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Building Science

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

www.buildingscience.com

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

$$k = Ae^{-E_a/(RT)}$$

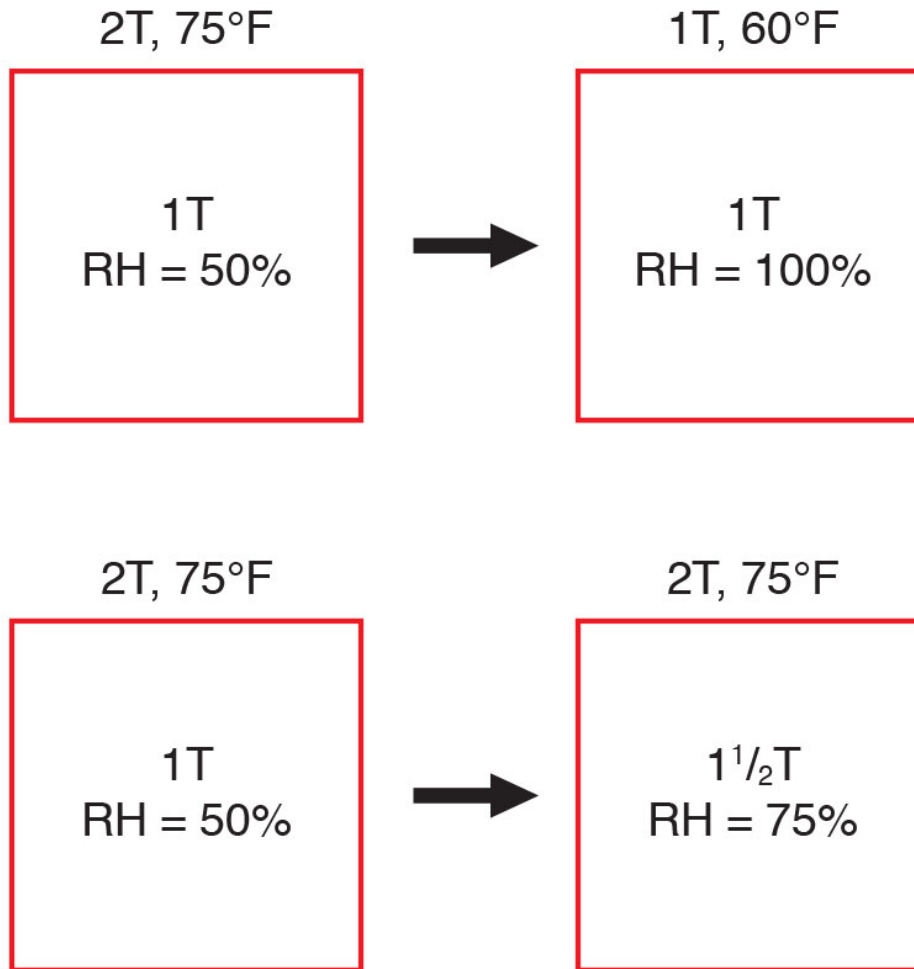
Damage Functions

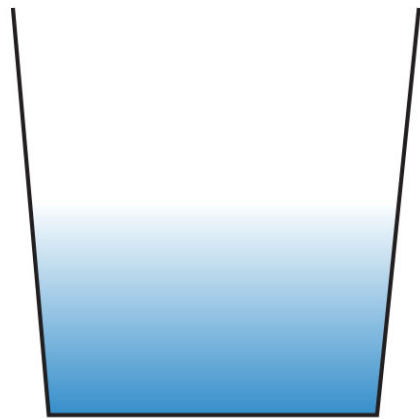
Water

Heat

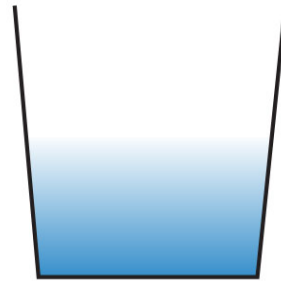
Ultra-violet Radiation

Vapor Pressure and Relative Humidity

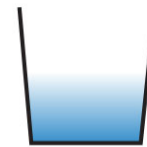




