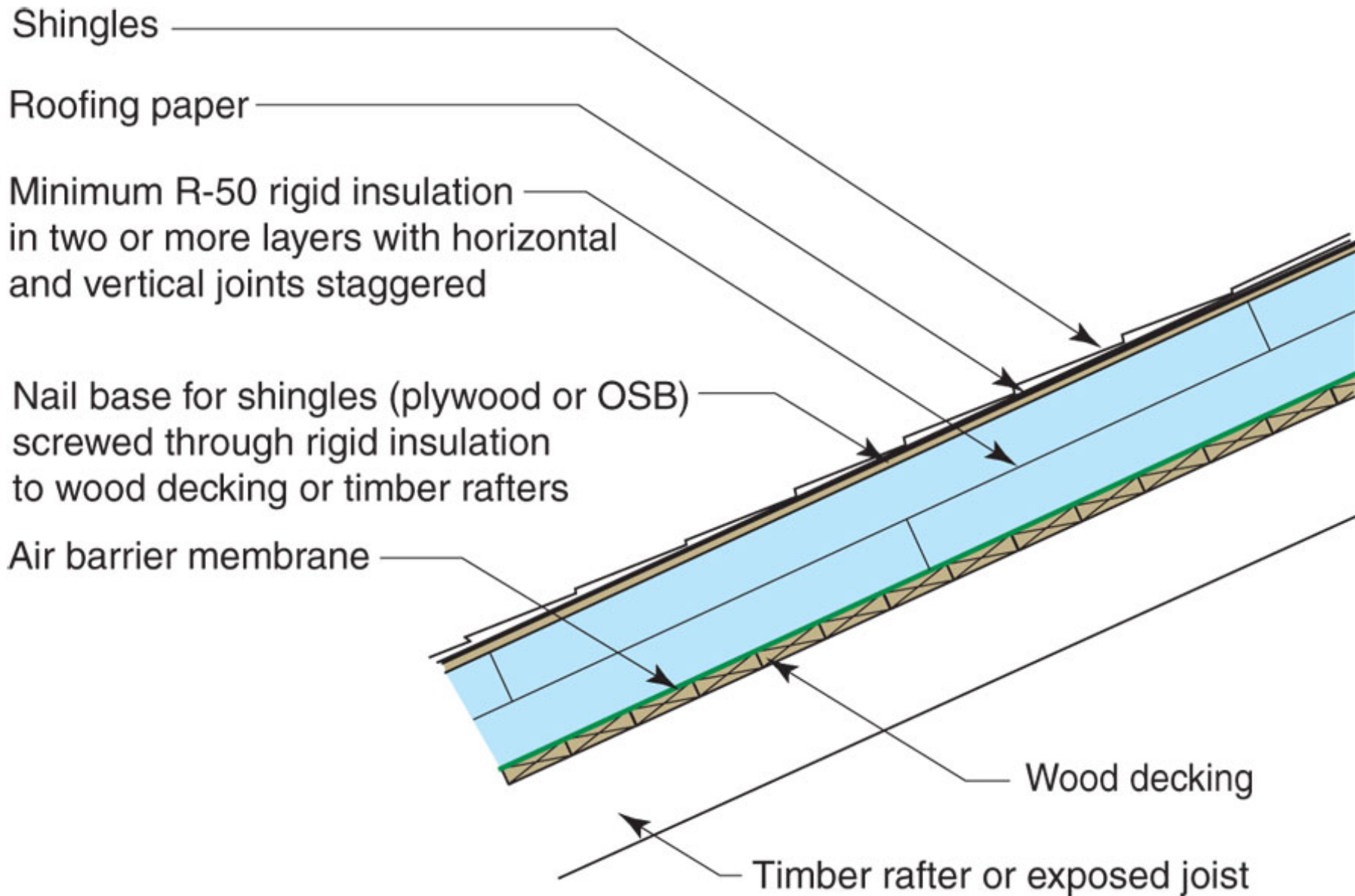


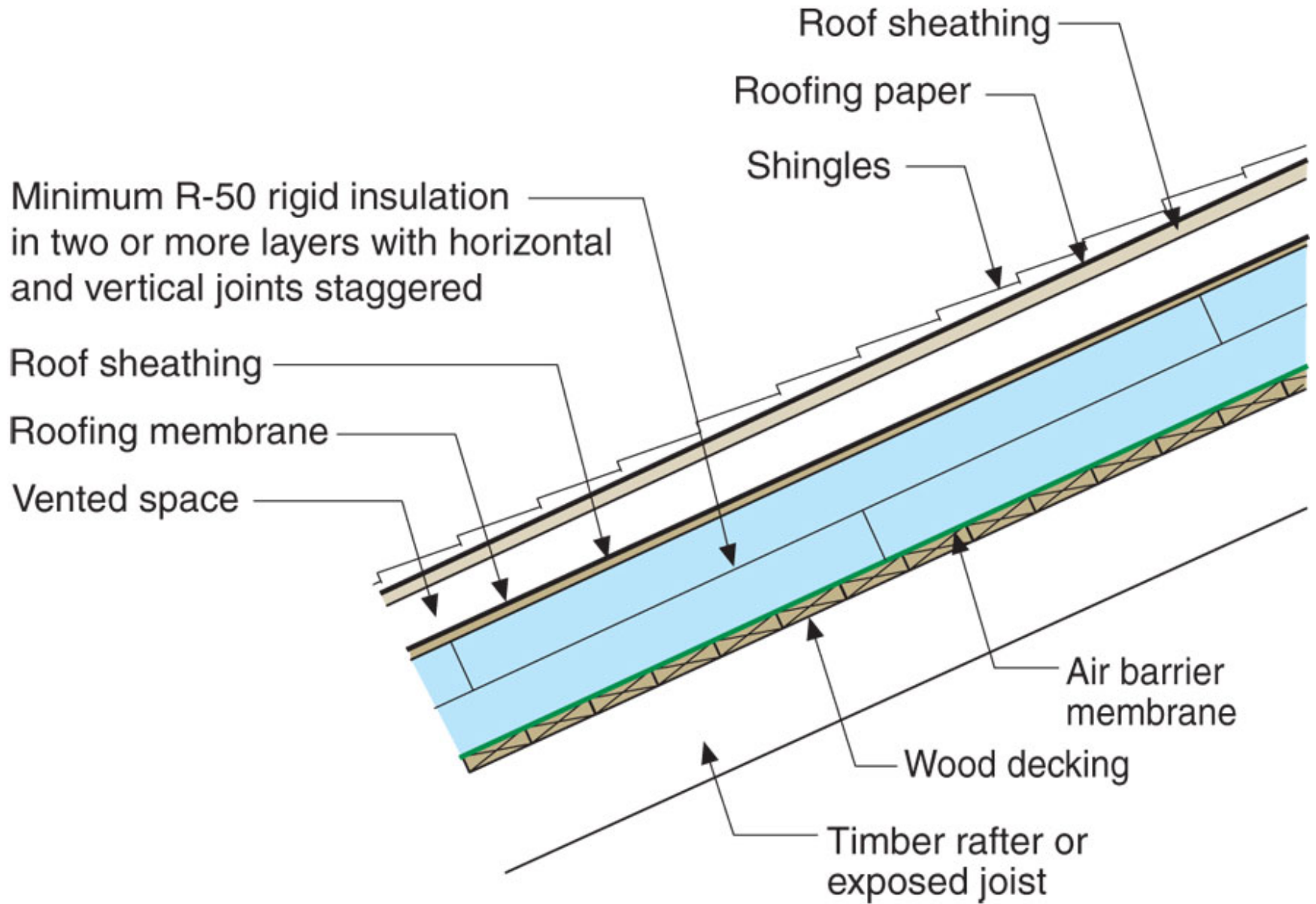


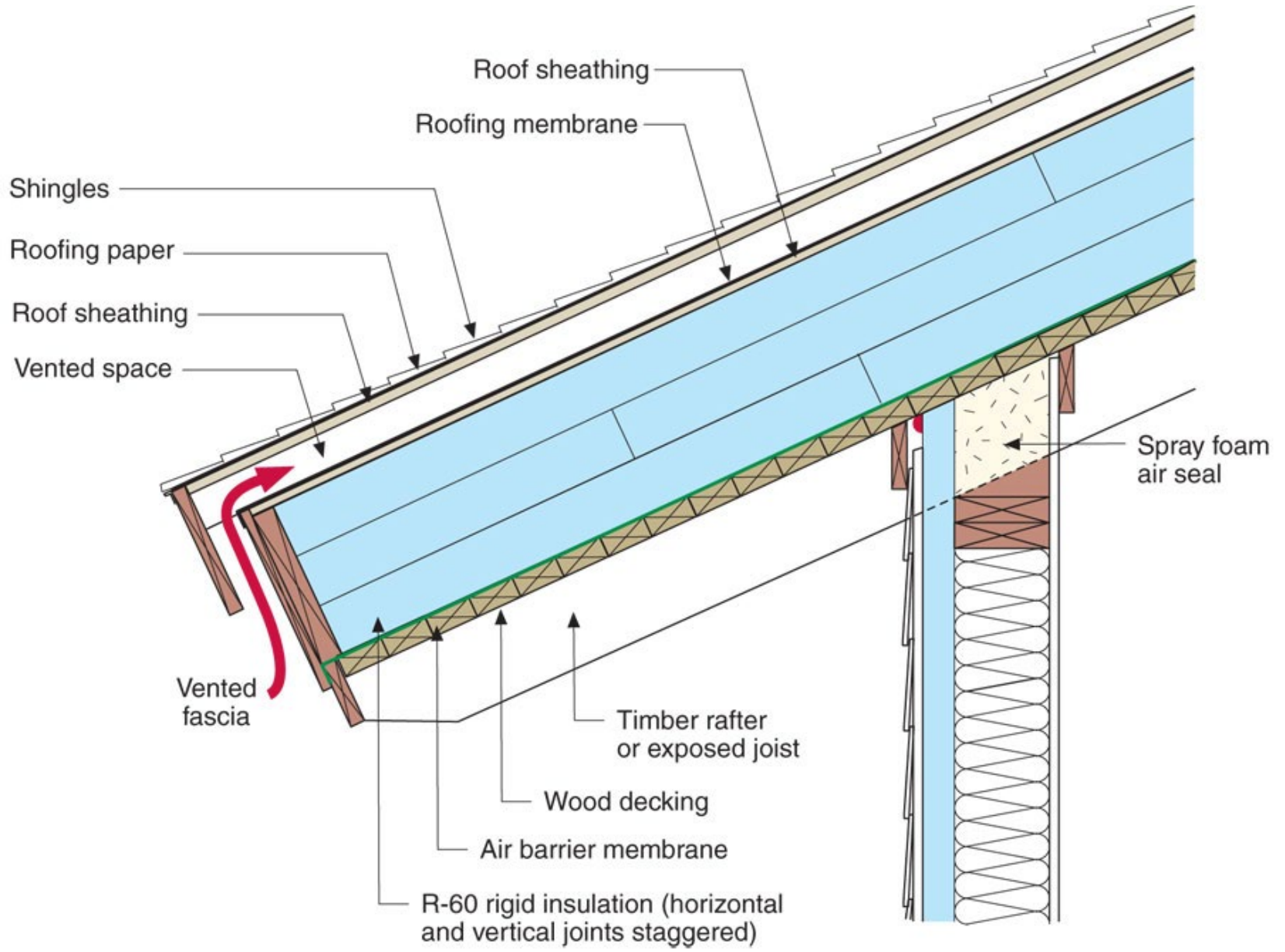


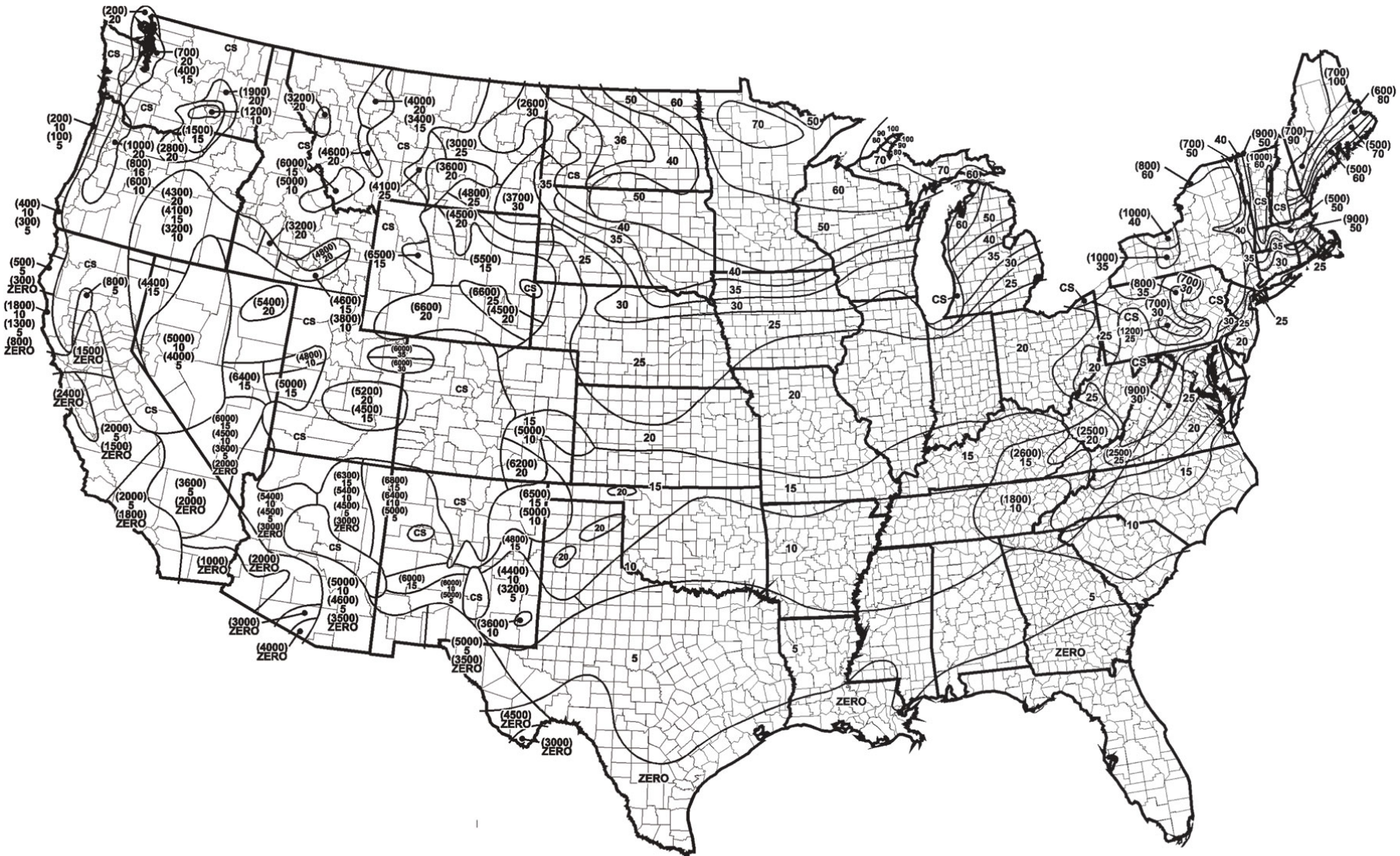
Note: Colored shading depicts the building's thermal barrier and pressure boundary. The thermal barrier and pressure boundary enclose the conditioned space.





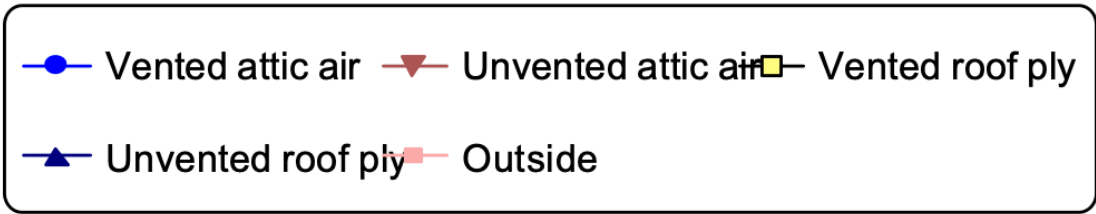
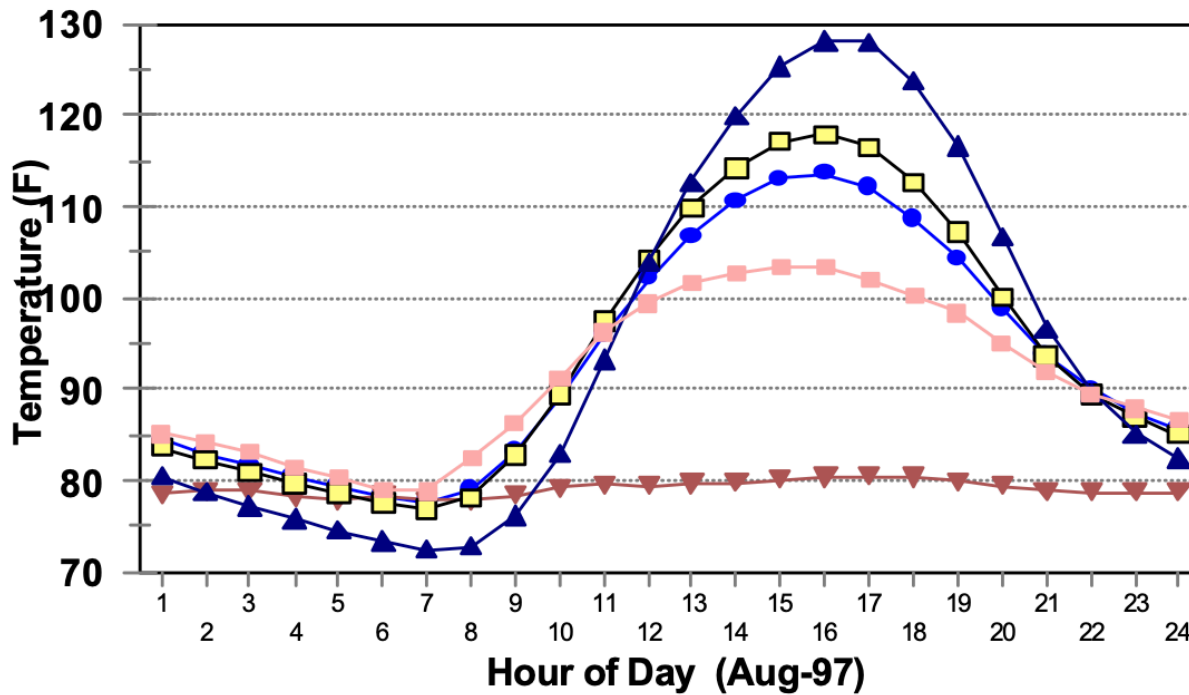






Roof Sheathing Temperatures

Average Temperatures Vented and Unvented Attics, Aug-97



Roof Sheathing Temperatures
5 to 10 percent difference...