90°F
50% RH



75°F
50% RH



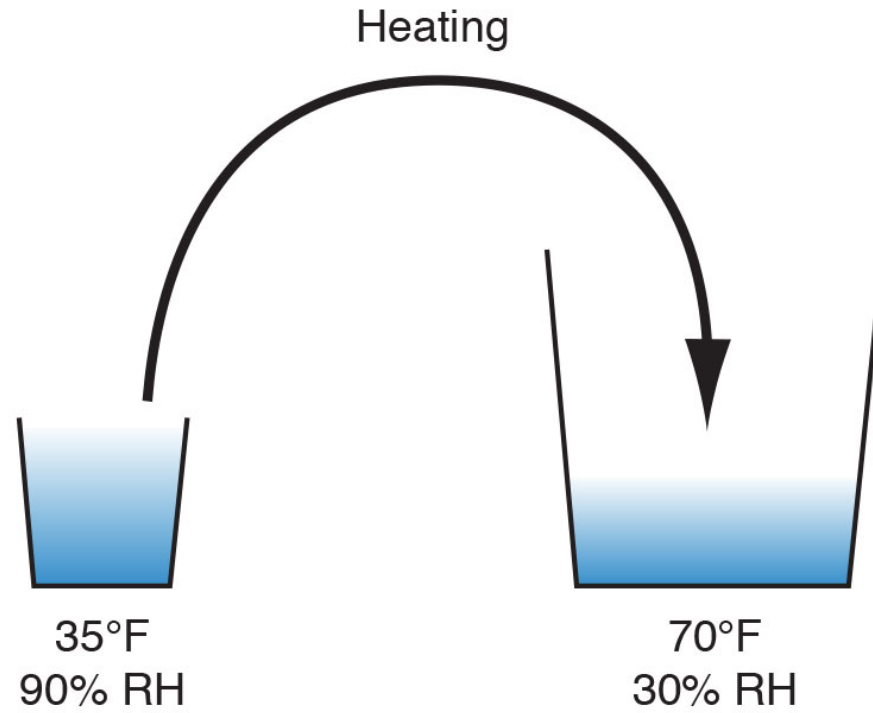
60°F
50% RH

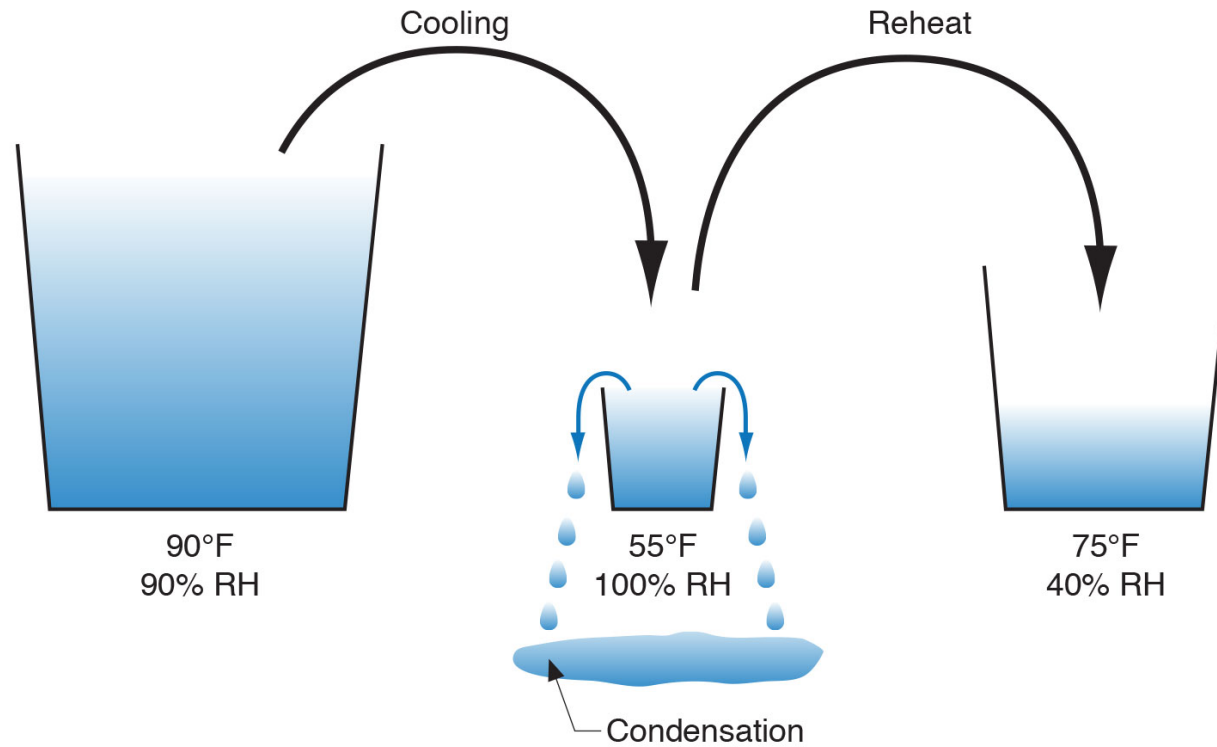


45°F
50% RH



30°F
50% RH







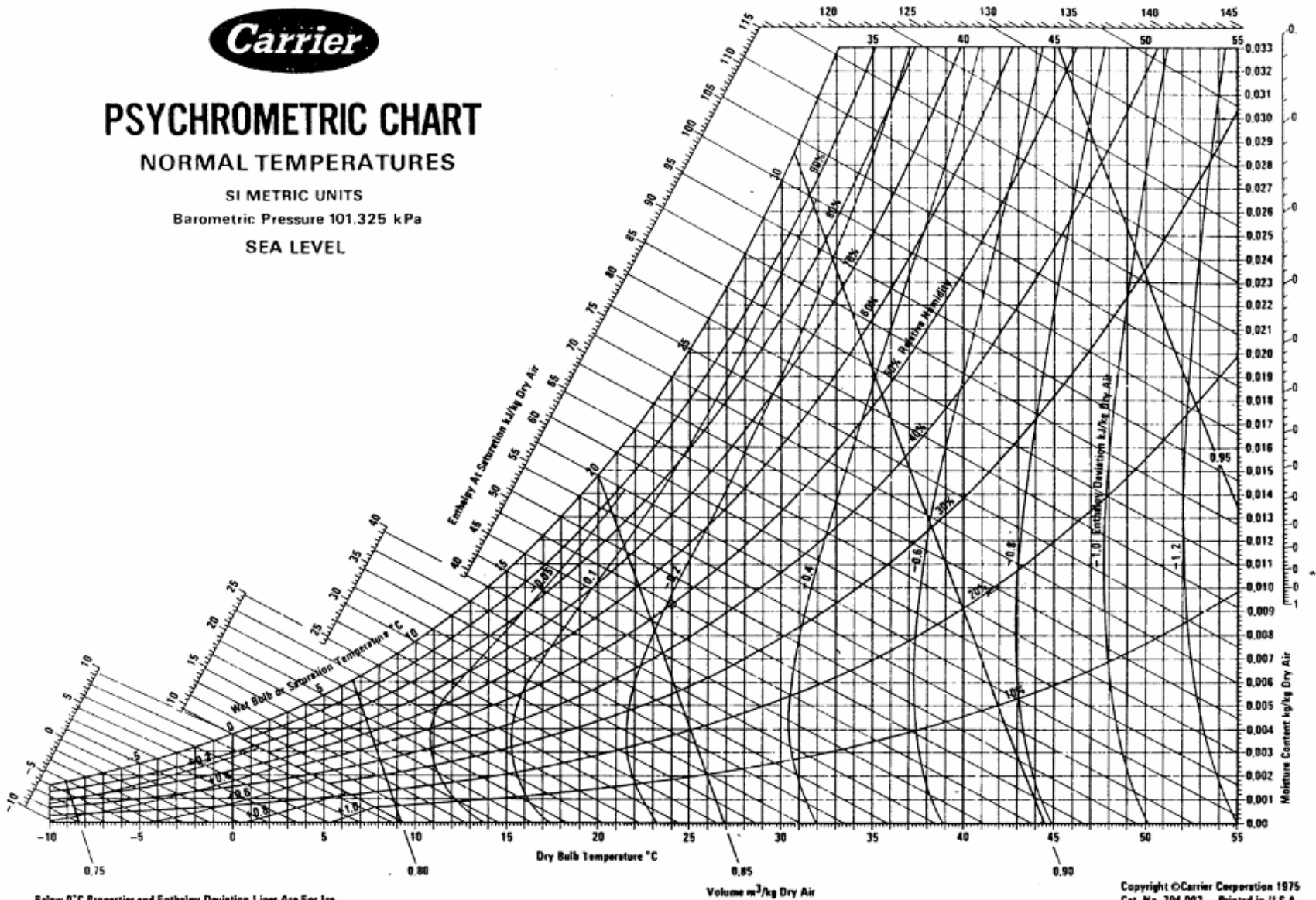
PSYCHROMETRIC CHART

NORMAL TEMPERATURES

SI METRIC UNITS

Barometric Pressure 101.325 kPa

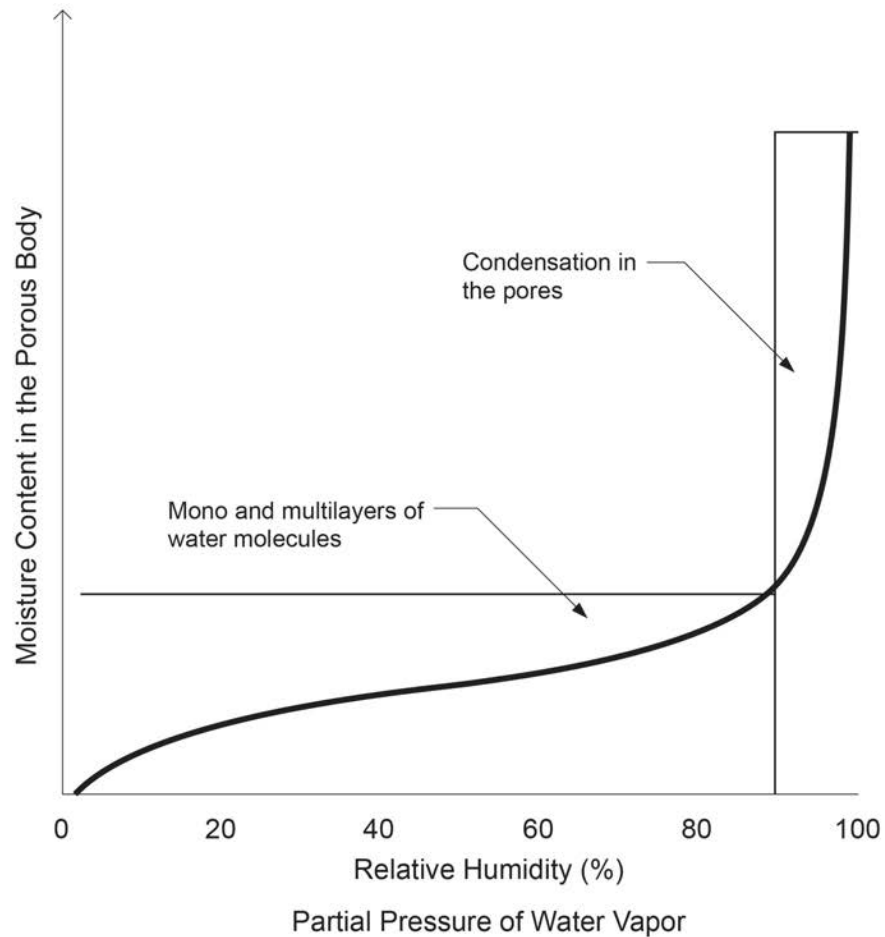
SEA LEVEL



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

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Cat. No. 794-002 Printed in U.S.A.