Shingle Temperatures

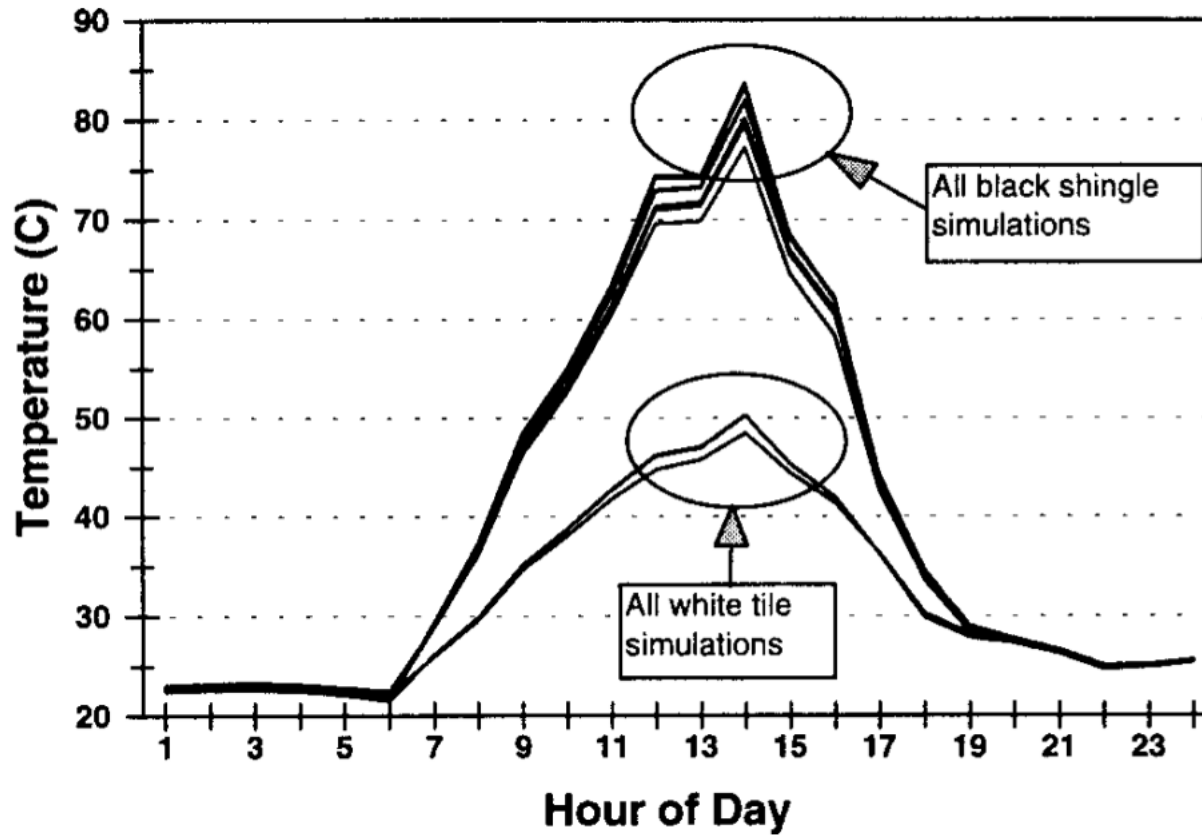


Figure 7 Orlando peak day top of roof shingle or top of roof tile temperature for all parametric simulations (south side of roof).