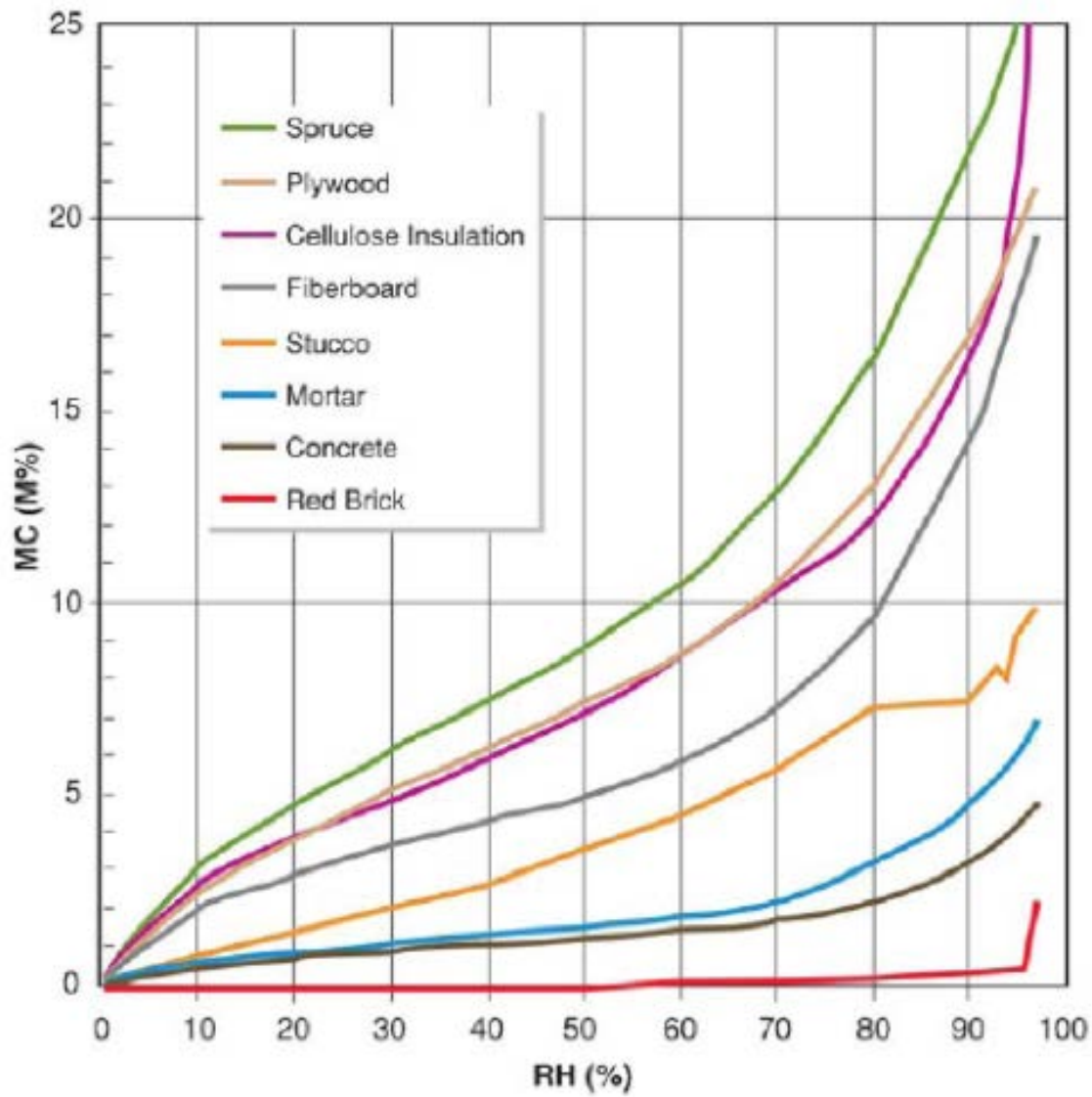
Sorption Isotherms

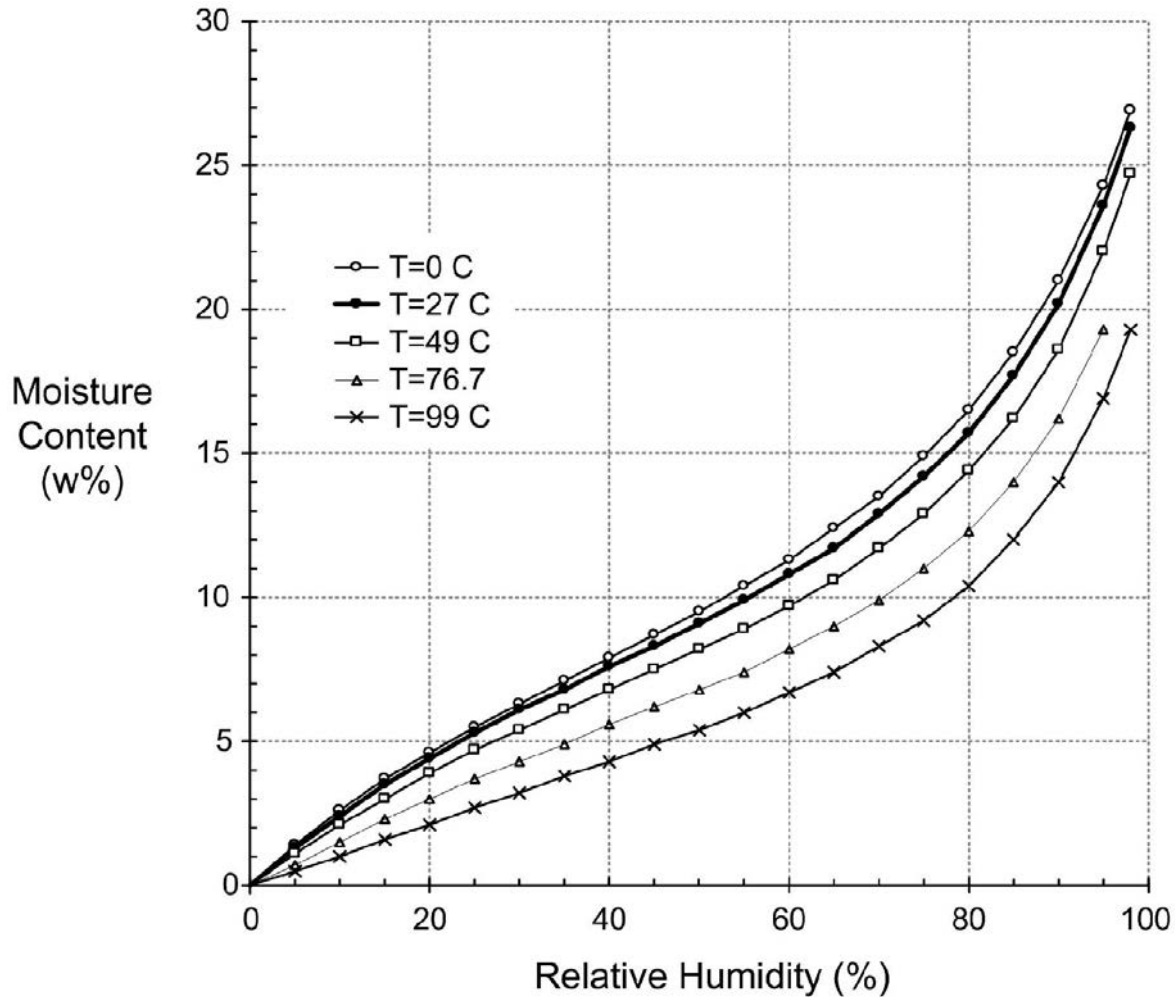


Change in the storage of moisture in a porous building material as the partial pressure of water vapor in the ambient air increases from zero to full saturation value at a given temperature.

Sorption Curve

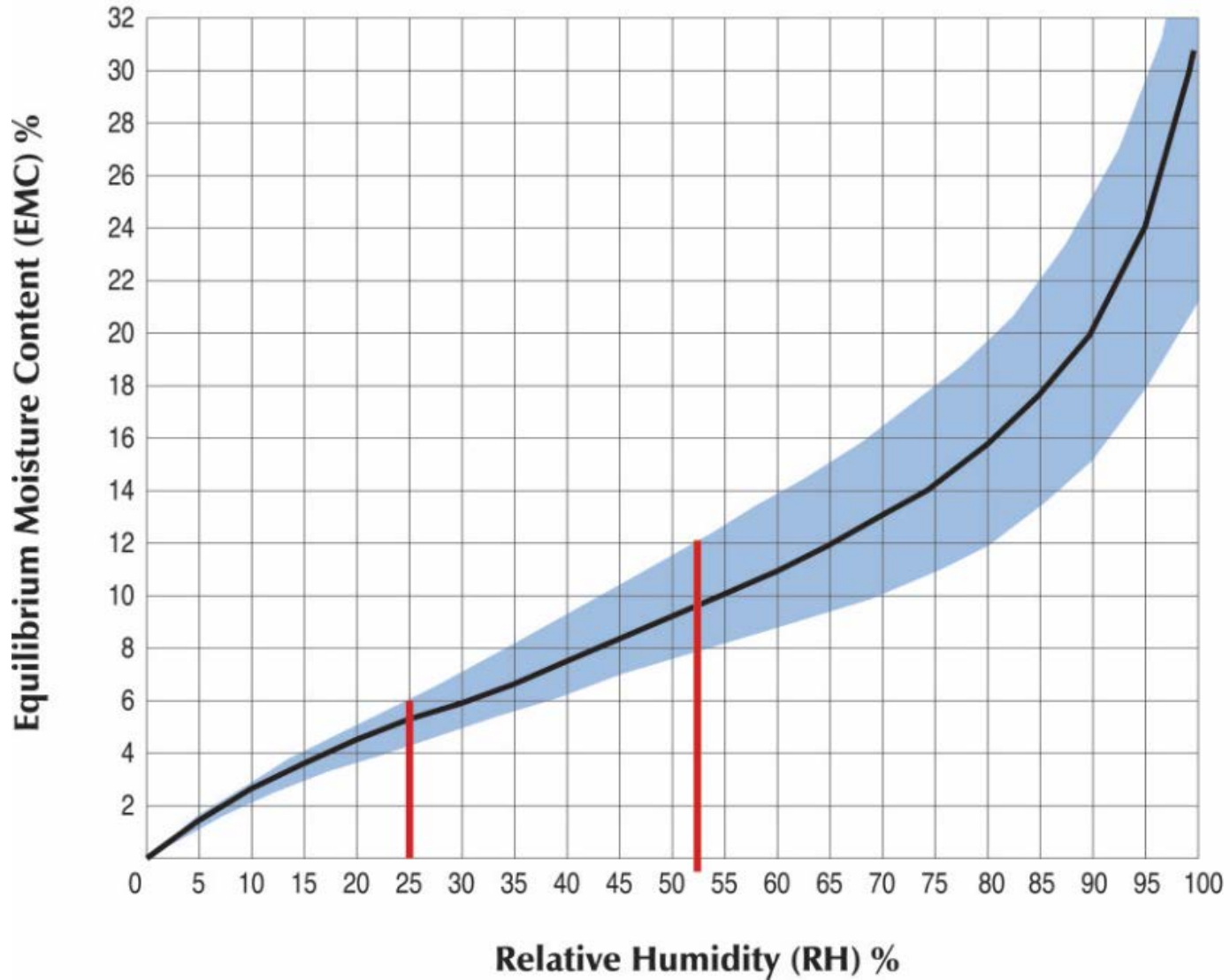
From M.K. Kumaran, ASTM MNL 18-2nd Edition,
Moisture Control in Buildings, 2009





Average sorption isotherm for wood as a function of temperature
 From Straube & Burnett, 2005

Moisture Content vs. Relative Humidity



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

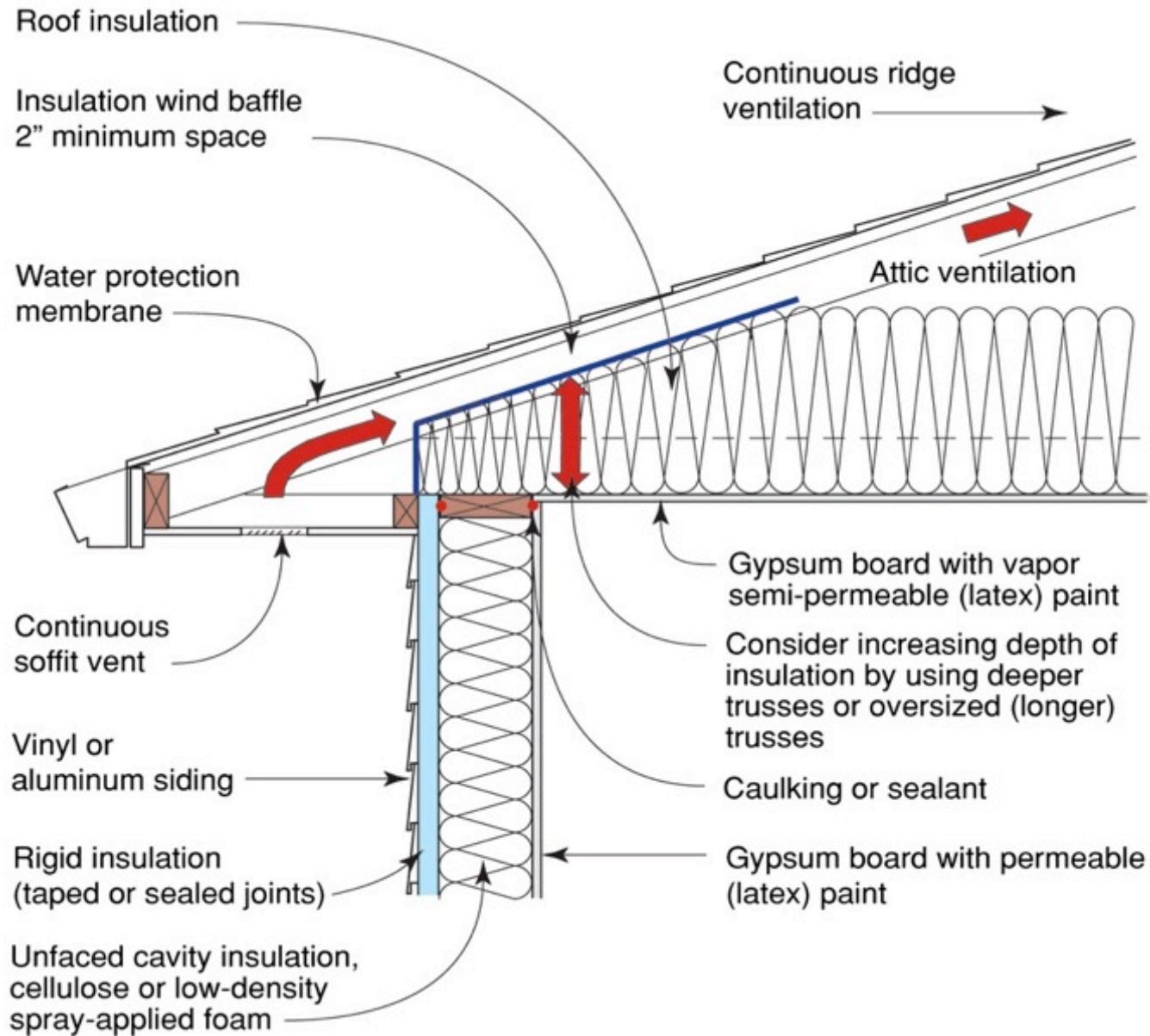


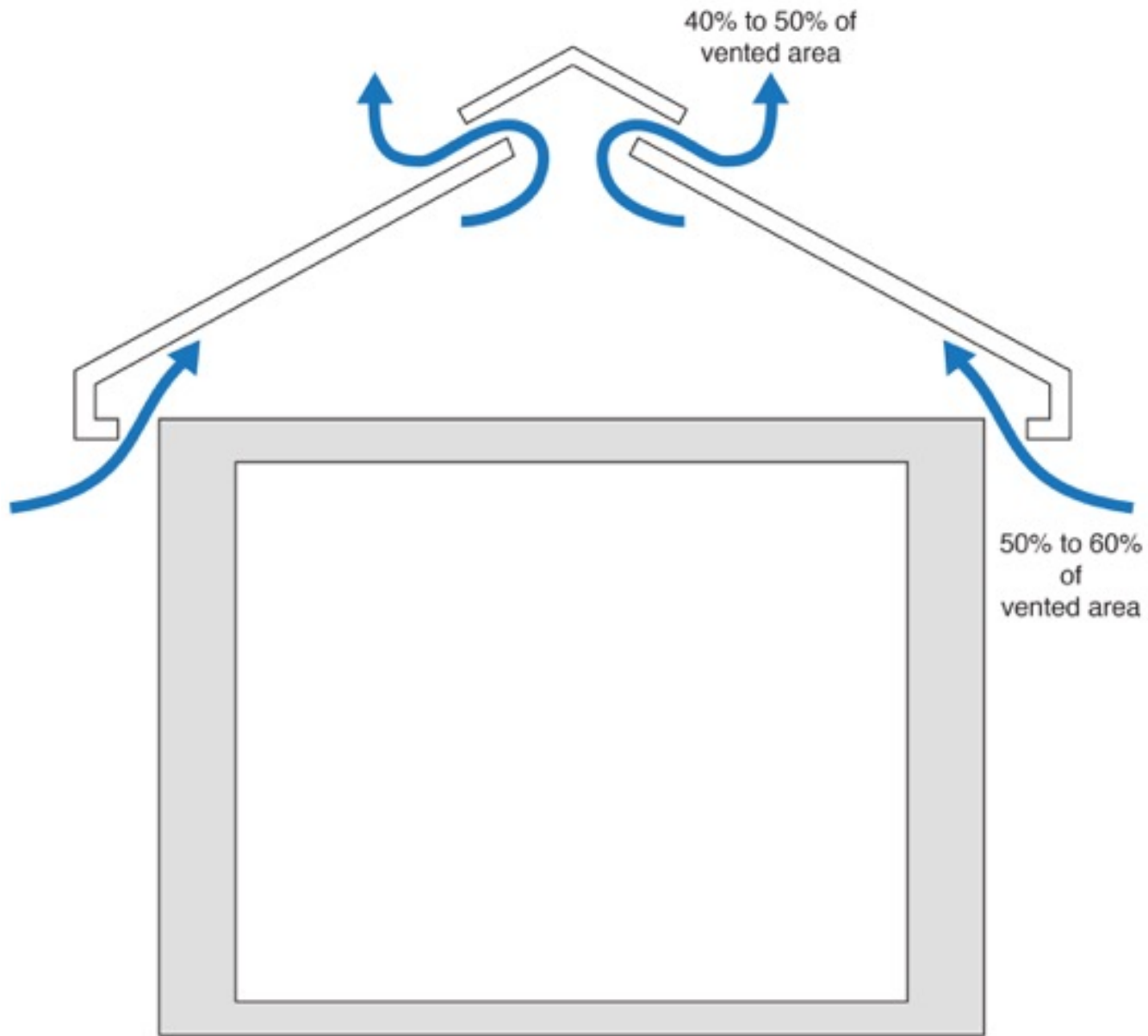


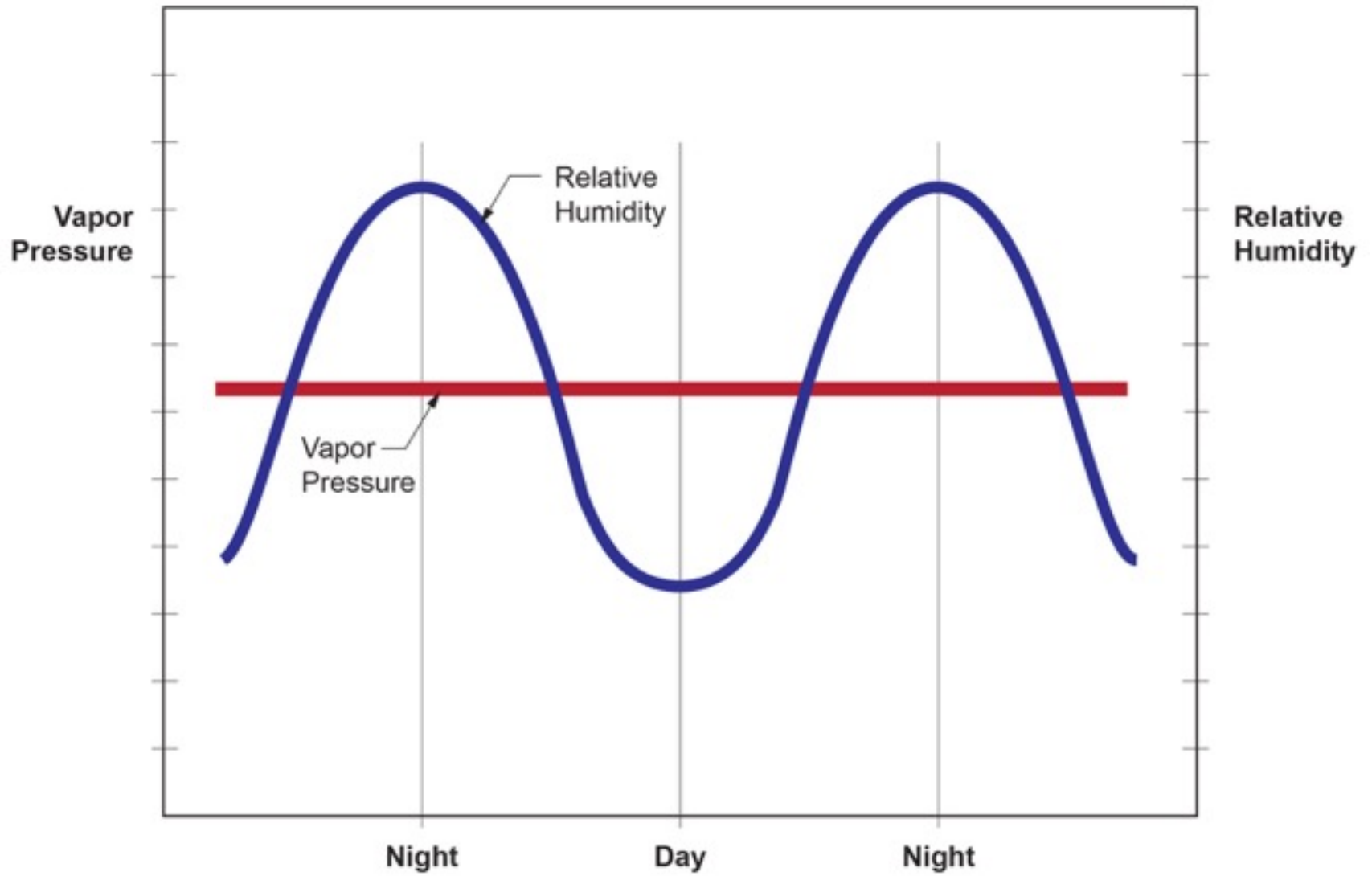
Exposure

Extreme		Over 60"
High		40" - 60"
Moderate		20" - 40"
Low		Under 20"