Shingle Temperatures

Color more important than ventilation

Orientation more important than ventilation

Climate zone more important than ventilation























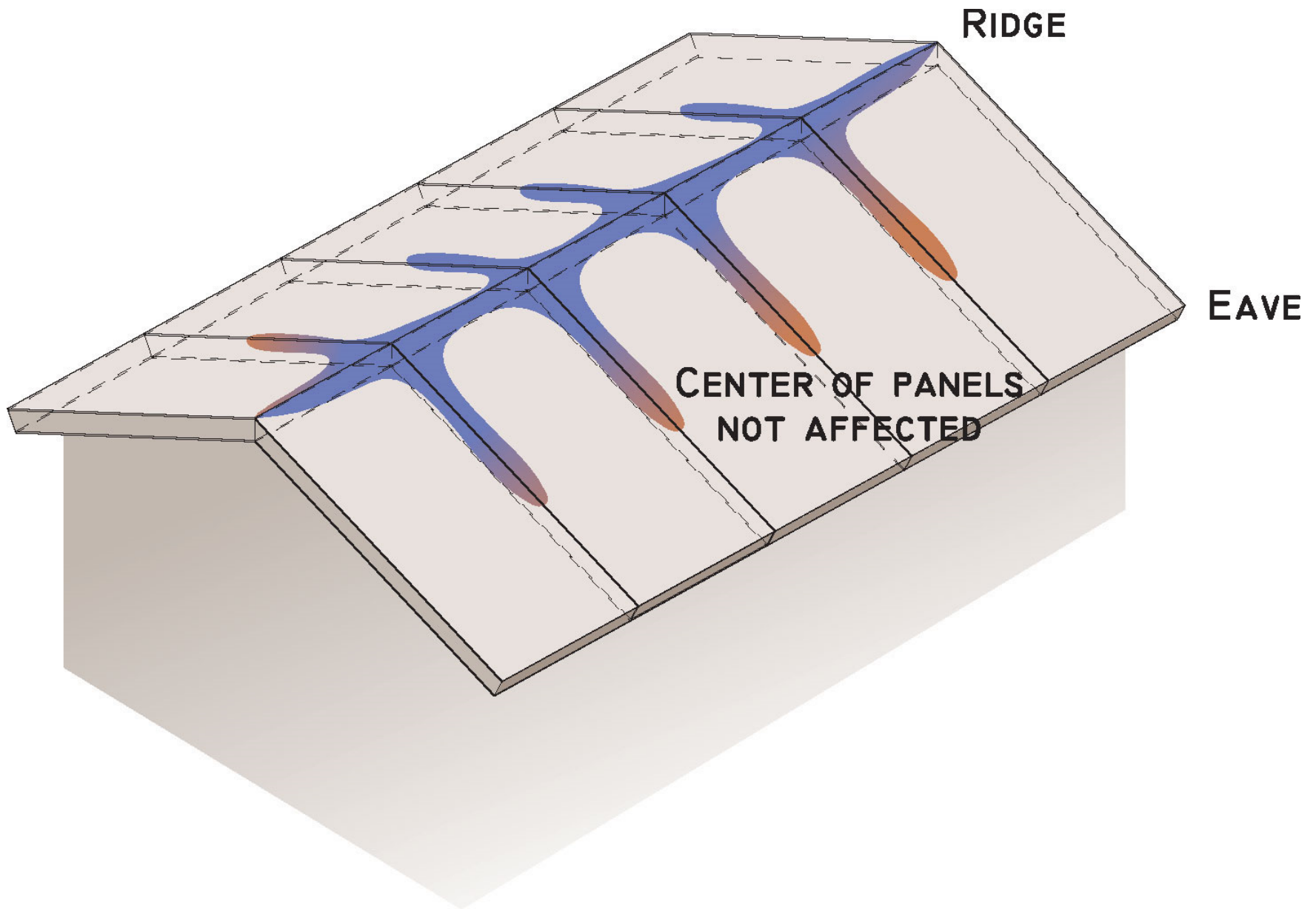




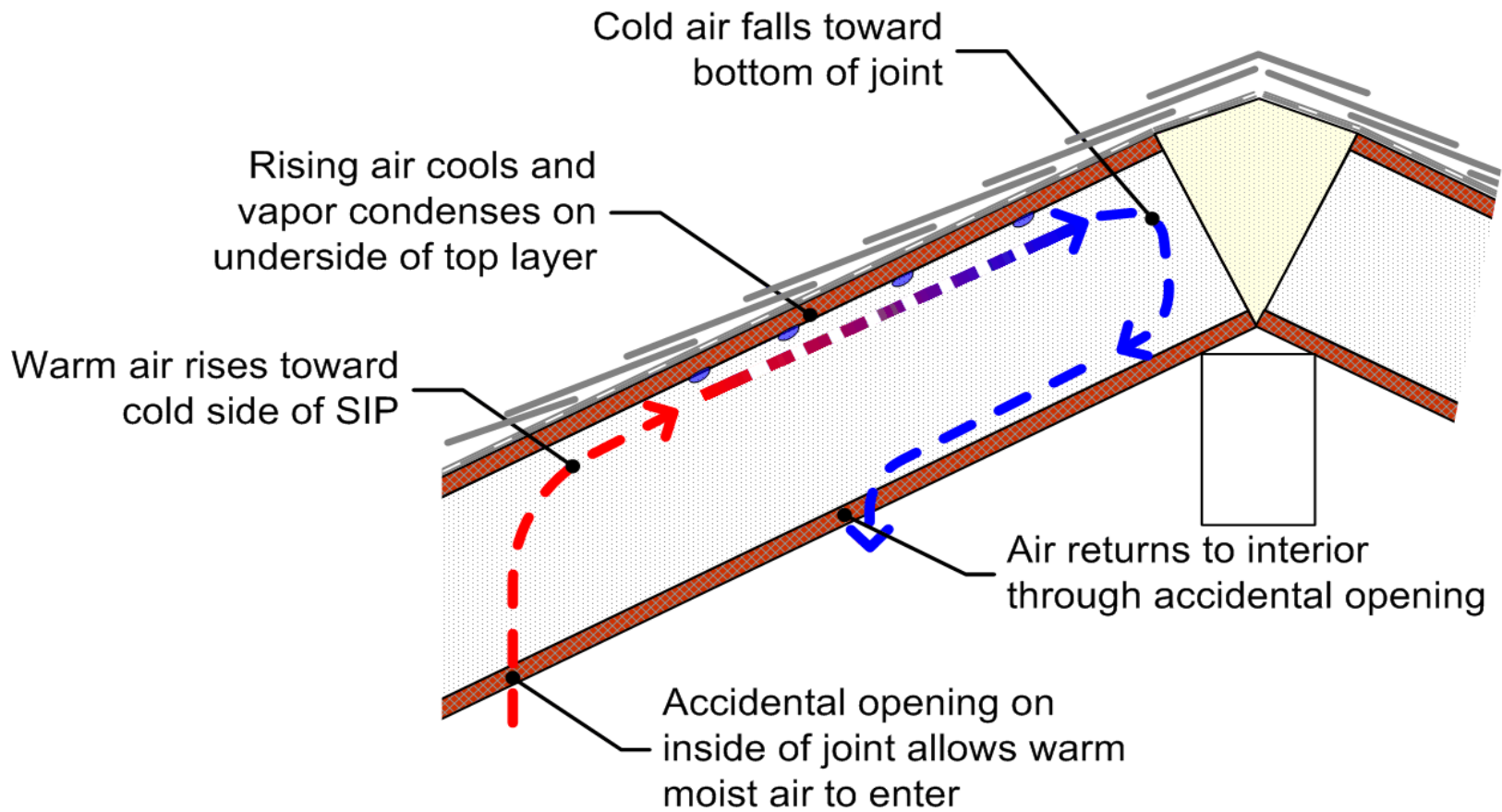


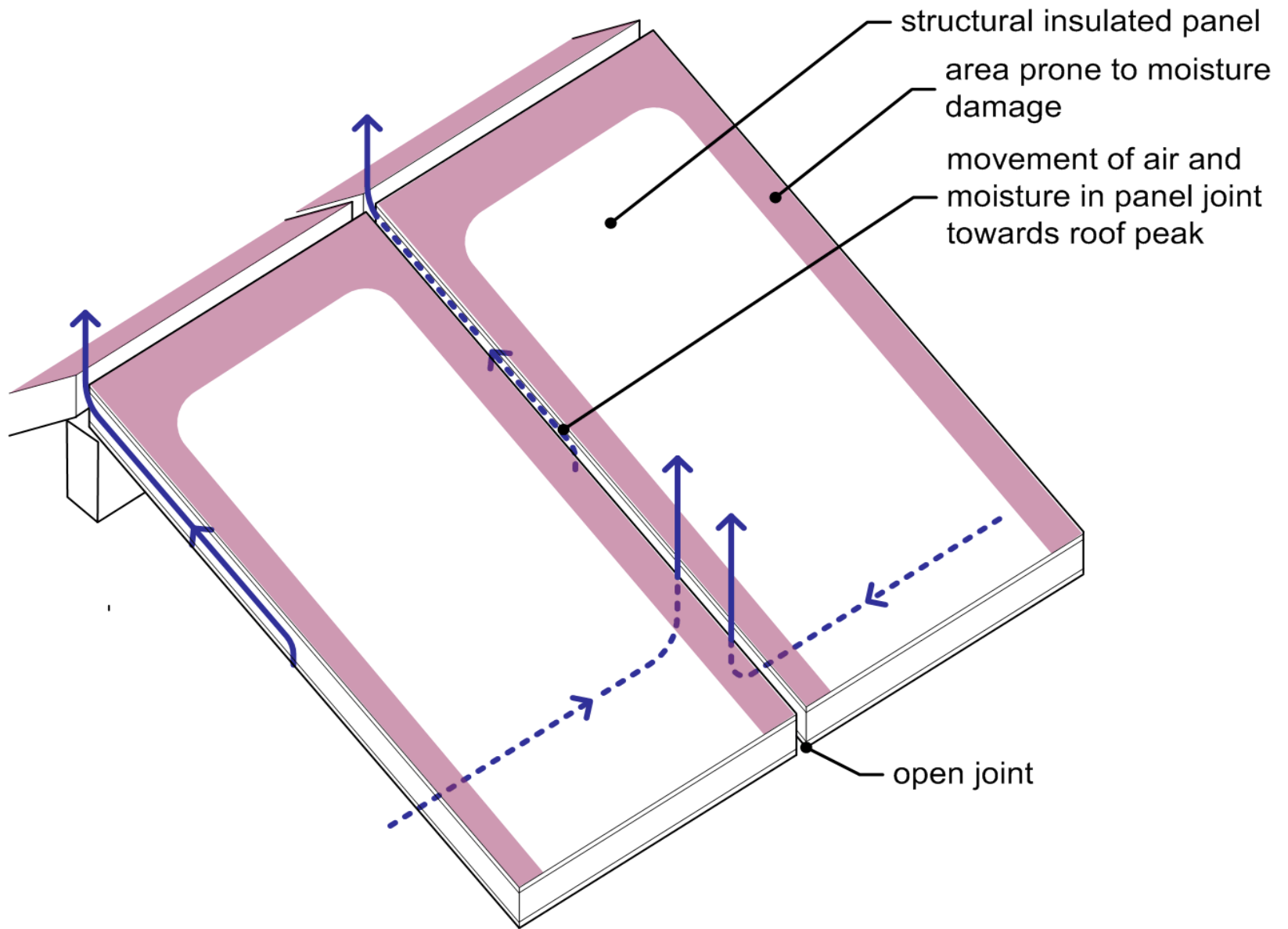


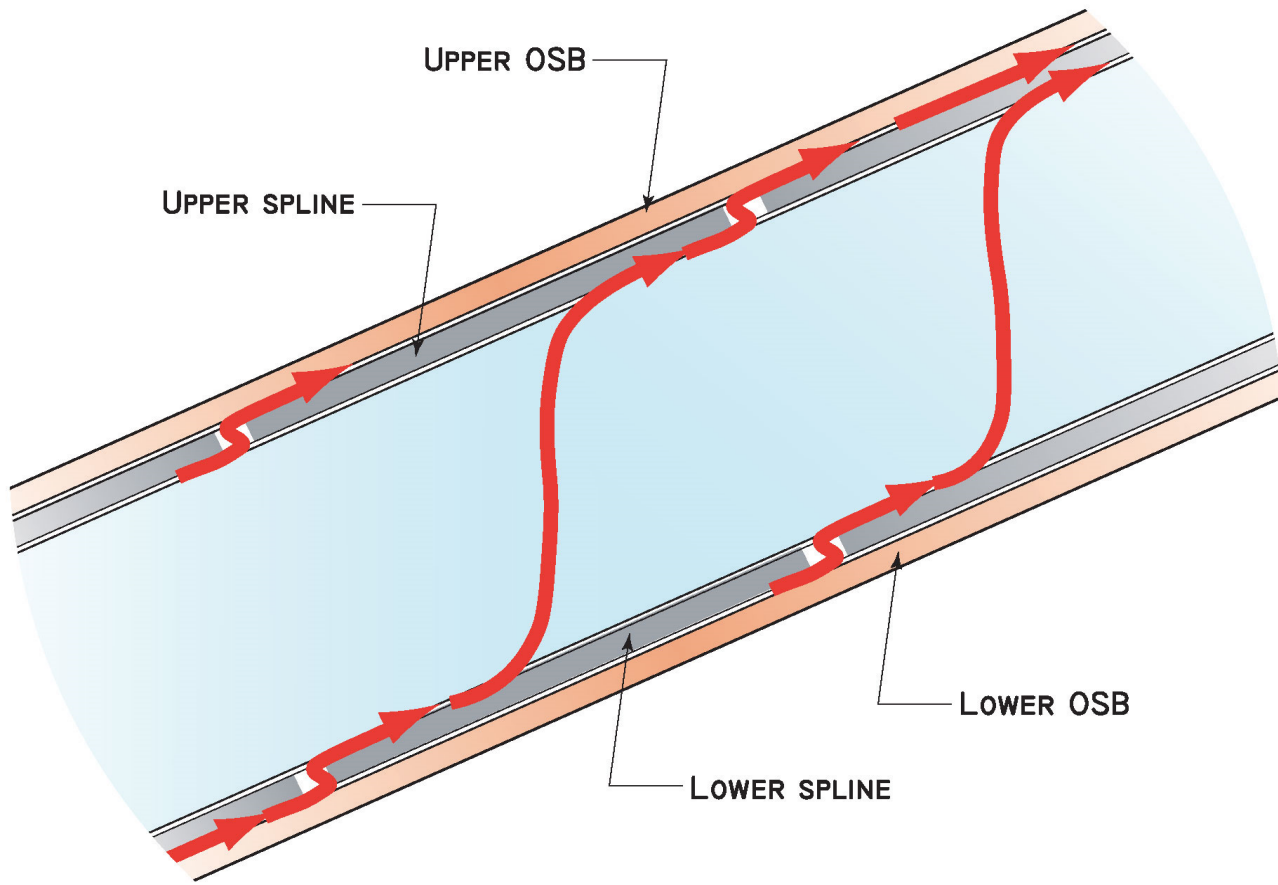
















8/22/01 10:13





8/22/01 10:30

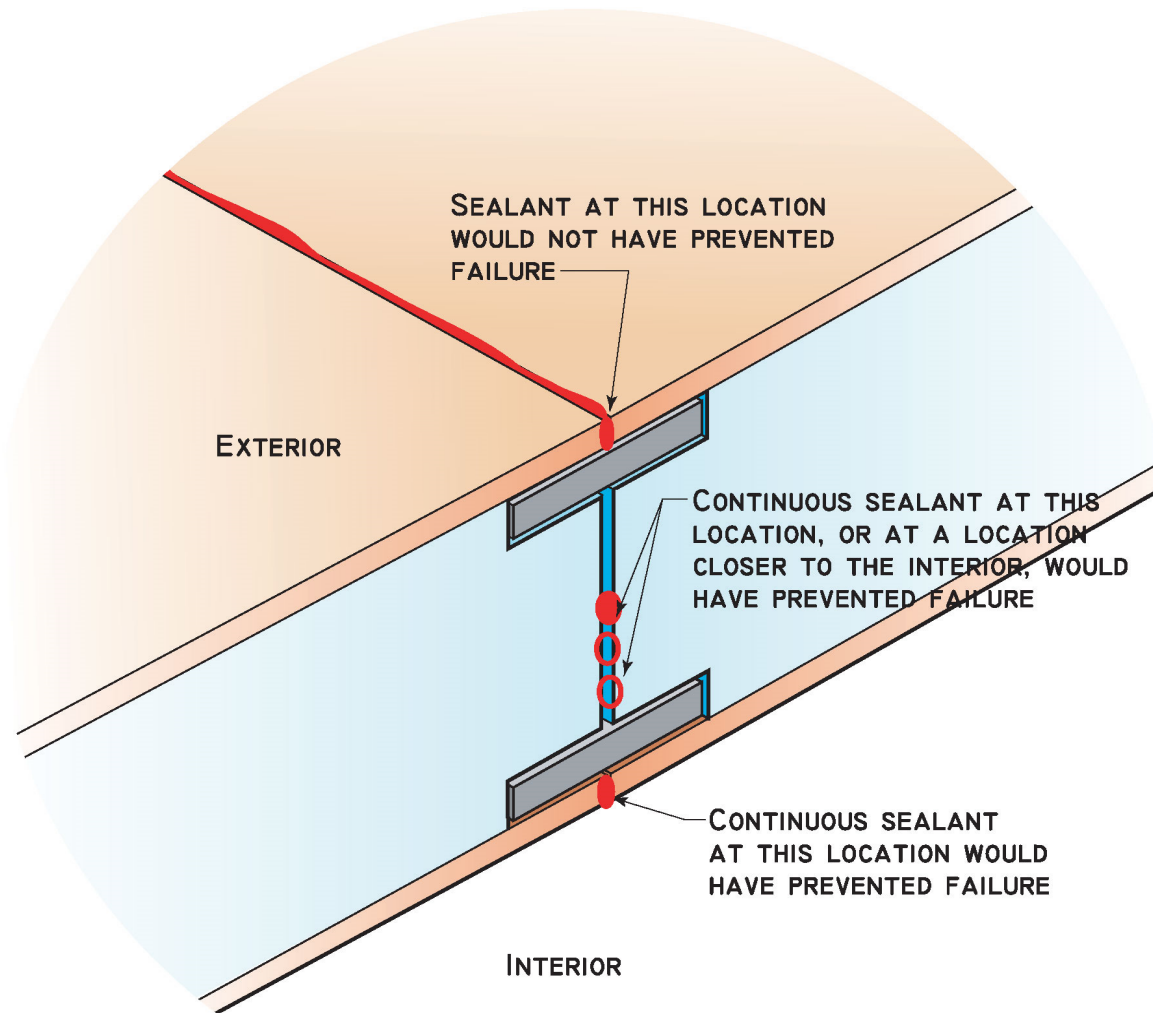


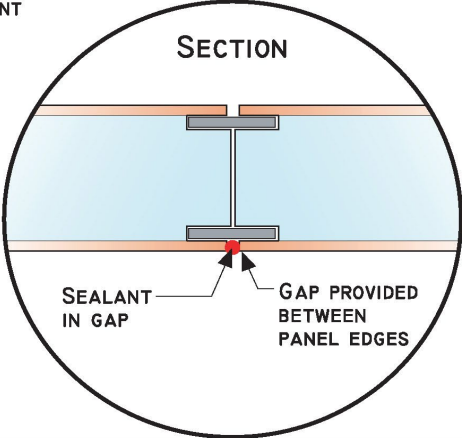
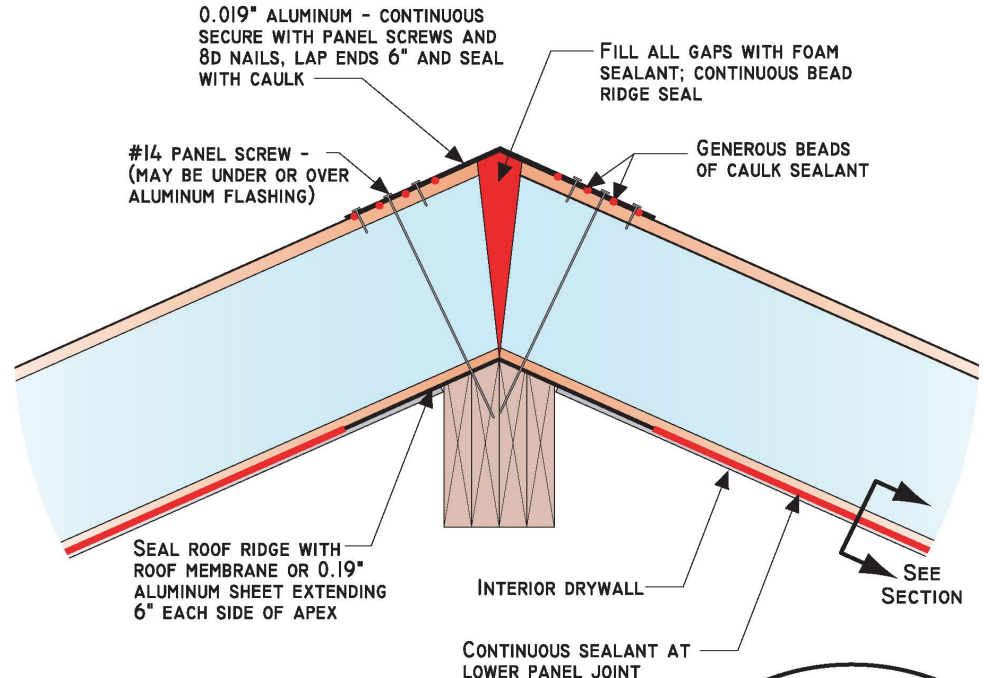