Vented Attics Are Climate Dependant





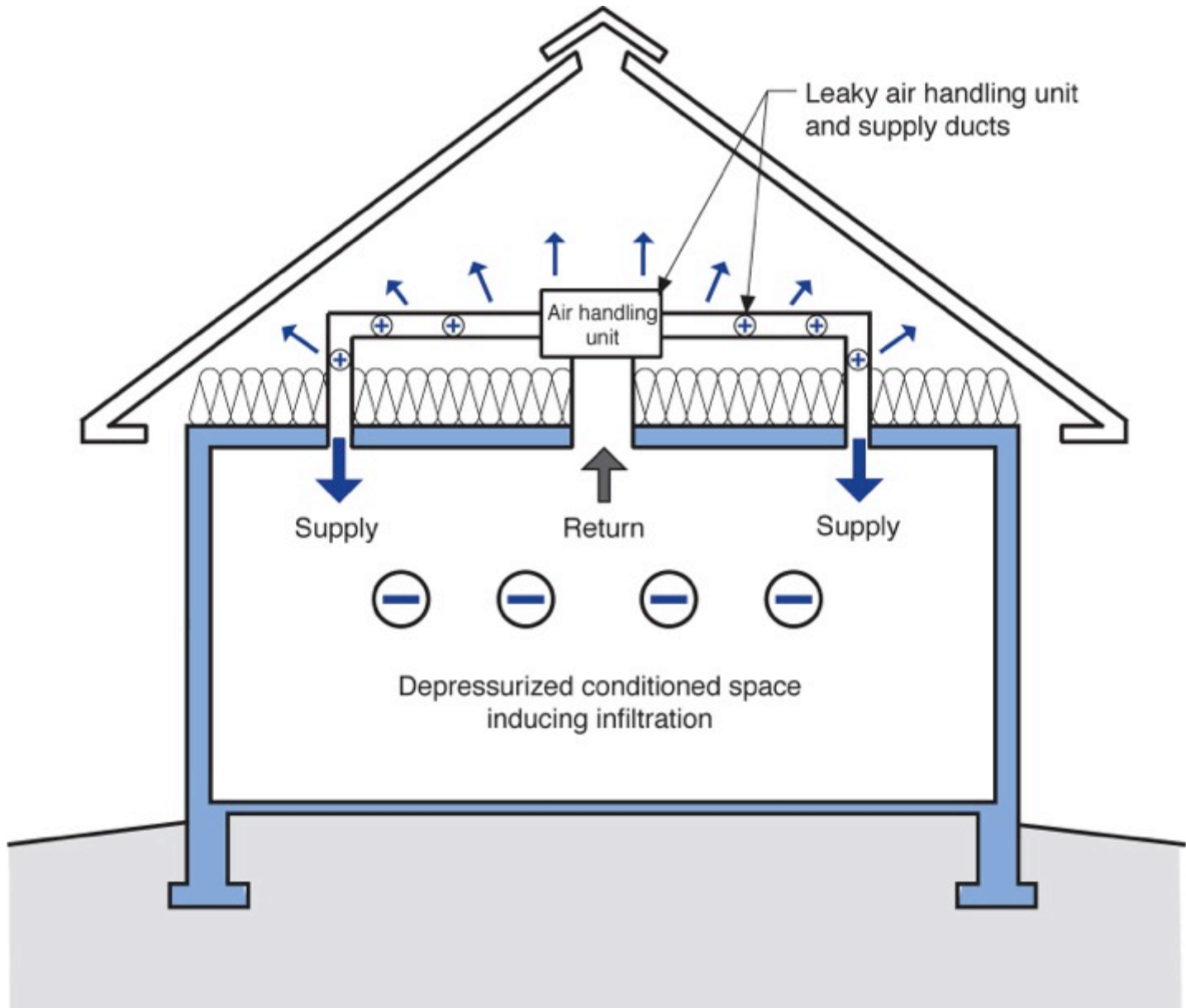


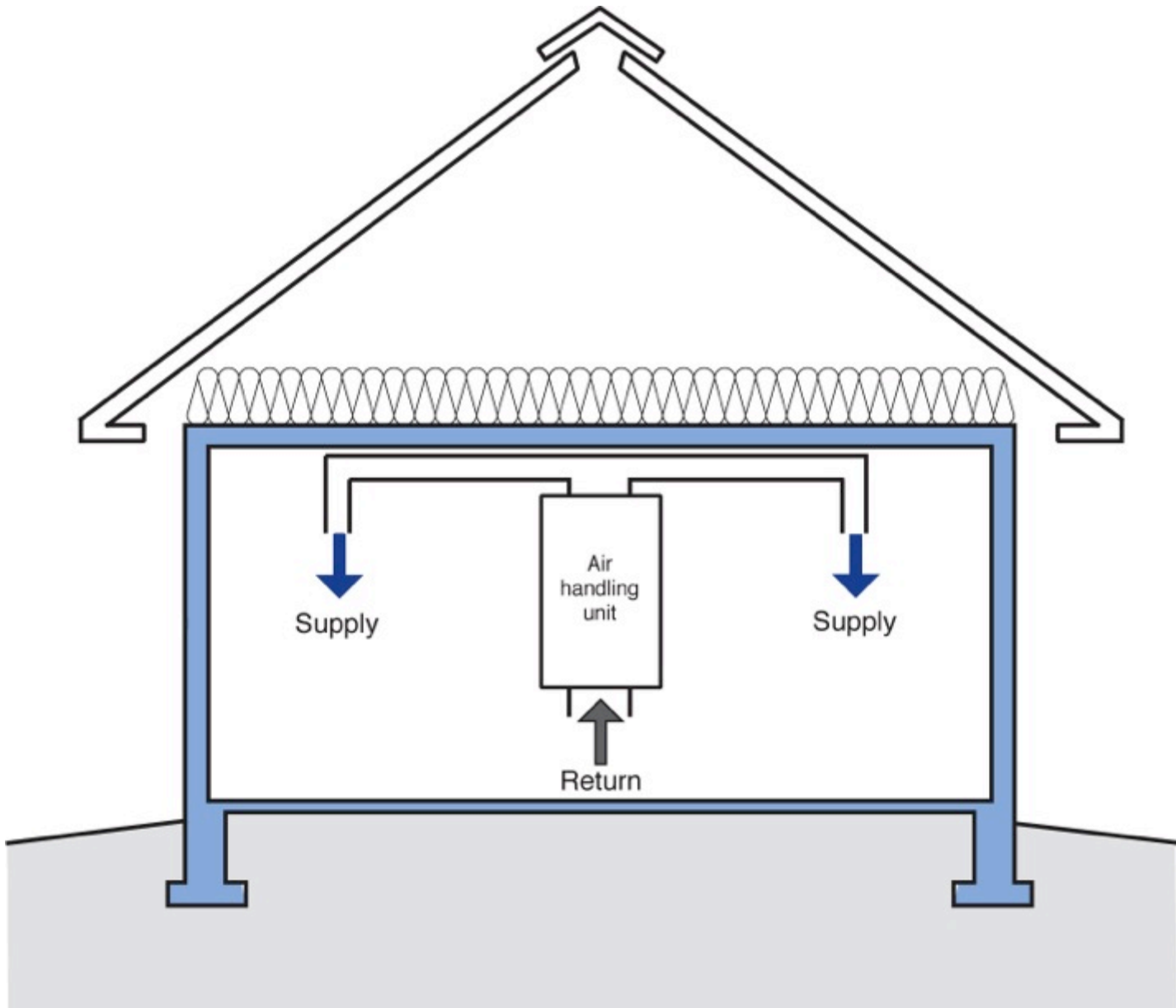
Houses With Vented Attics Suck

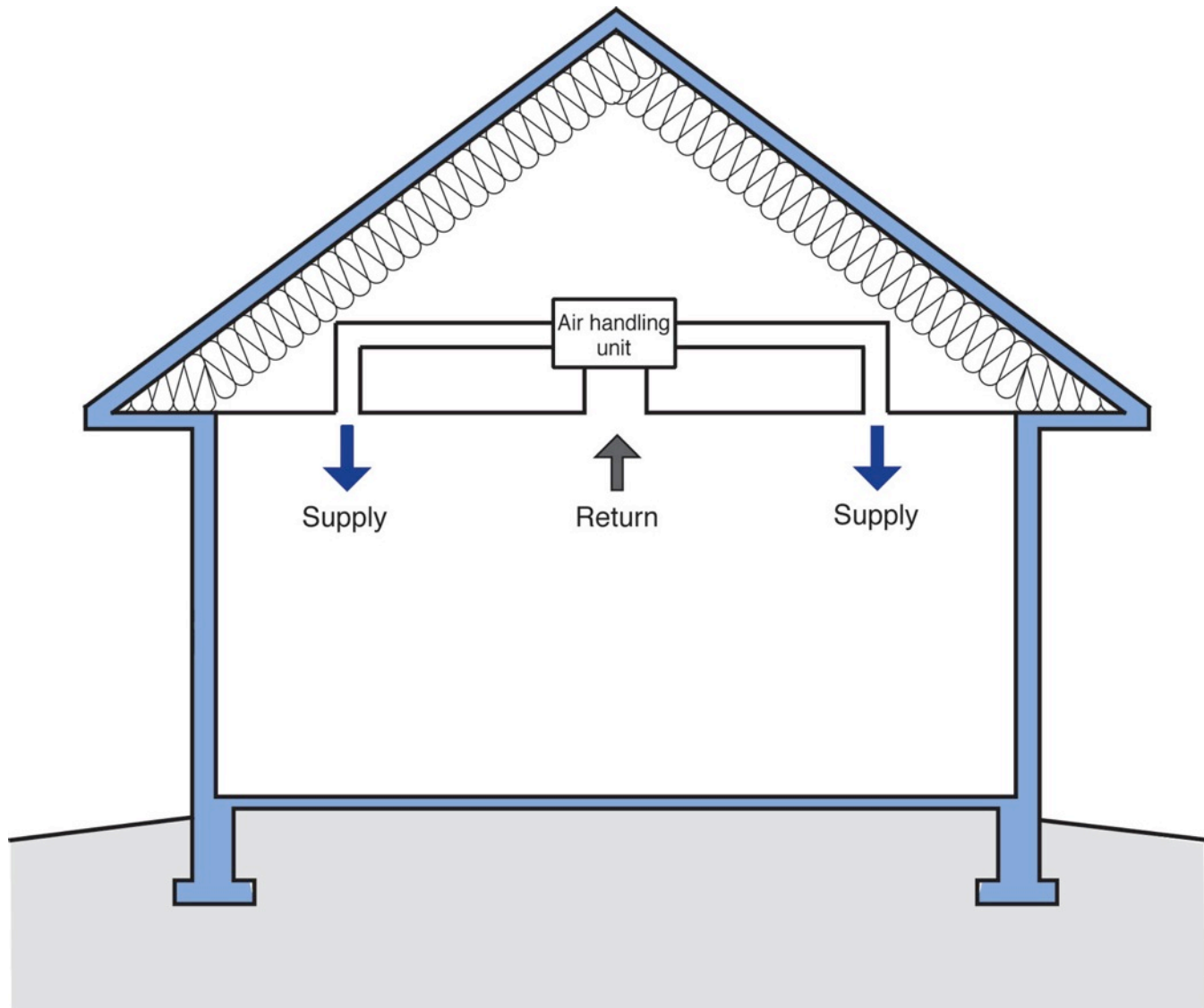
Houses With Vented Attics Suck
Not all the Time.....but.....