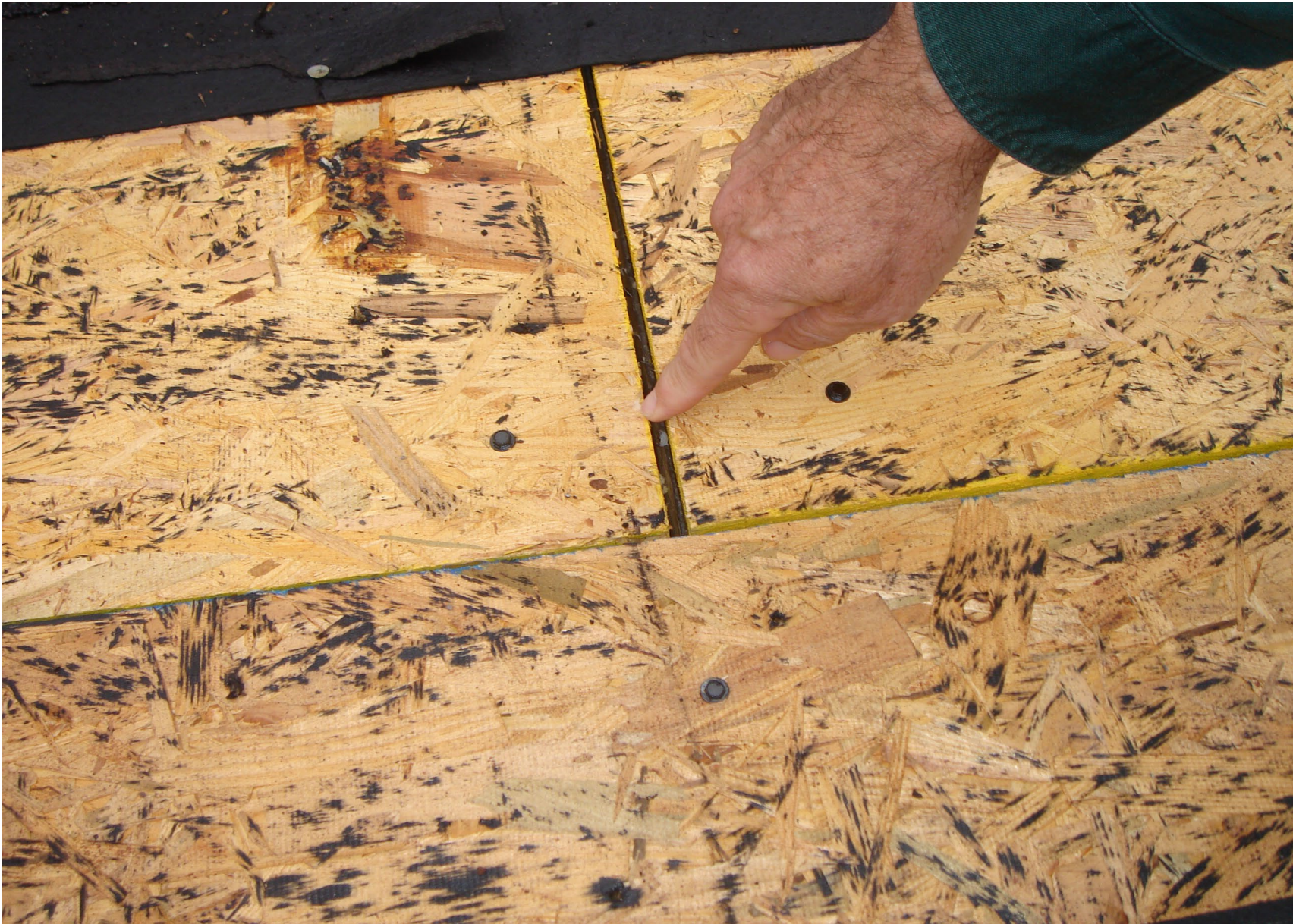




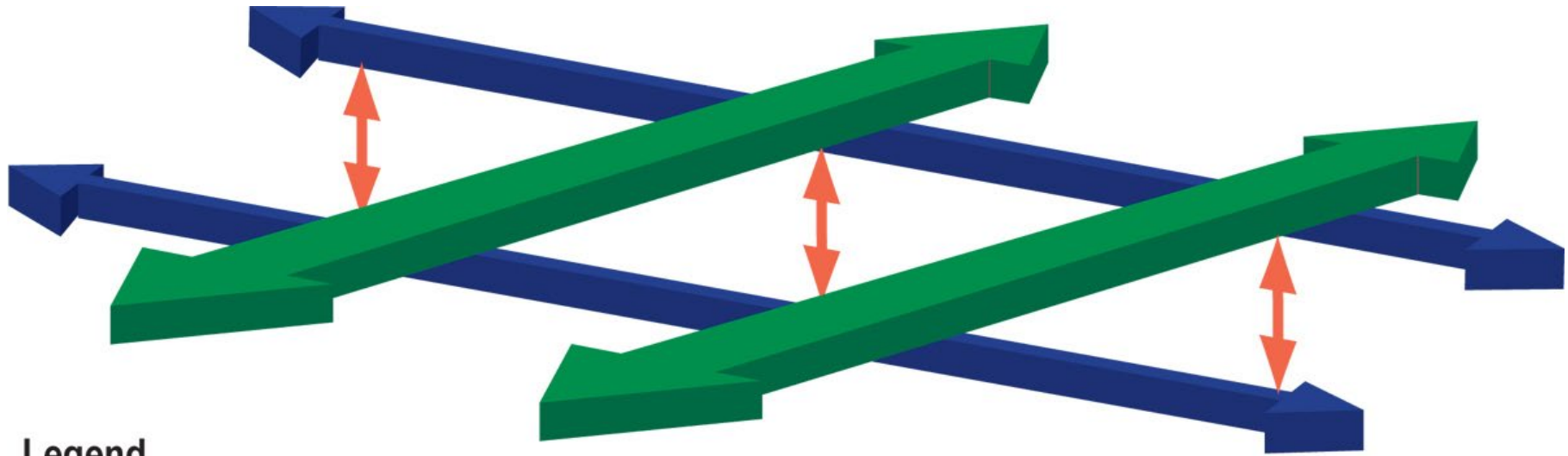









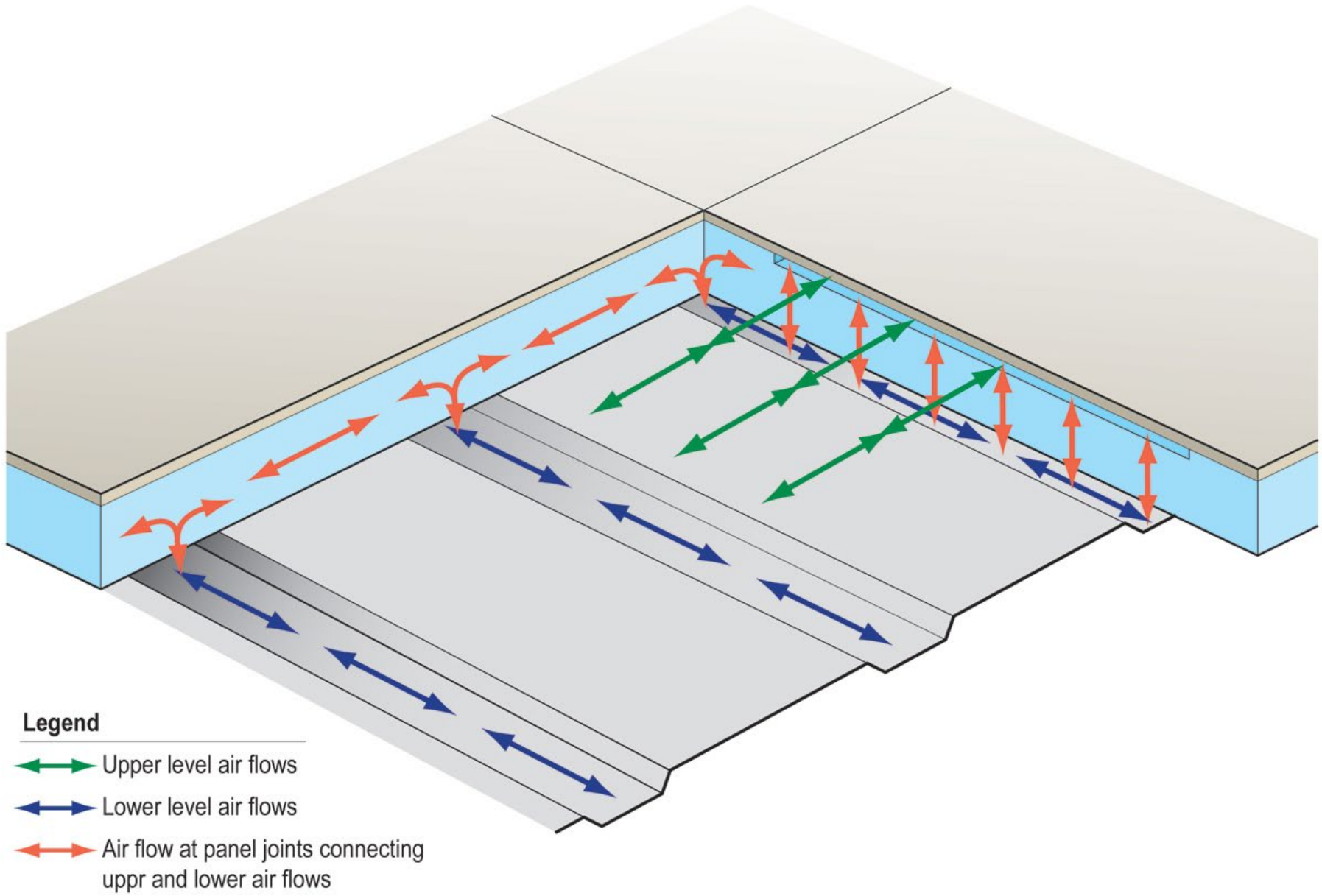


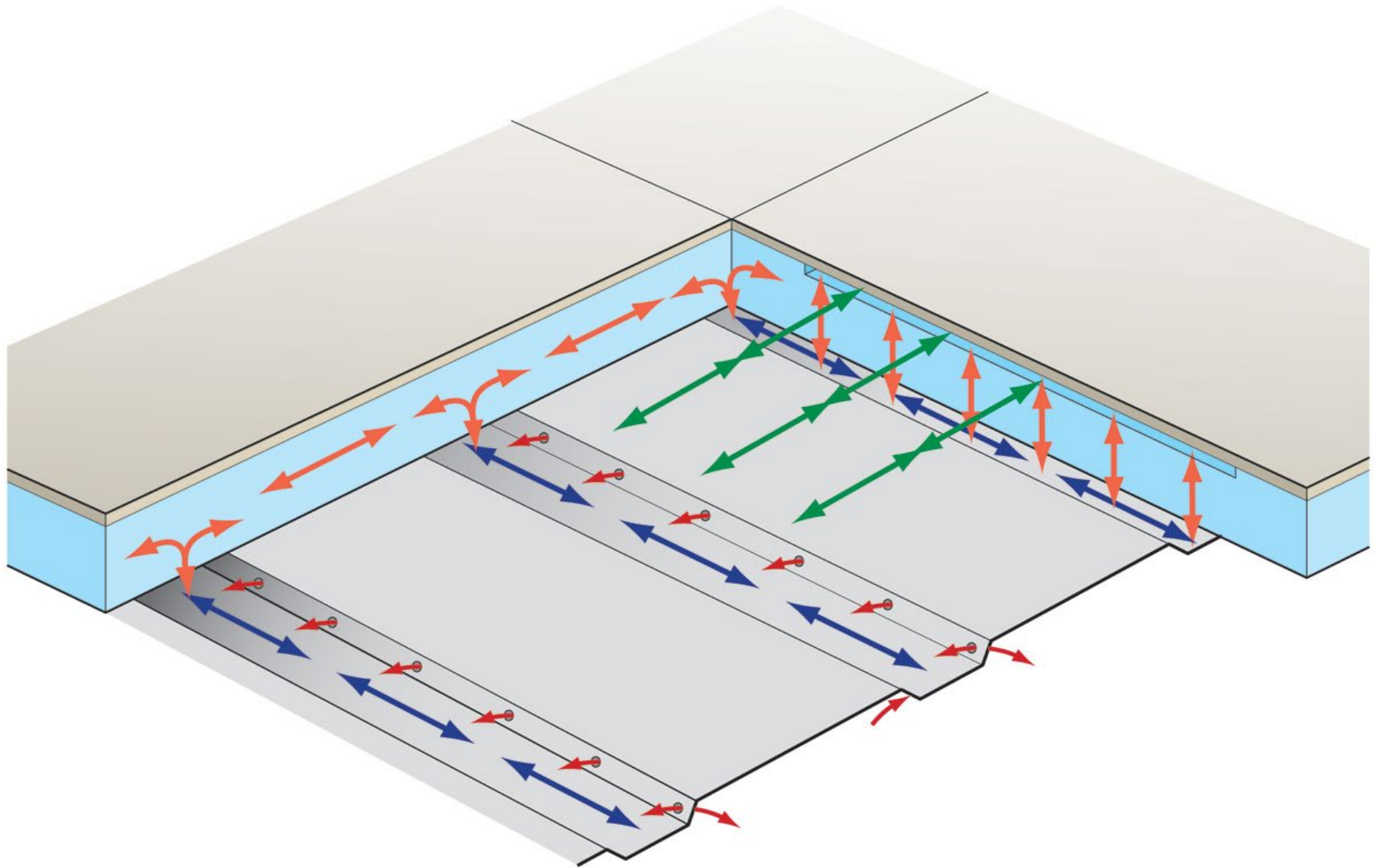




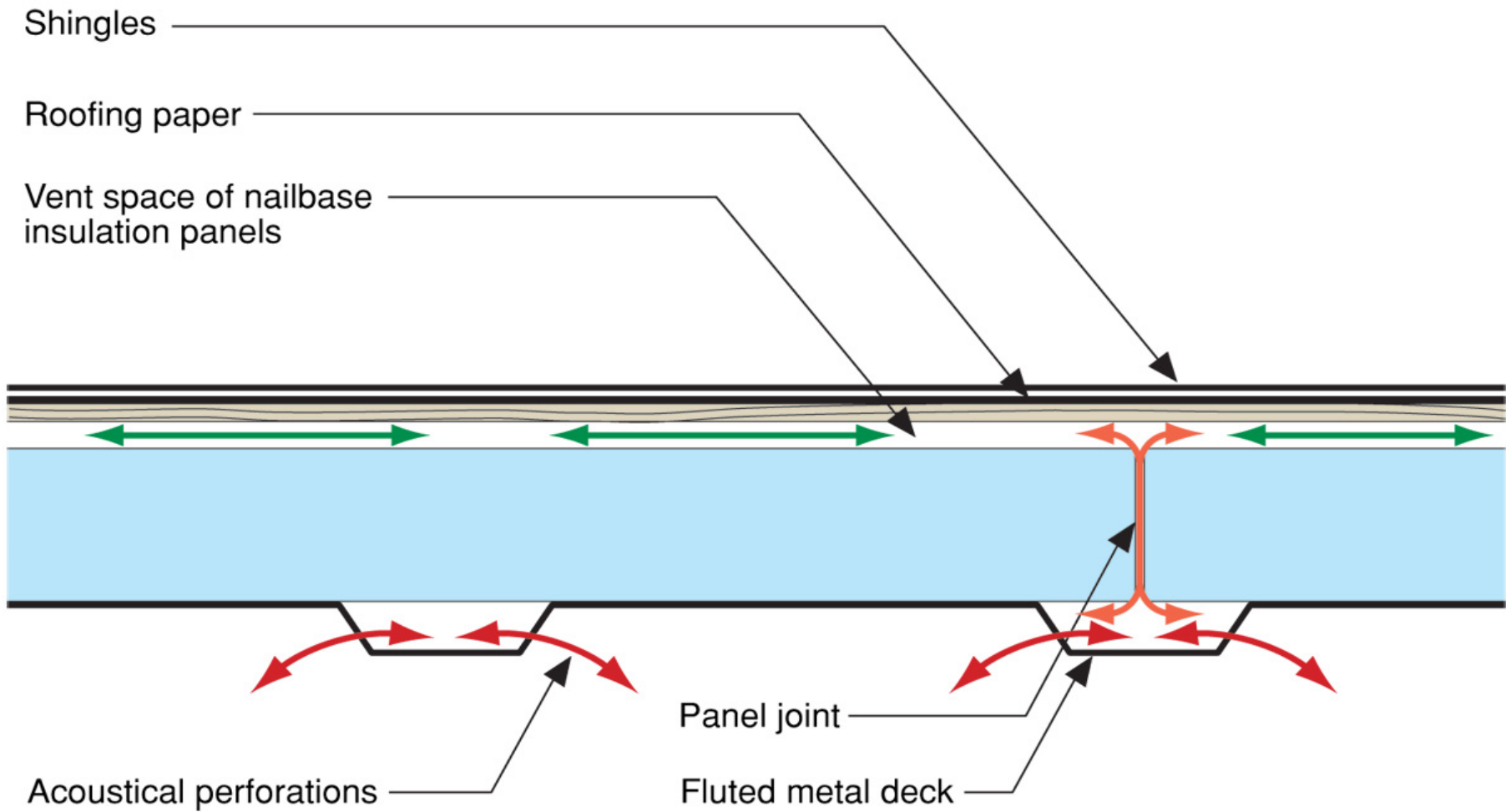
Legend

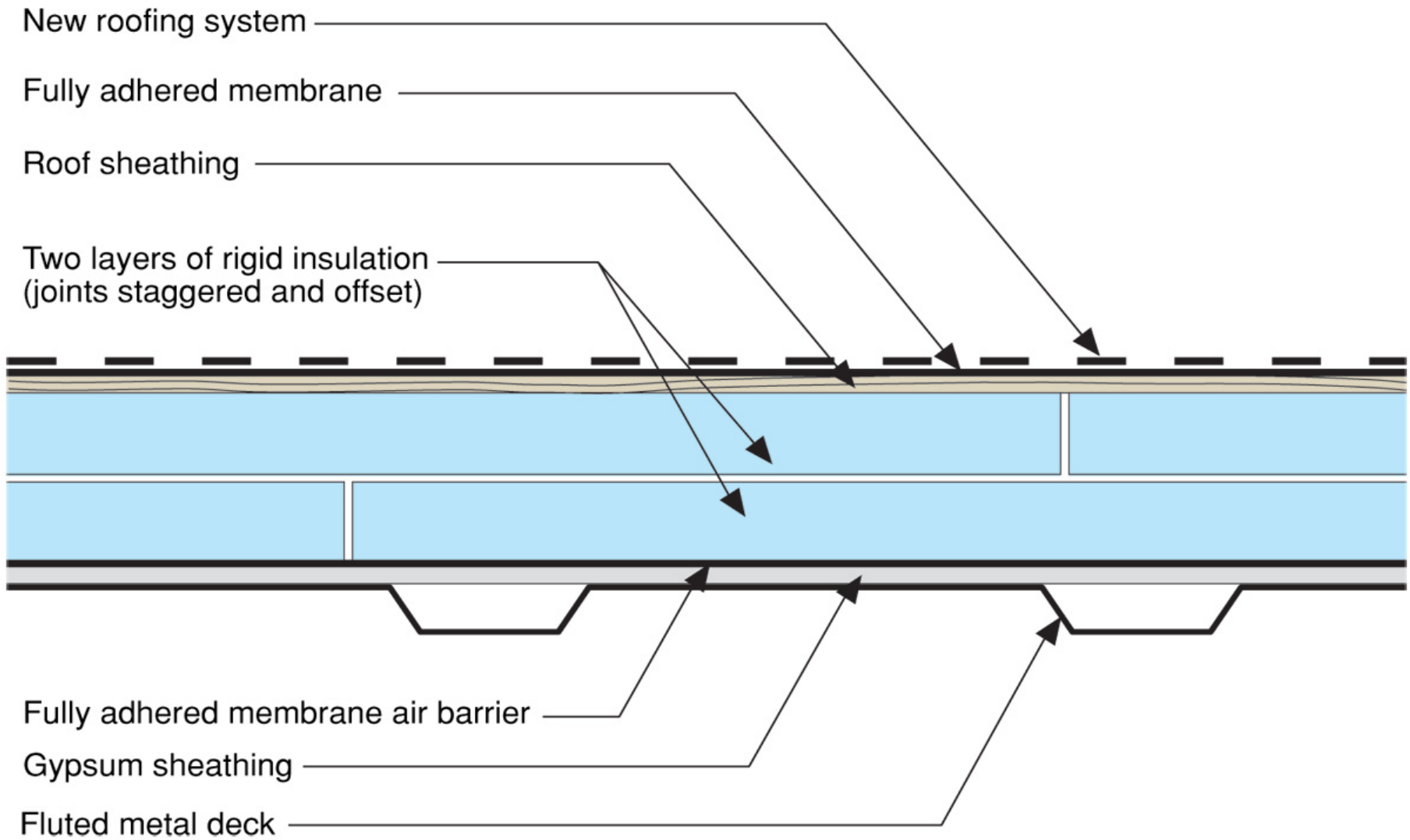
-  Upper level air flows
-  Lower level air flows
-  Air flow at panel joints

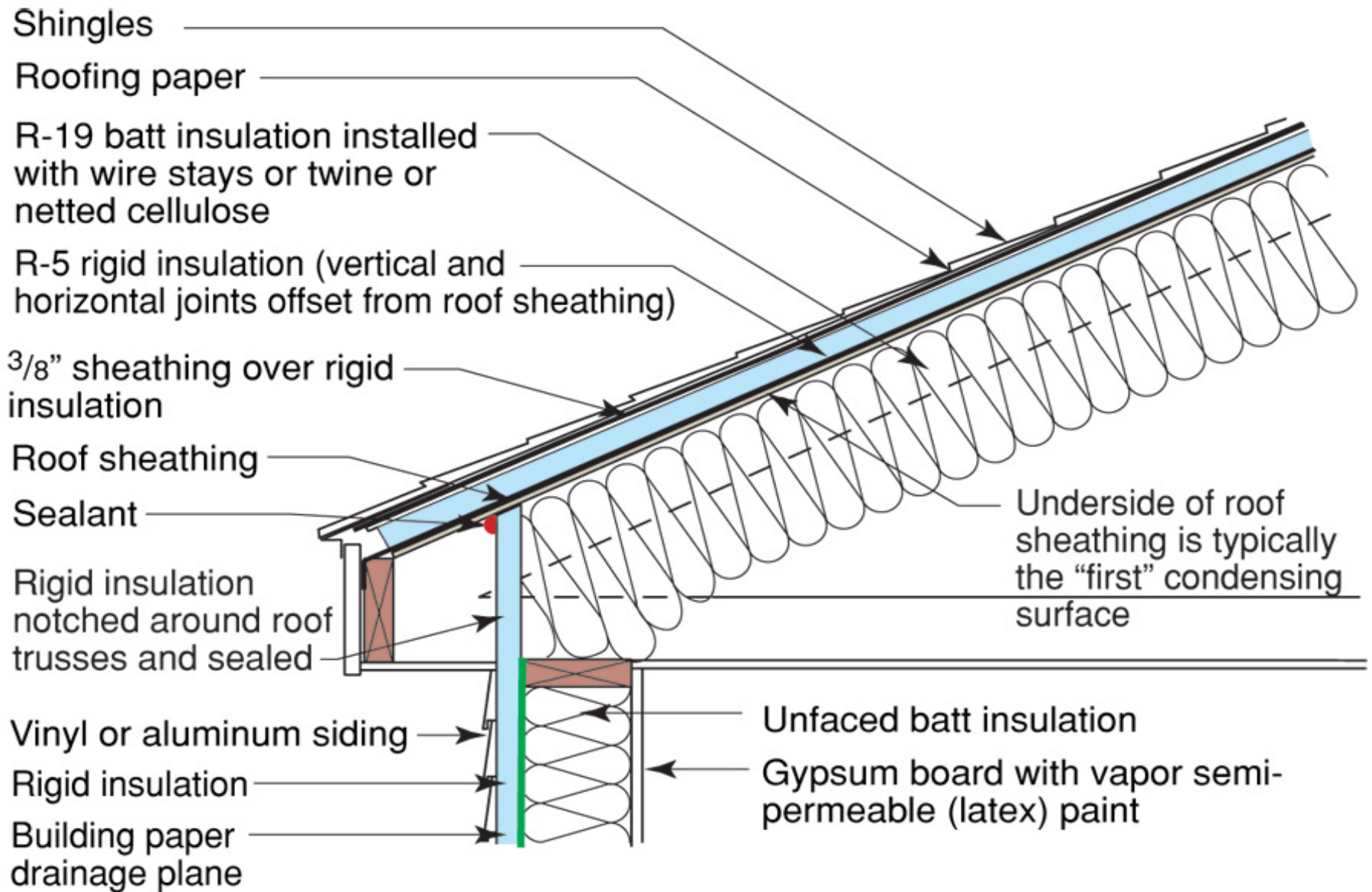


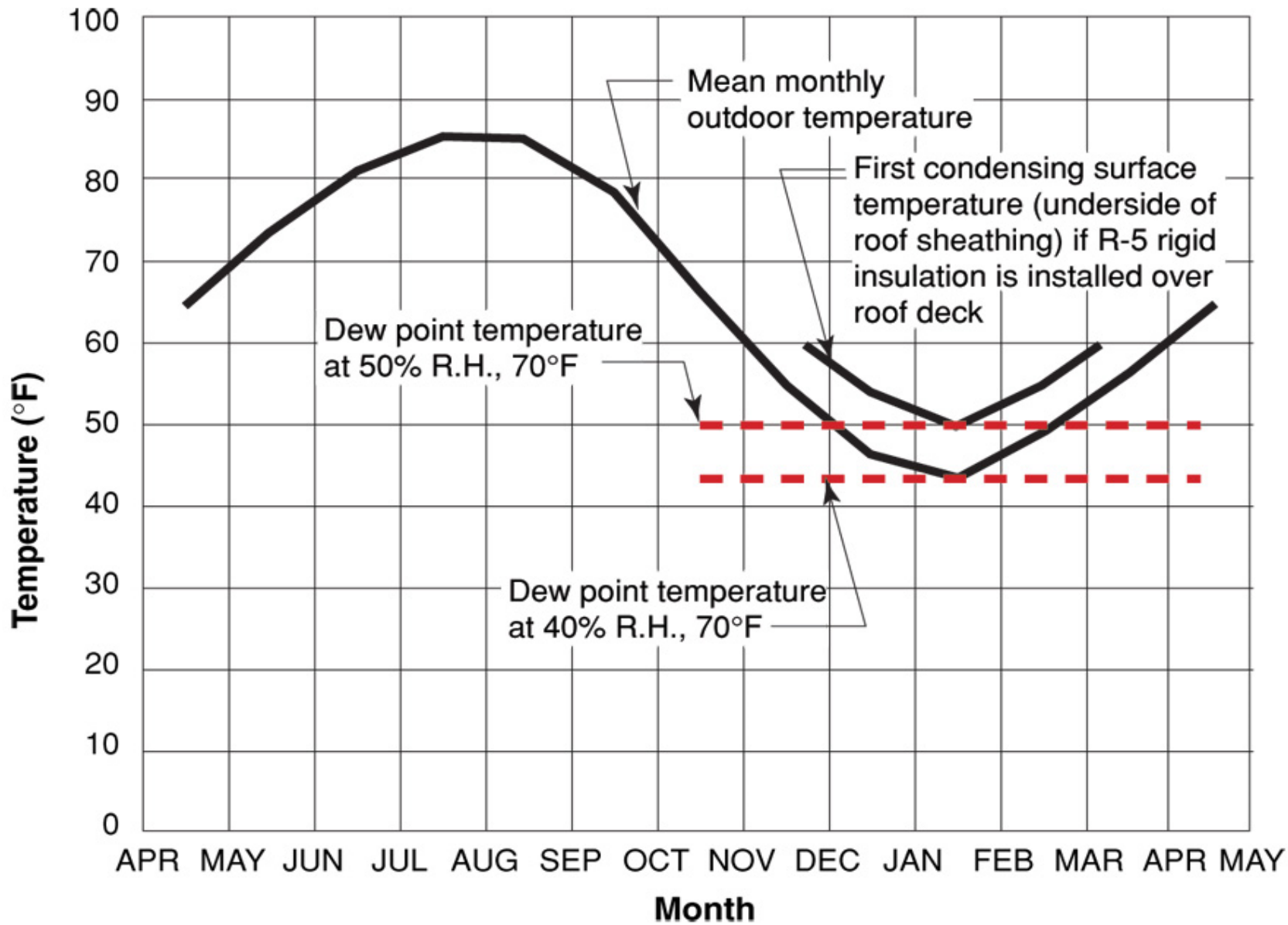












The inside face of the roof sheathing forming the cavity is the first condensing surface