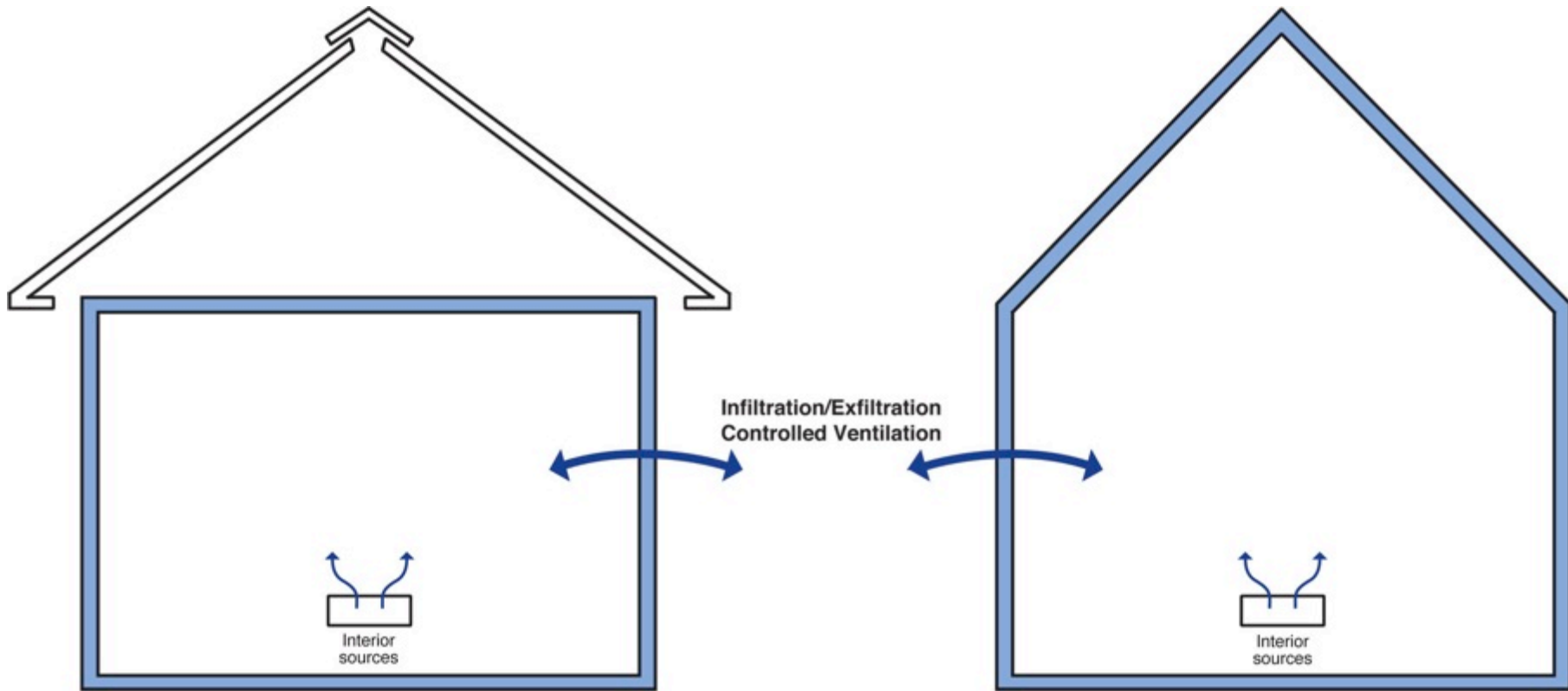


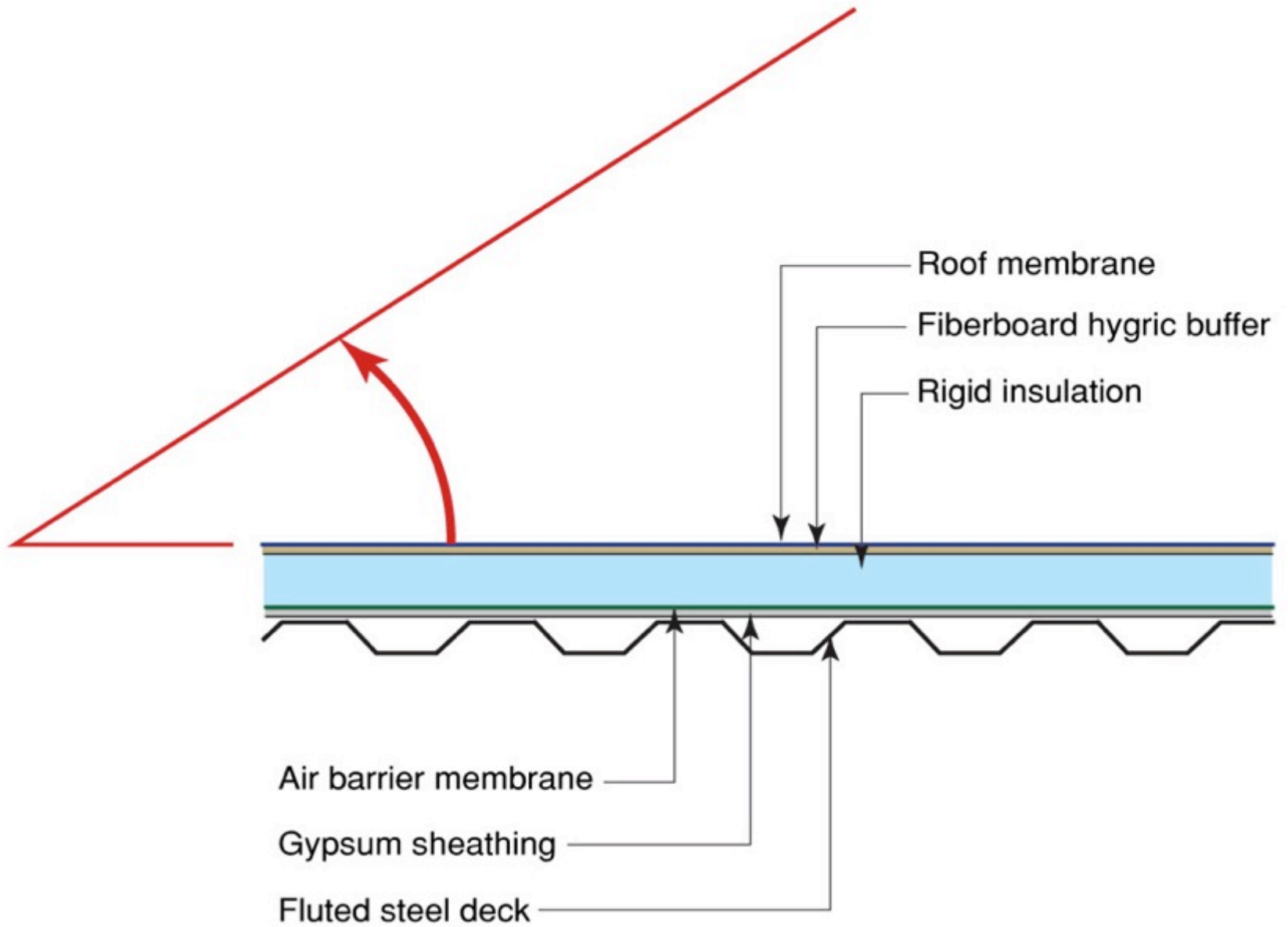