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)

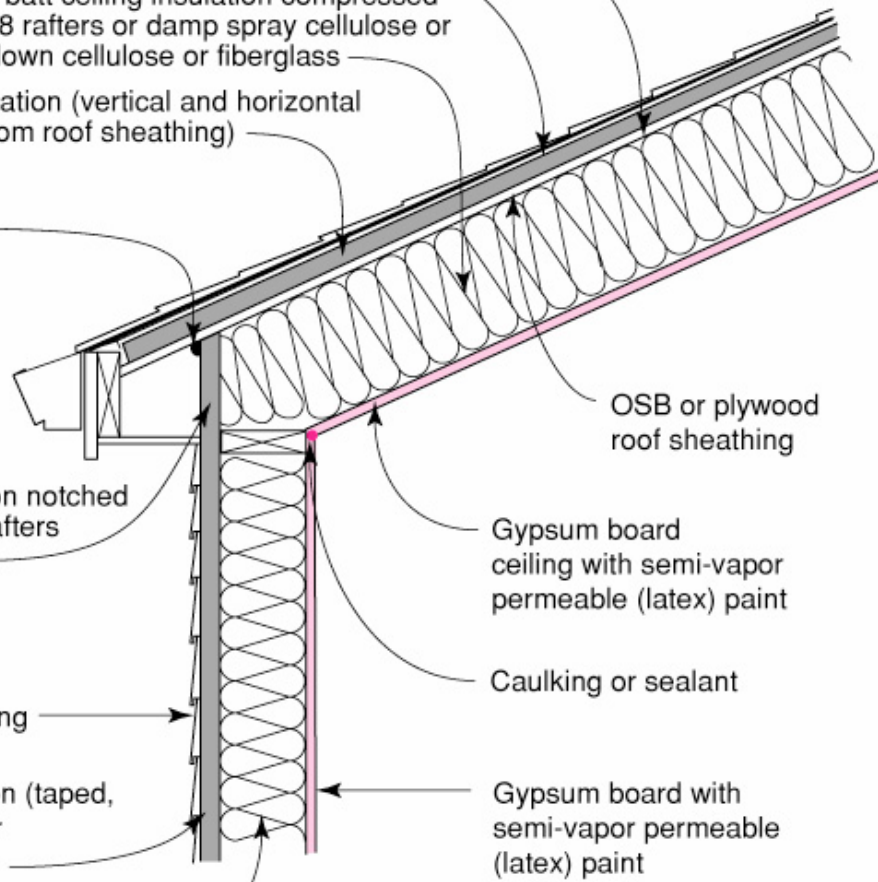
Sealant

Rigid insulation notched around roof rafters and sealed

Vinyl or aluminum siding

Rigid insulation (taped, shiplapped or sealed joints)