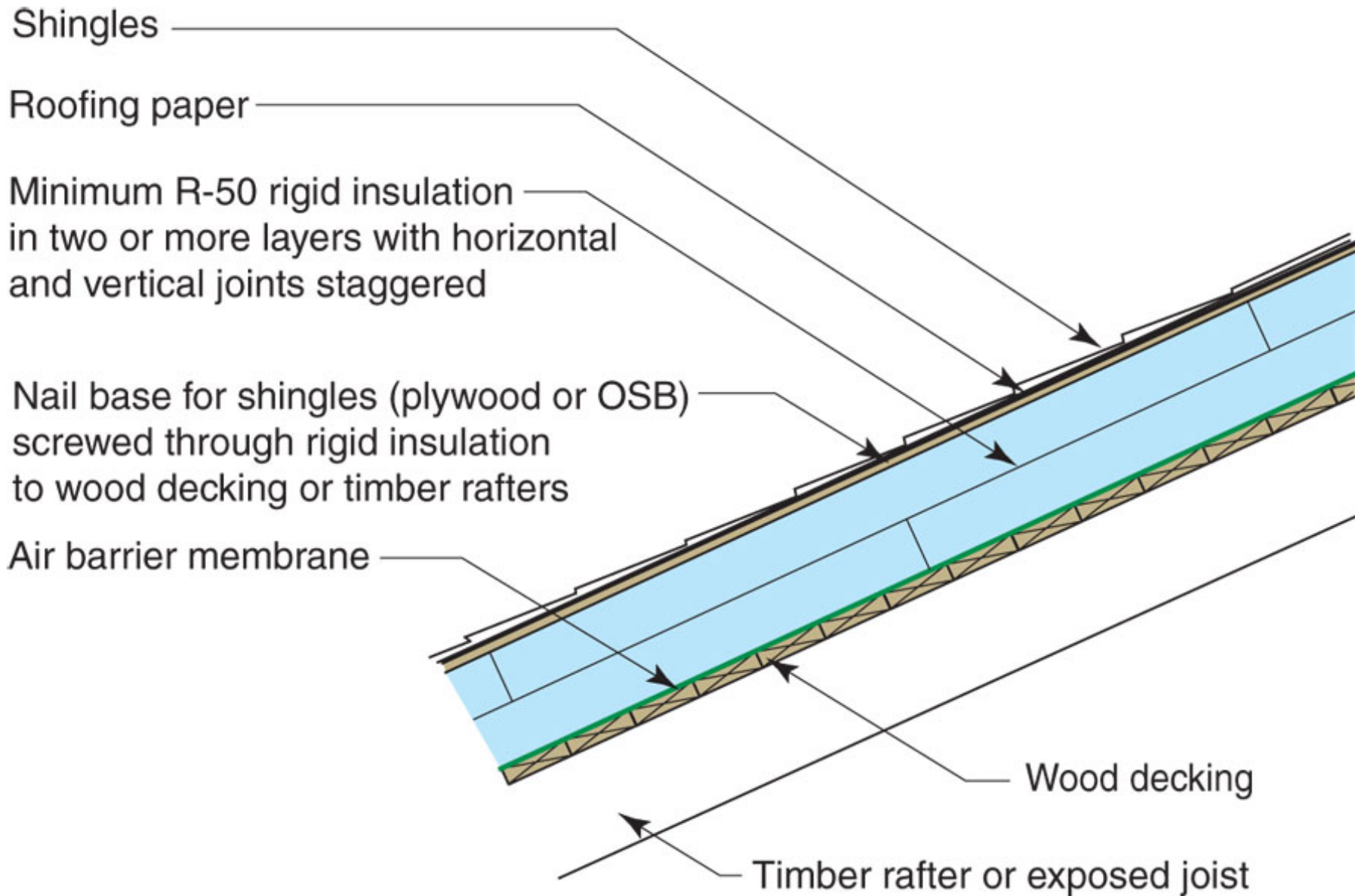


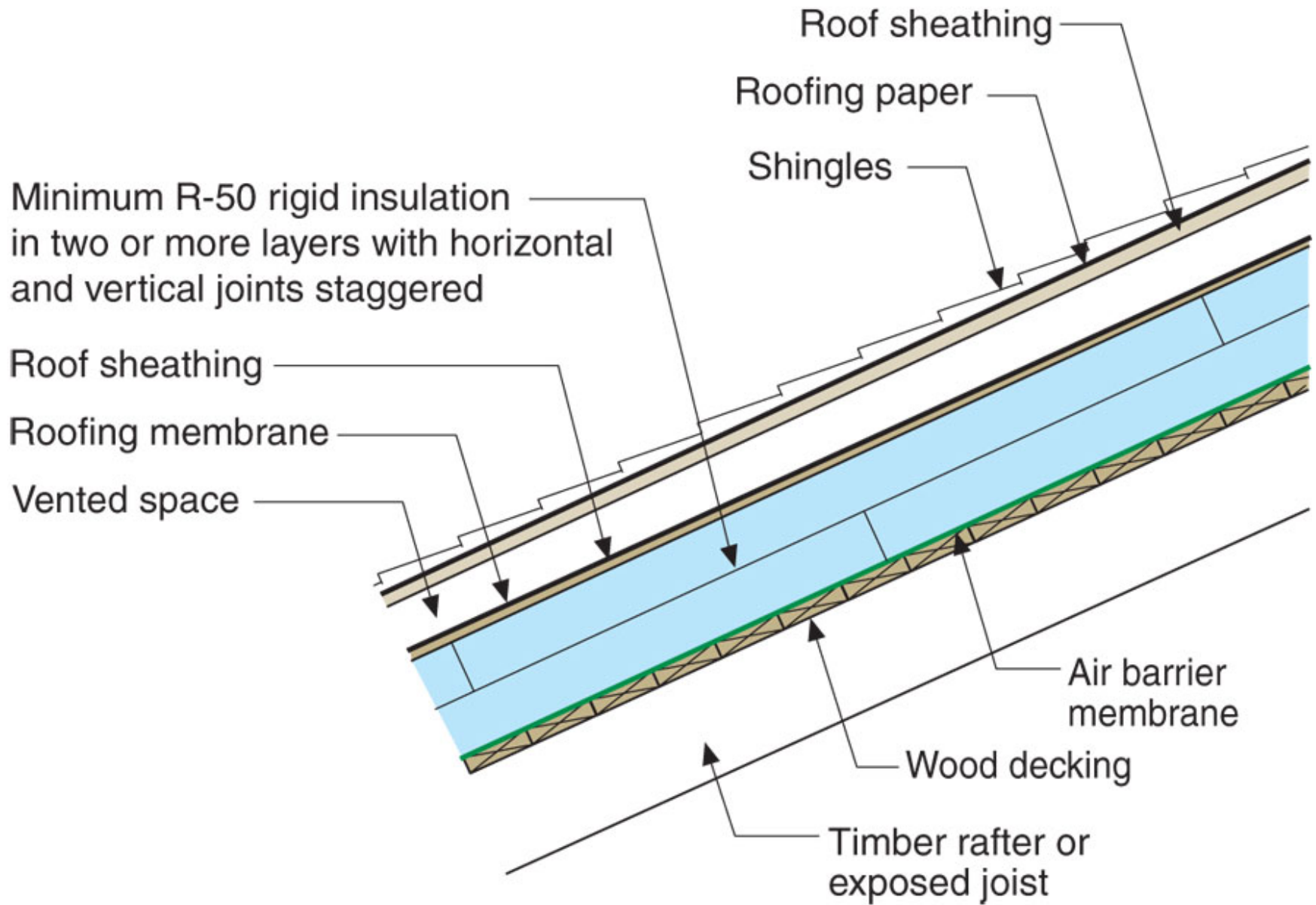