Unfaced batt insulation

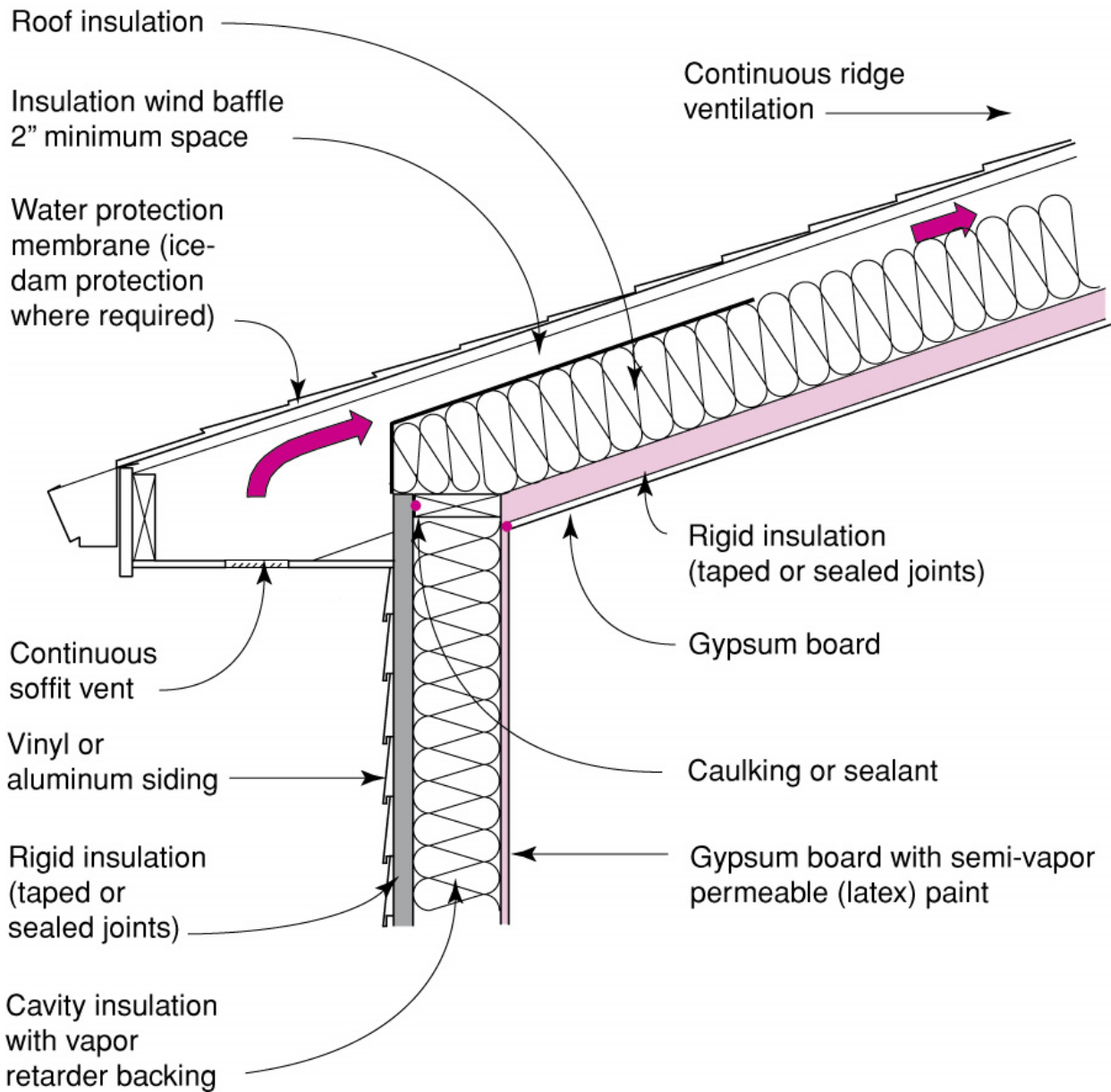


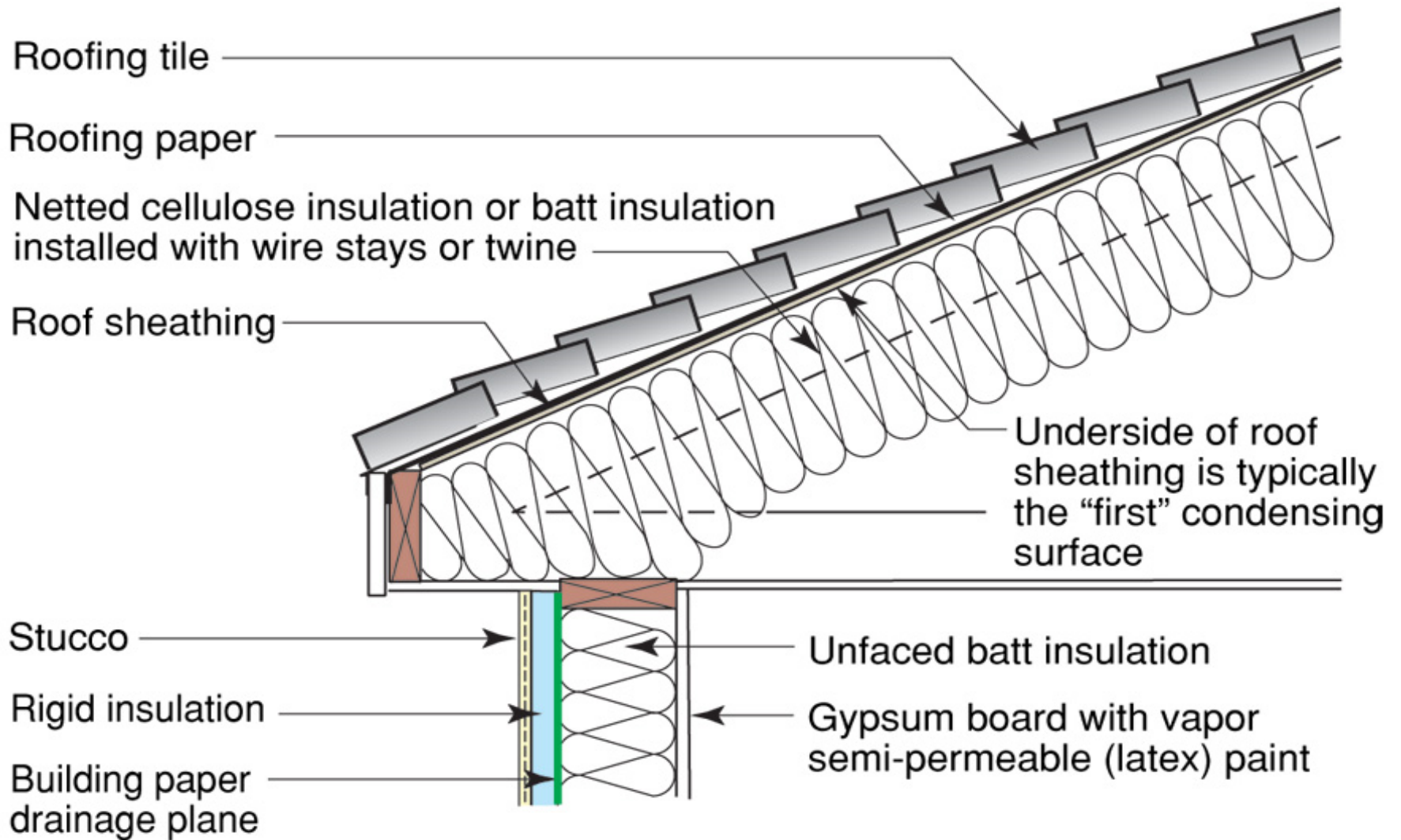
OSB or plywood roof sheathing

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

Caulking or sealant

Gypsum board with semi-vapor permeable (latex) paint

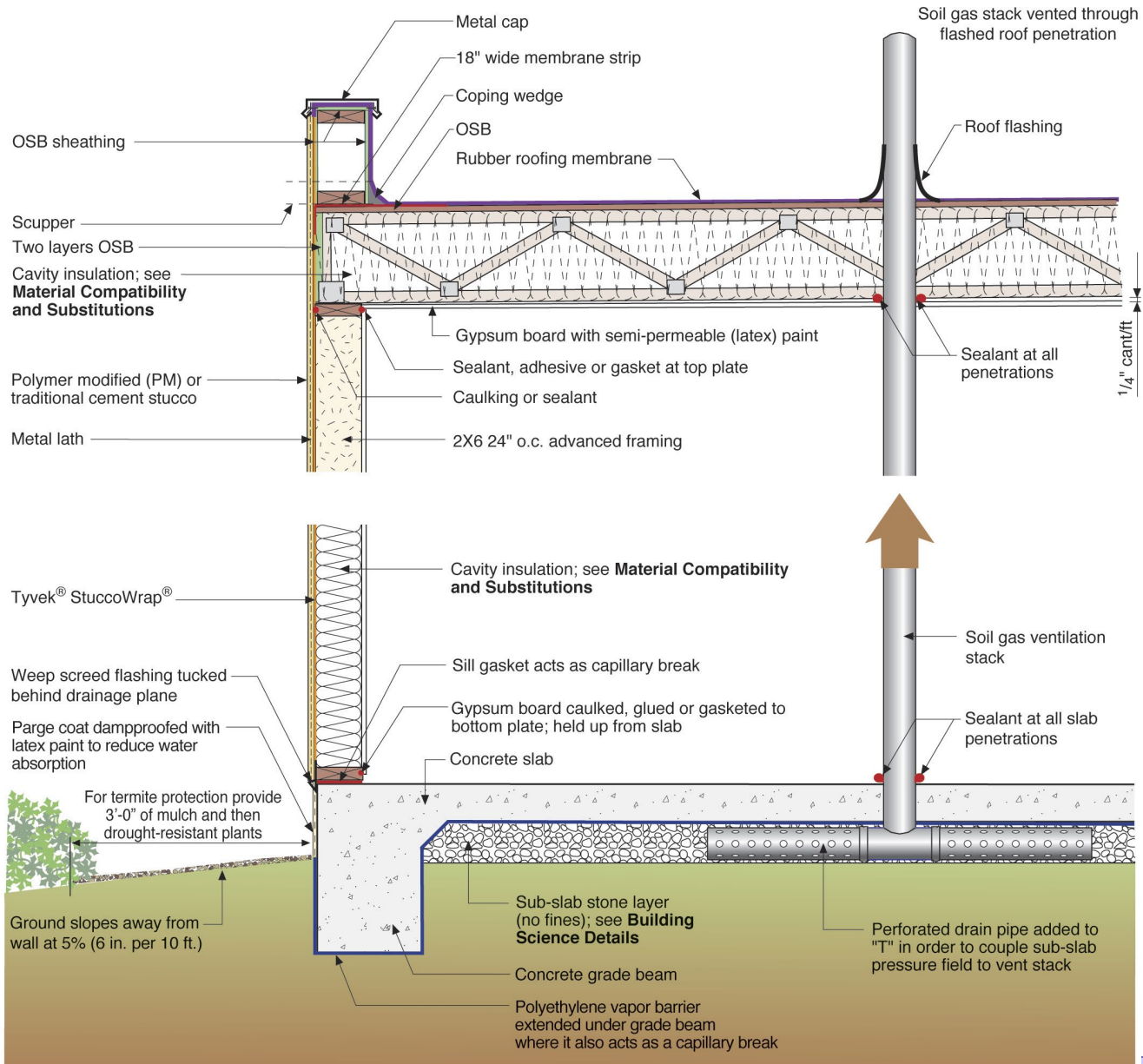


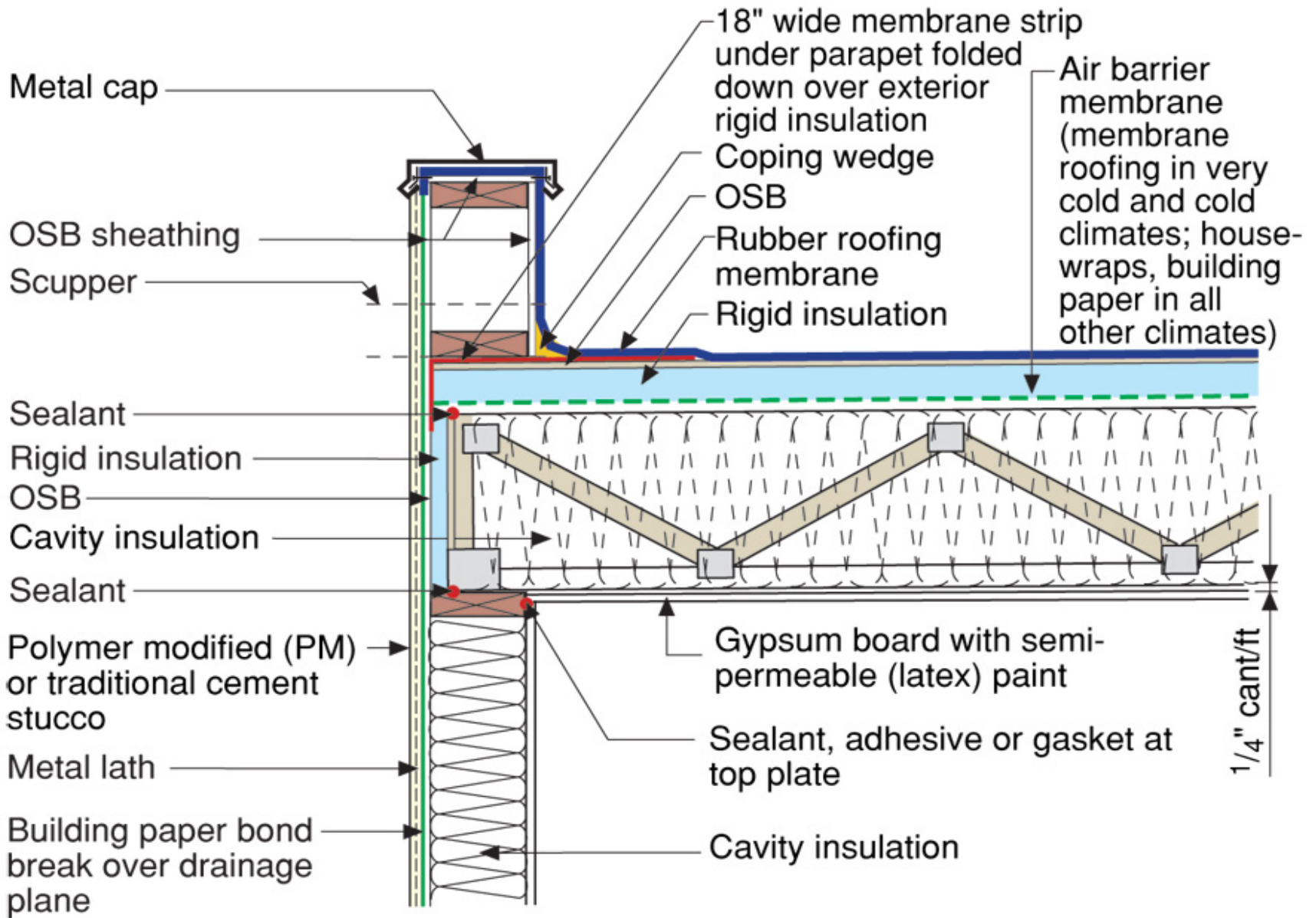


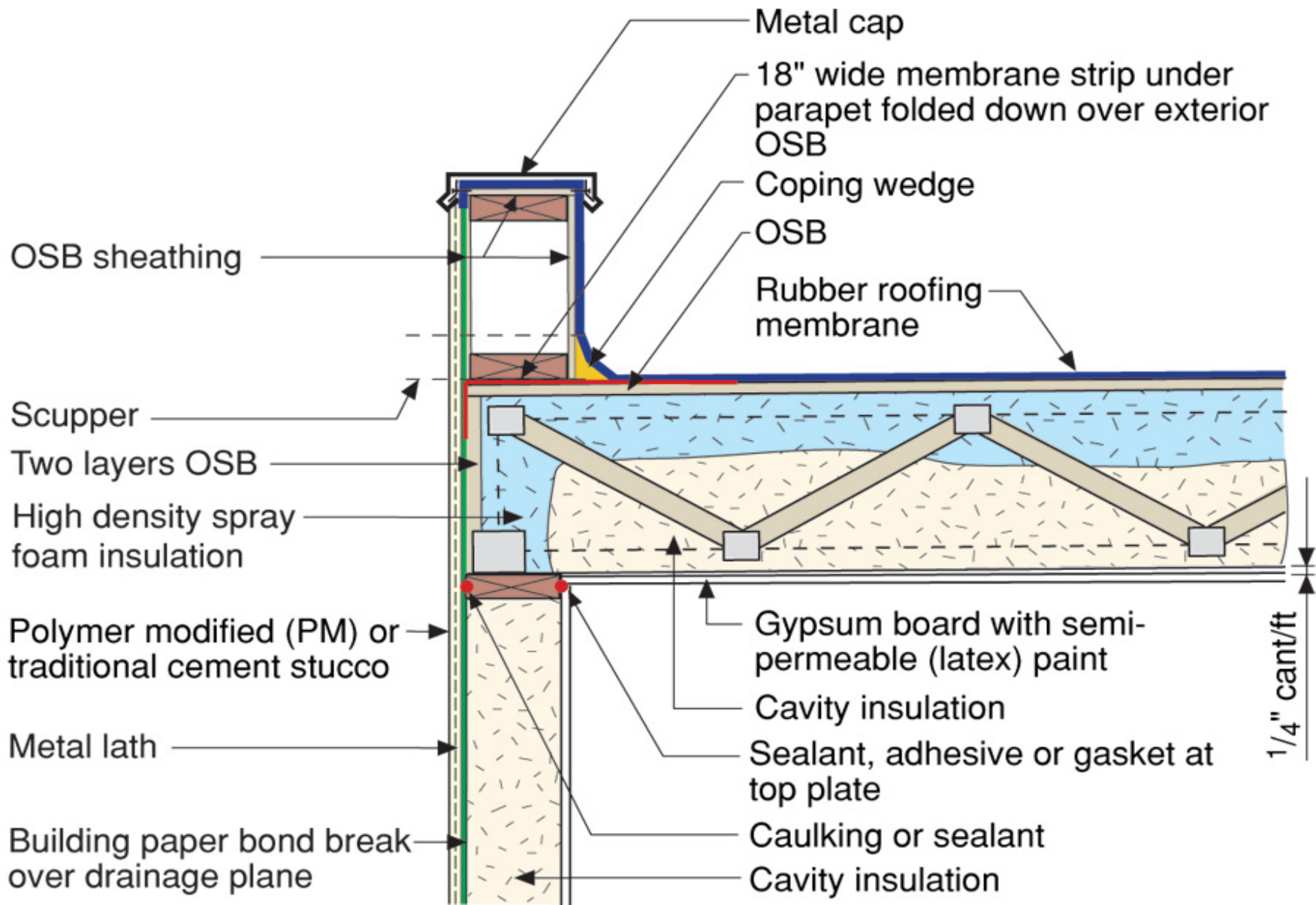




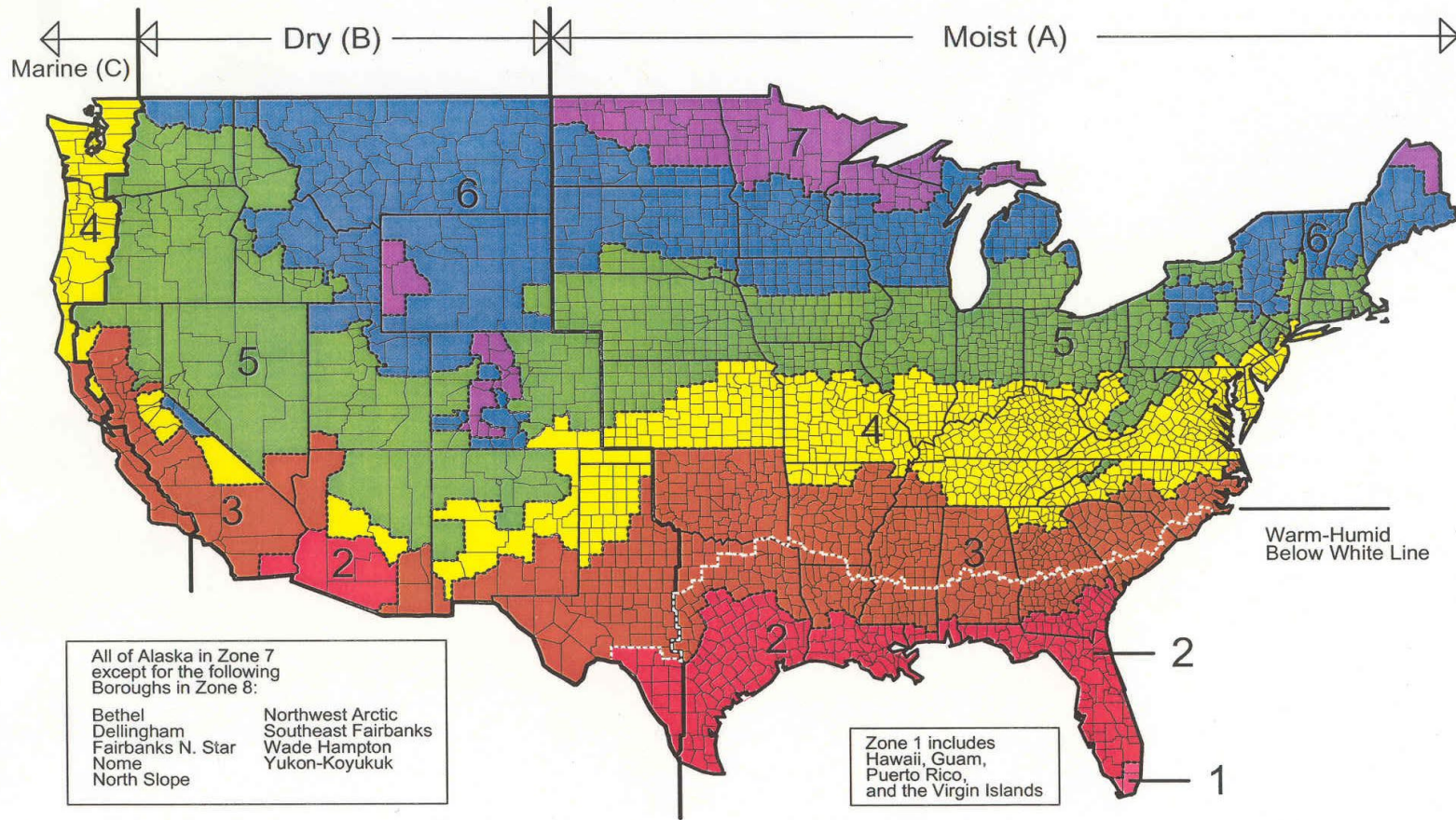




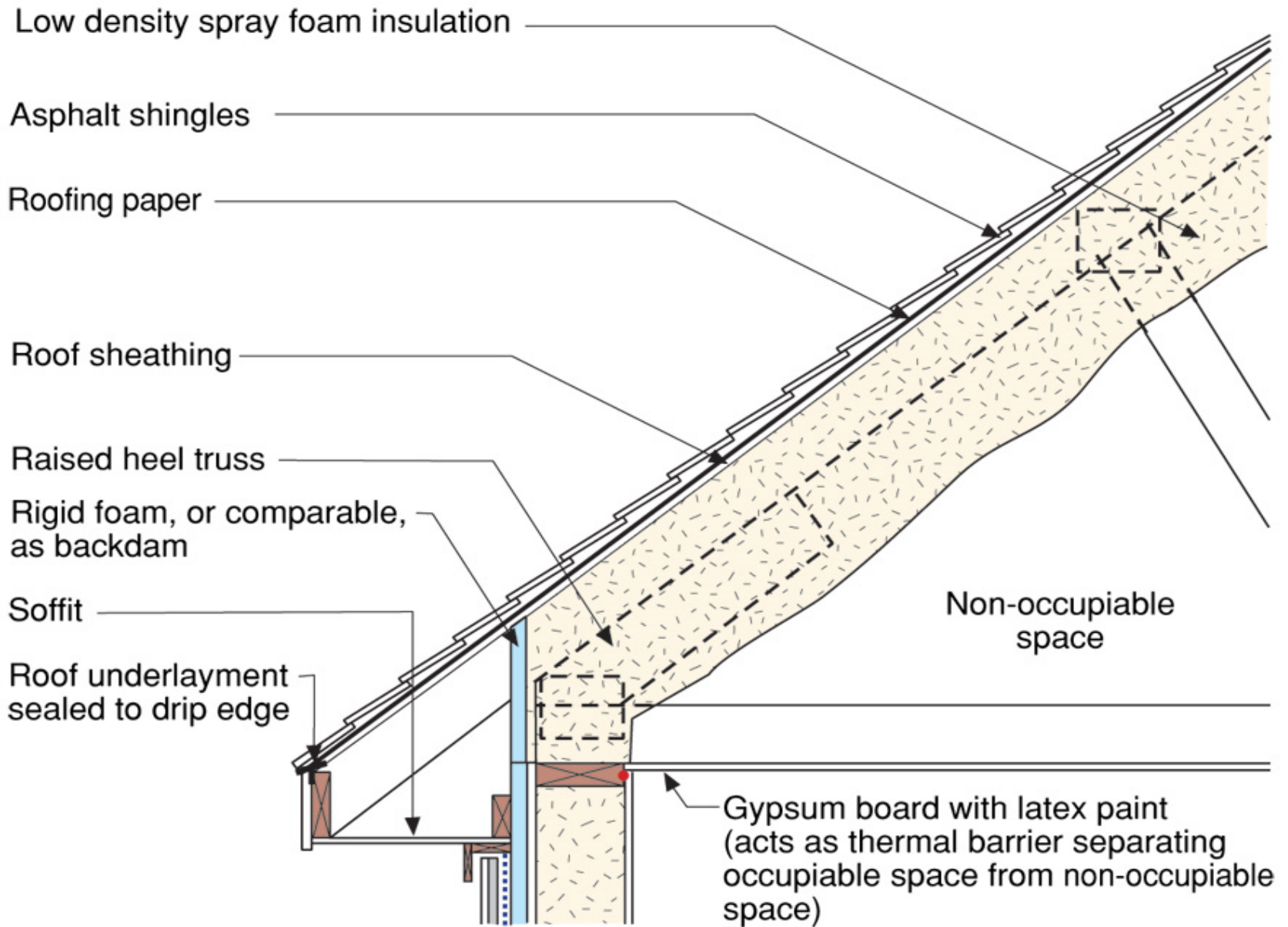




Map of DOE's Proposed Climate Zones



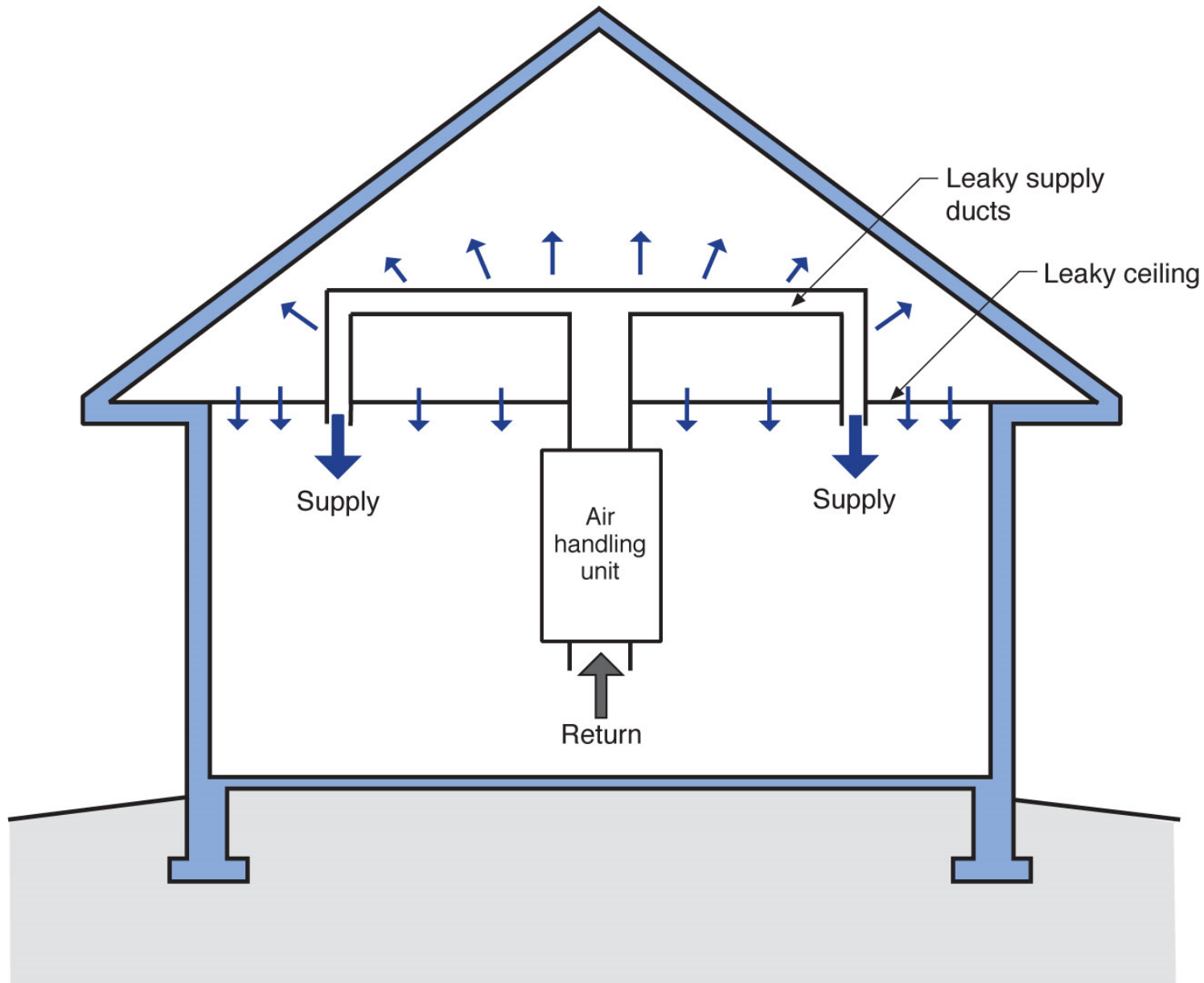
March 24, 2003















Conditioned Attics Not Unvented Attics
Need Supply Air

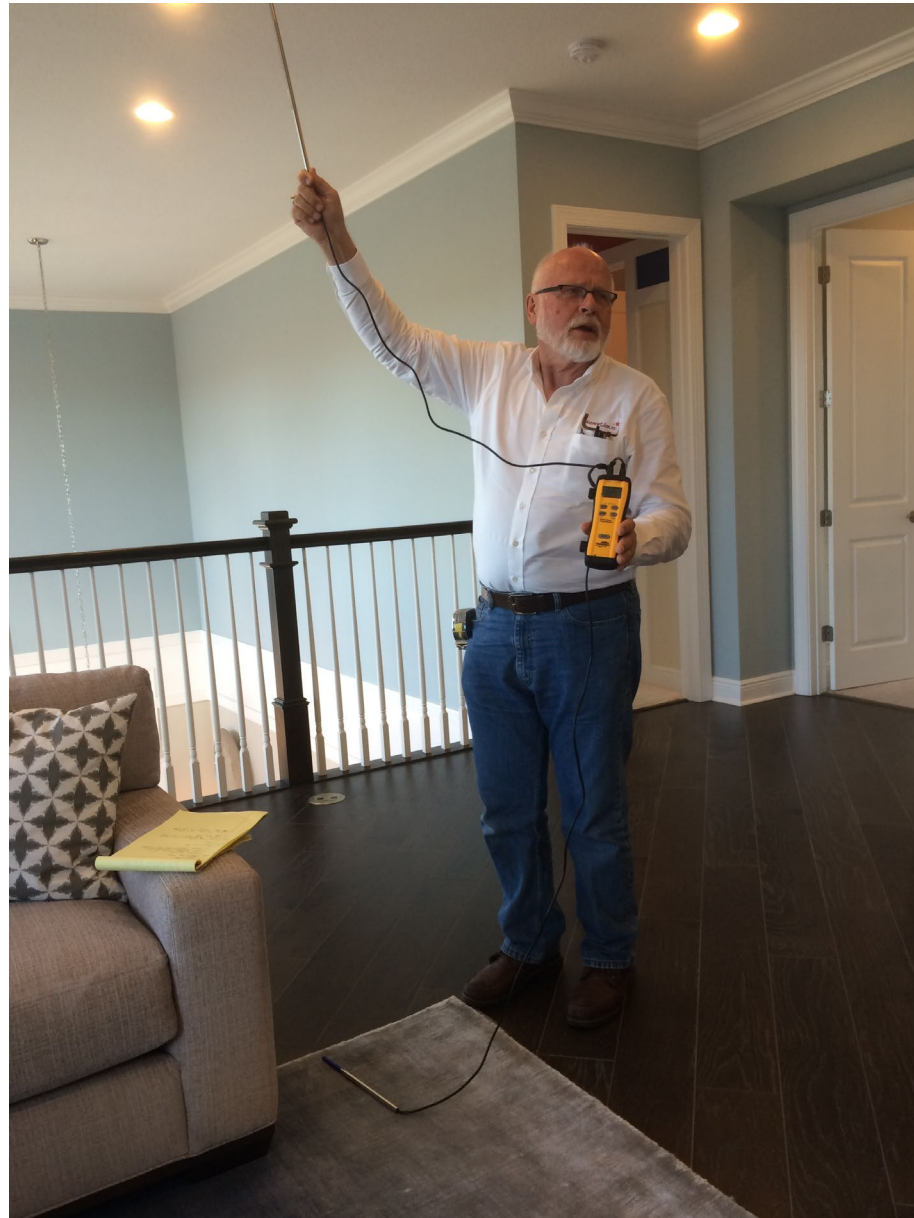
Conditioned Attics Not Unvented Attics
Need Supply Air
50 cfm/1000 ft² of Attic

Hygric Buoyancy

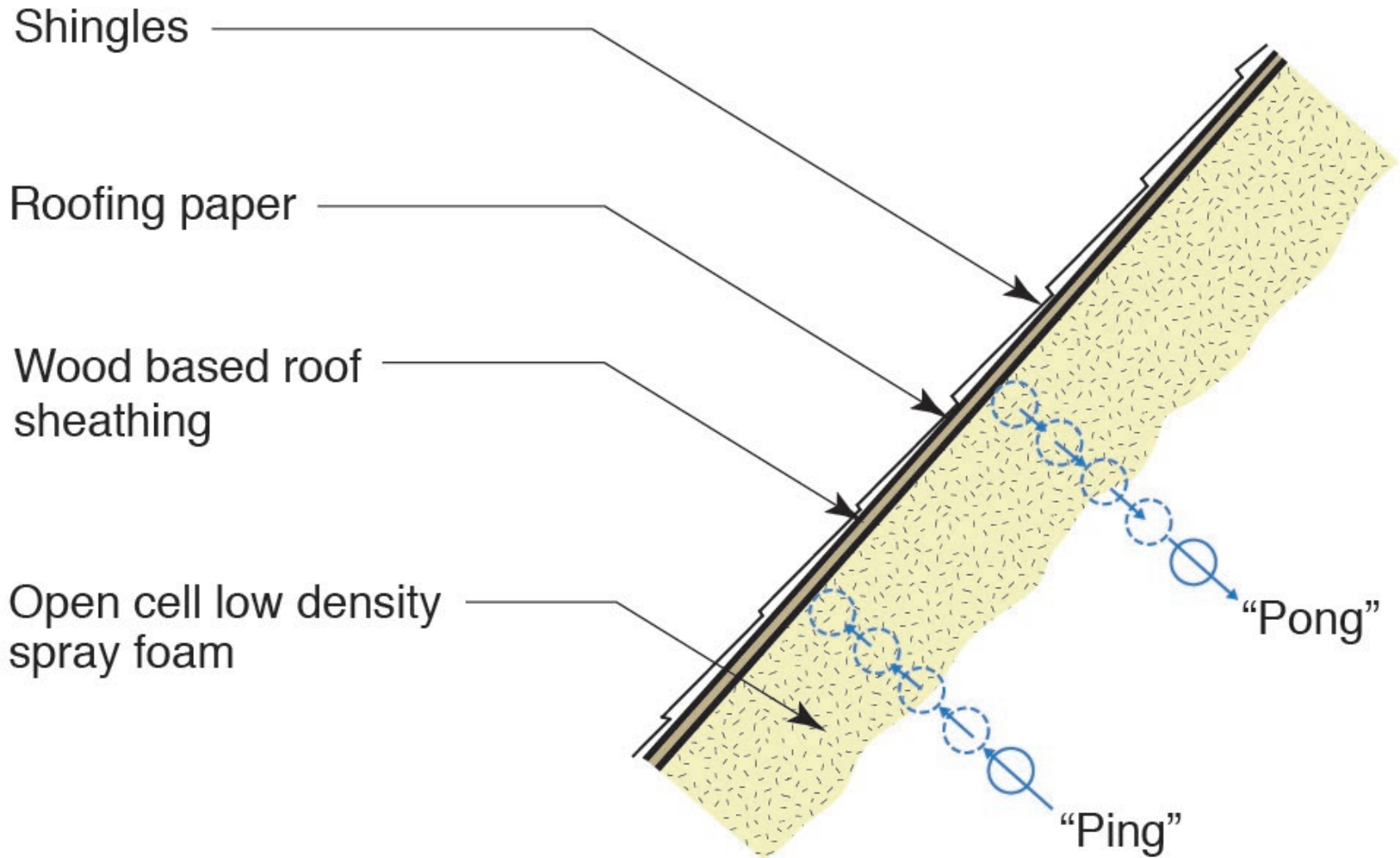
Components in Dry Air	Volume Ratio compared to Dry Air	Molecular Mass - M (kg/kmol)	Molecular Mass in Air
Oxygen	0.2095	32.00	6.704
Nitrogen	0.7809	28.02	21.88
Carbon Dioxide	0.0003	44.01	0.013
Hydrogen	0.0000005	2.02	0
Argon	0.00933	39.94	0.373
Neon	0.000018	20.18	0
Helium	0.000005	4.00	0
Krypton	0.000001	83.8	0
Xenon	$0.09 \cdot 10^{-6}$	131.29	0
Total Molecular Mass of Air			28.97

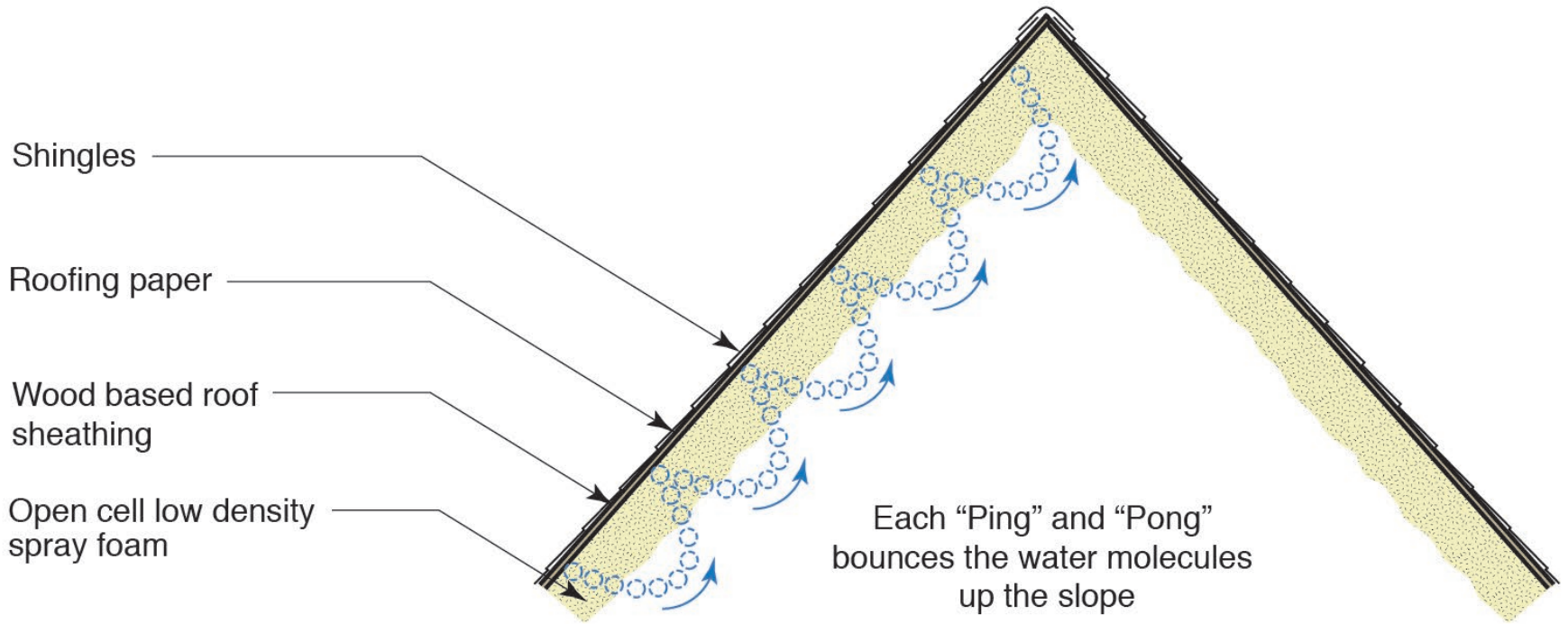
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Krypton	0.000001	83.8	0
Xenon	$0.09 \cdot 10^{-6}$	131.29	0
Total Molecular Mass of Air			28.97

Note Water Vapor (H₂O) is 18
 Dry Air is 29









Shingles

Roofing paper

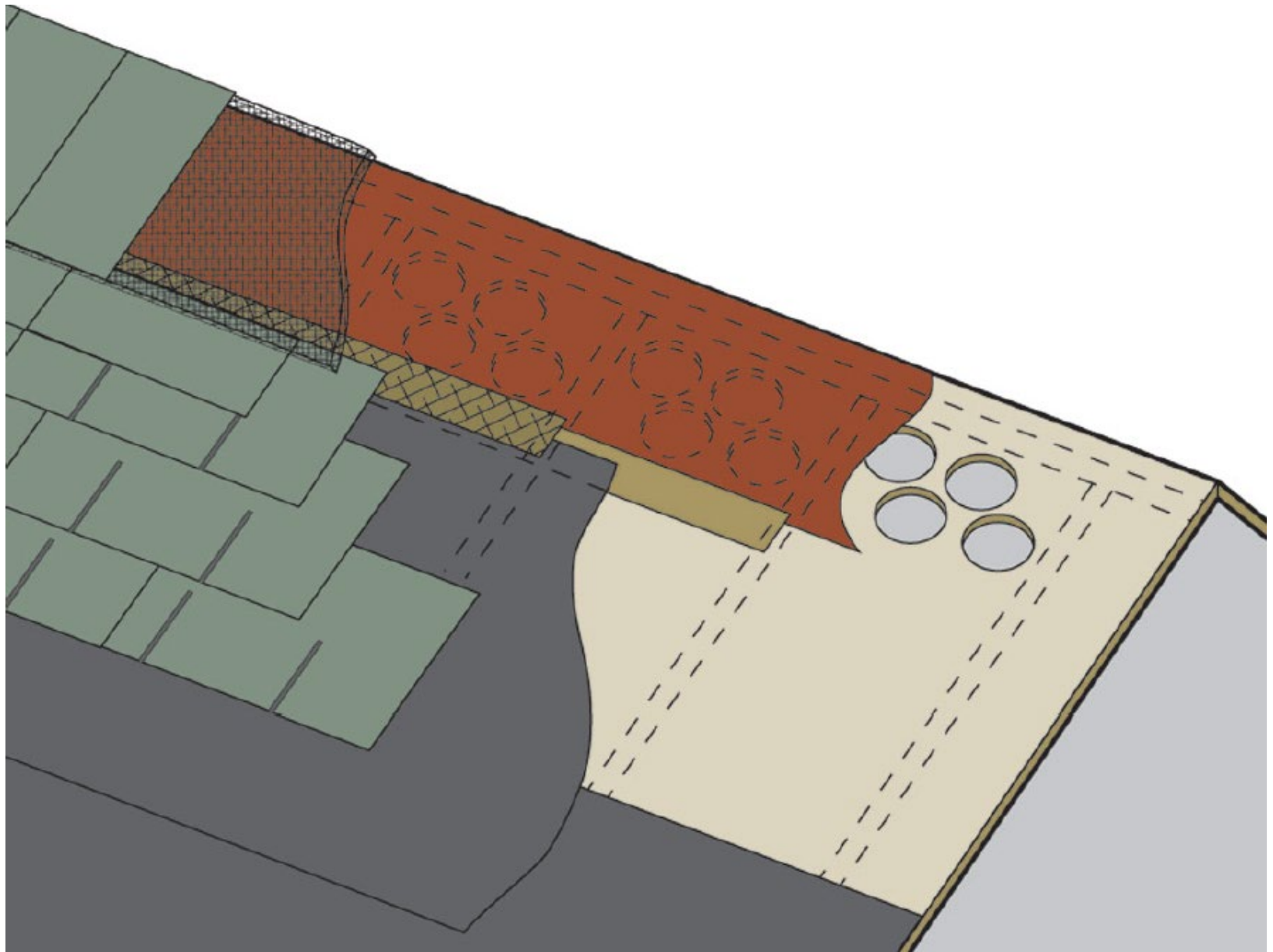
Wood based roof sheathing

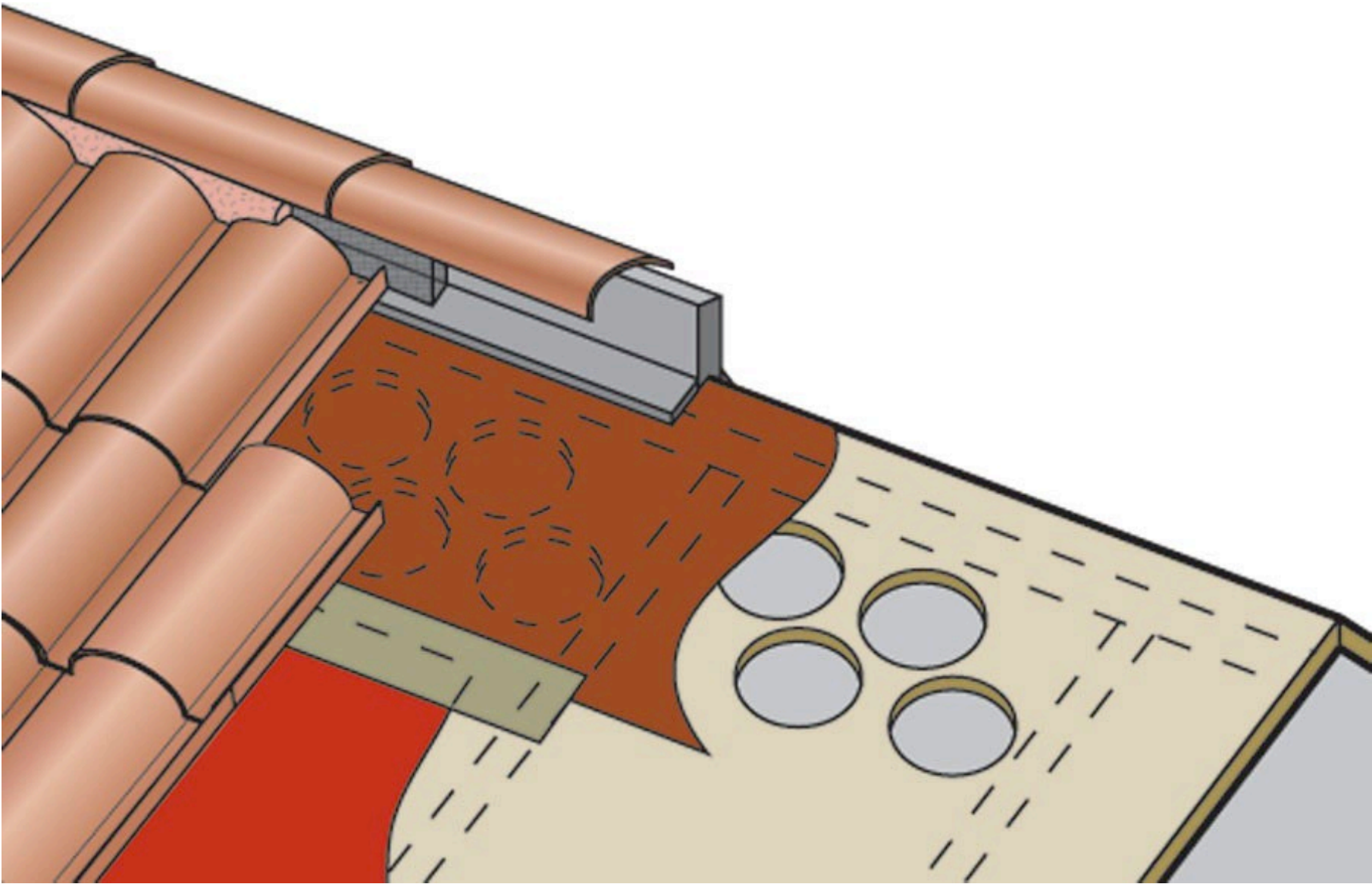
Open cell low density spray foam

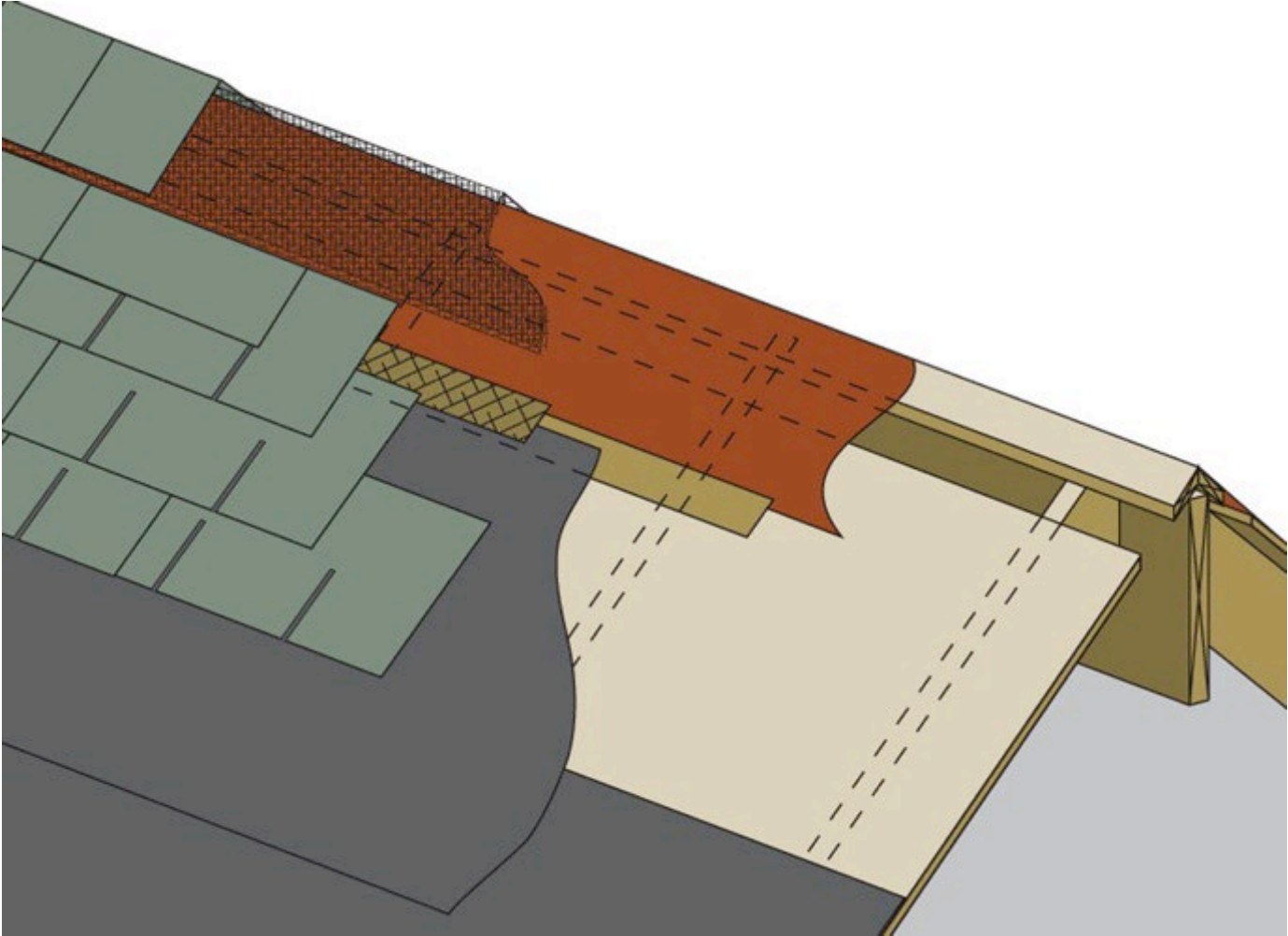
Each "Ping" and "Pong" bounces the water molecules up the slope

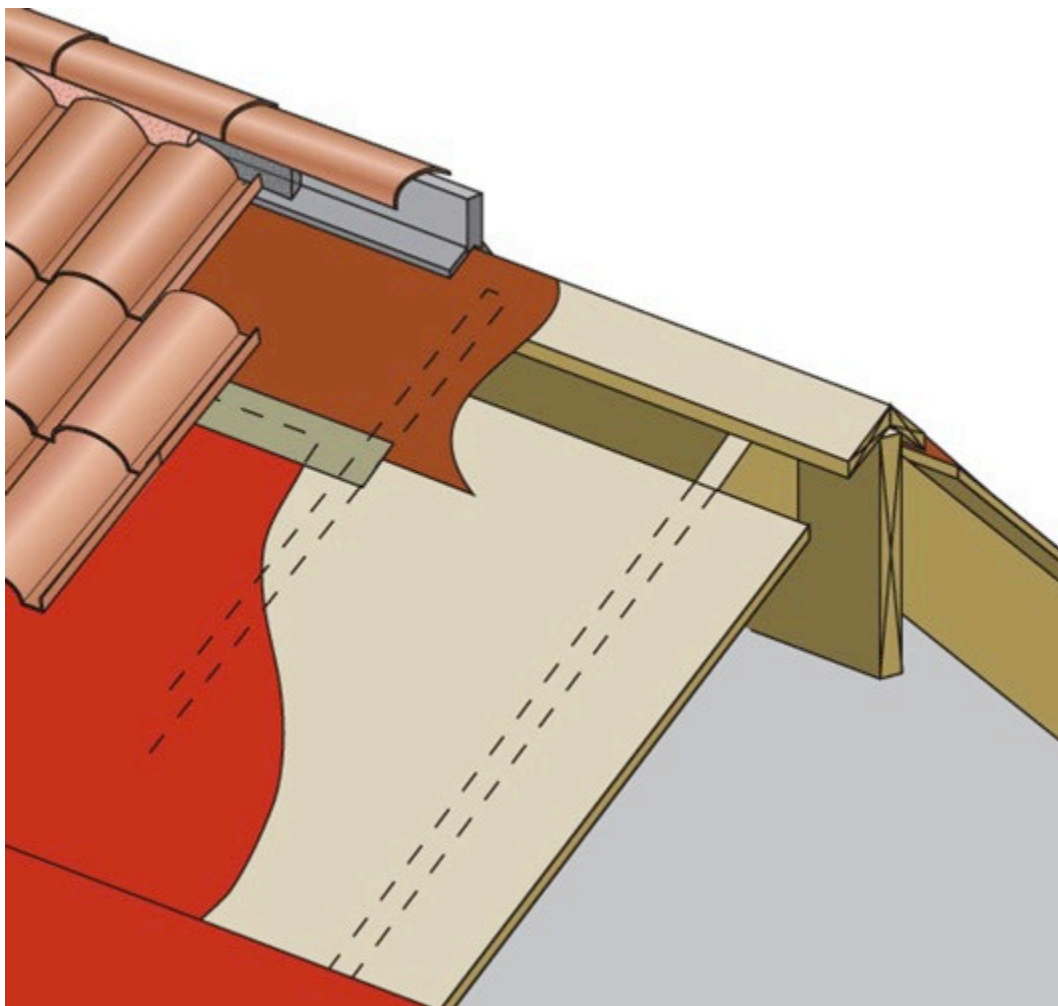


























Code Change

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
- insulation under the roof deck or at the ceiling
- air supply 50 cfm/1000 ft² ceiling area when insulation installed directly under the roof deck
- Climate Zones 1, 2 and 3

Vapor Diffusion Port: A passageway for conveying water vapor from an unvented attic to the atmosphere.

Sweating Ducts

Sweating Ducts

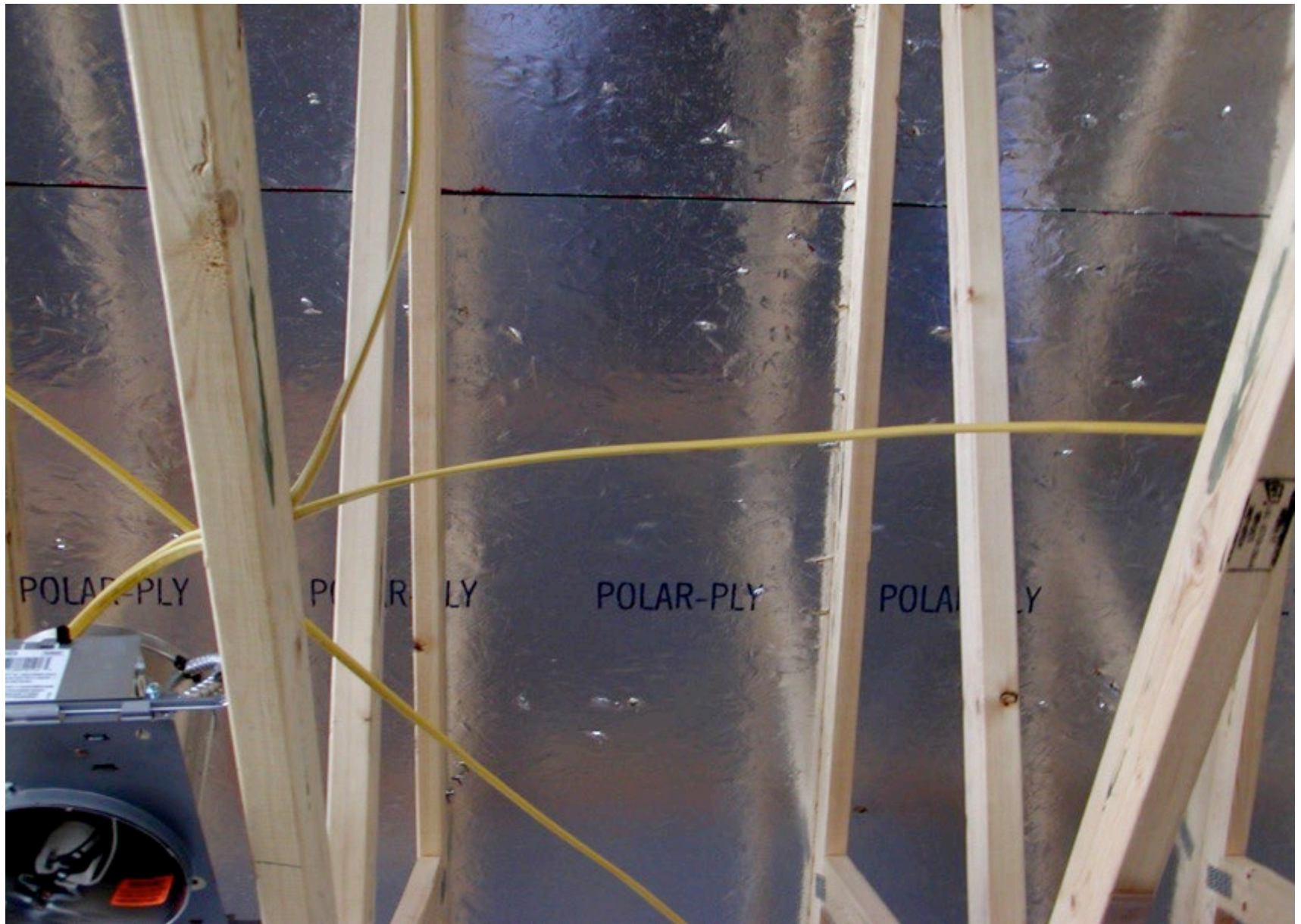
Light Colored Roofs

Cool Roofs

Radiant Barriers

ACCA Manual J, S and D

ASHRAE 62.2

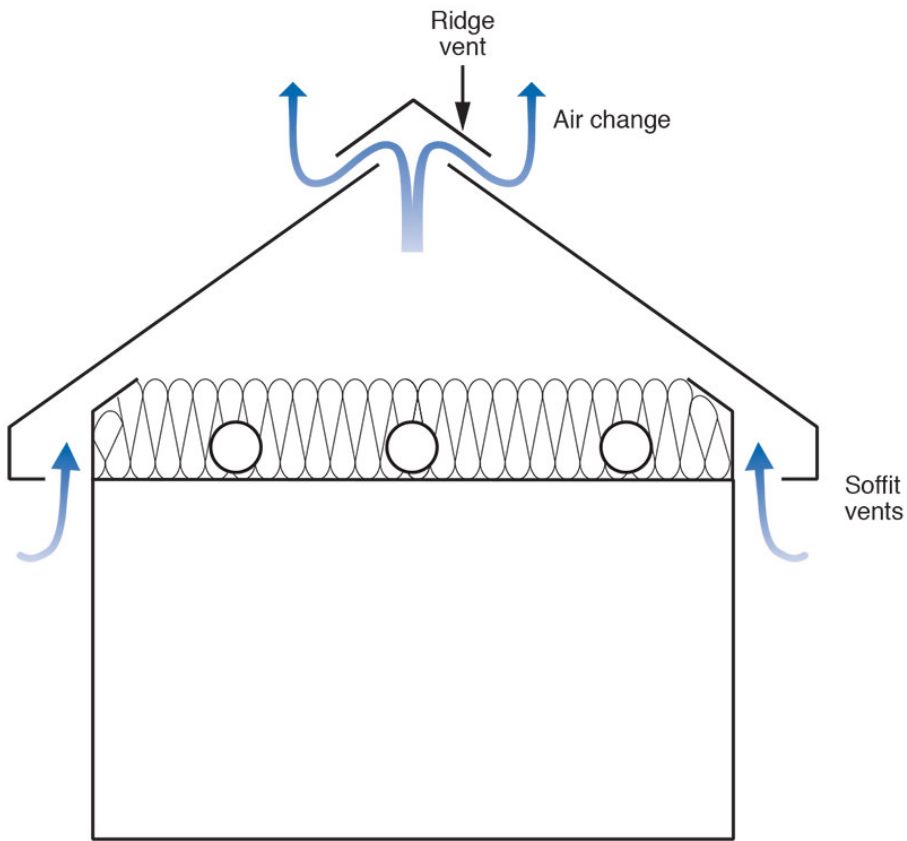




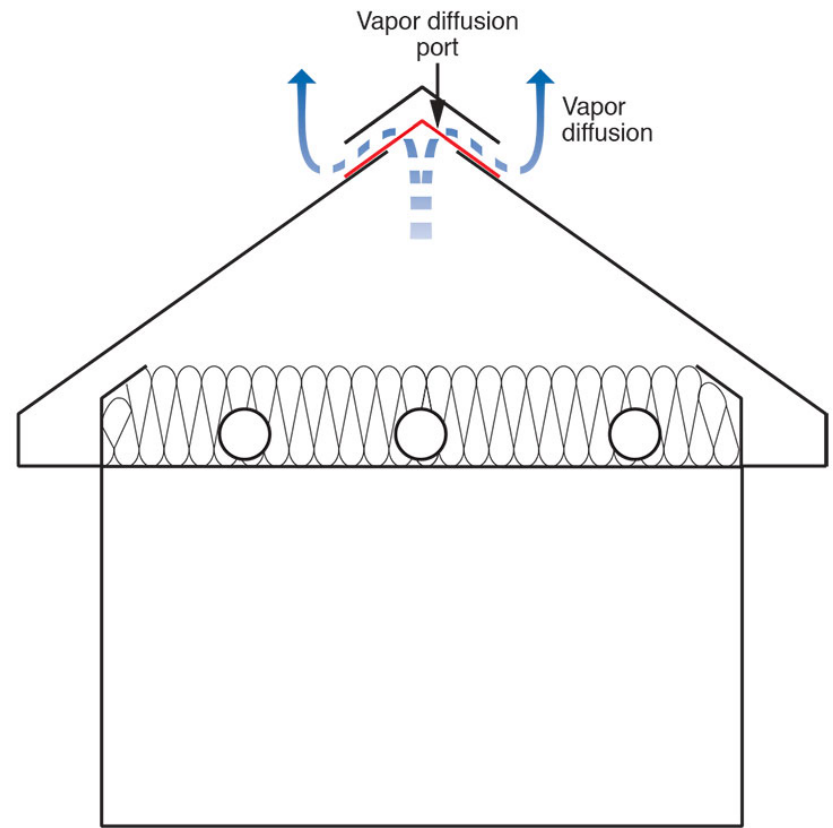








Classic vented attic



Unvented attic with vapor diffusion port