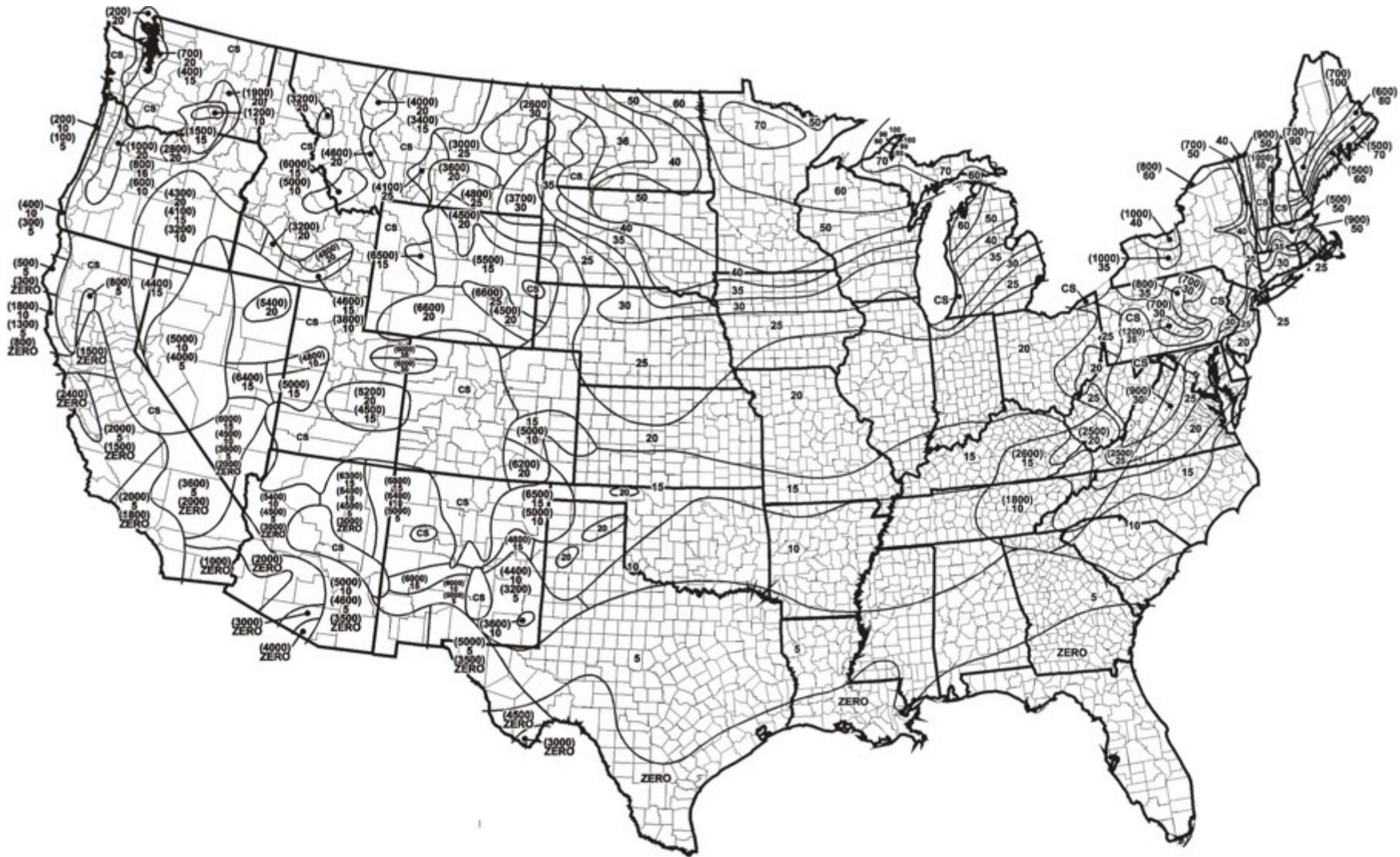


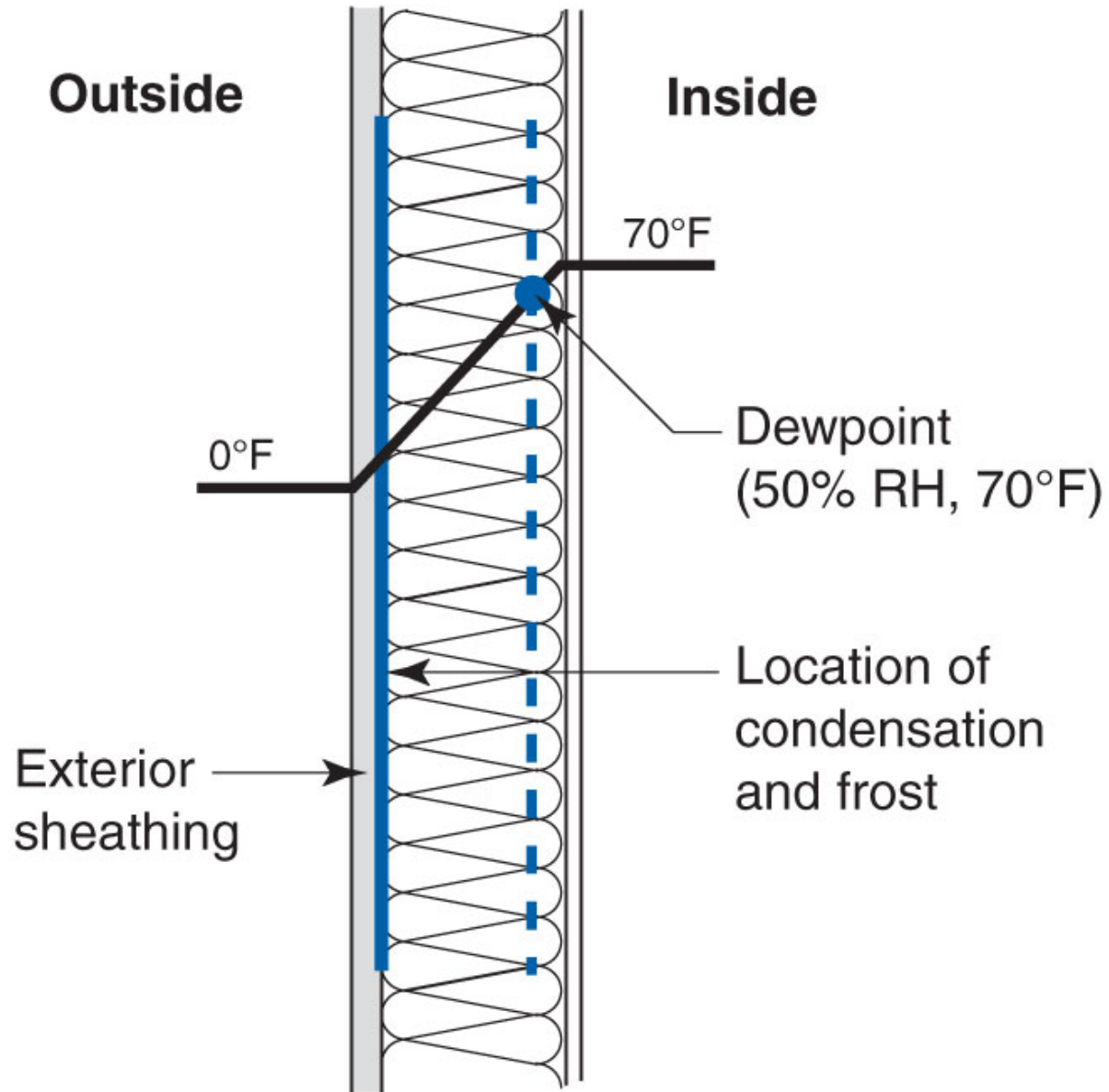




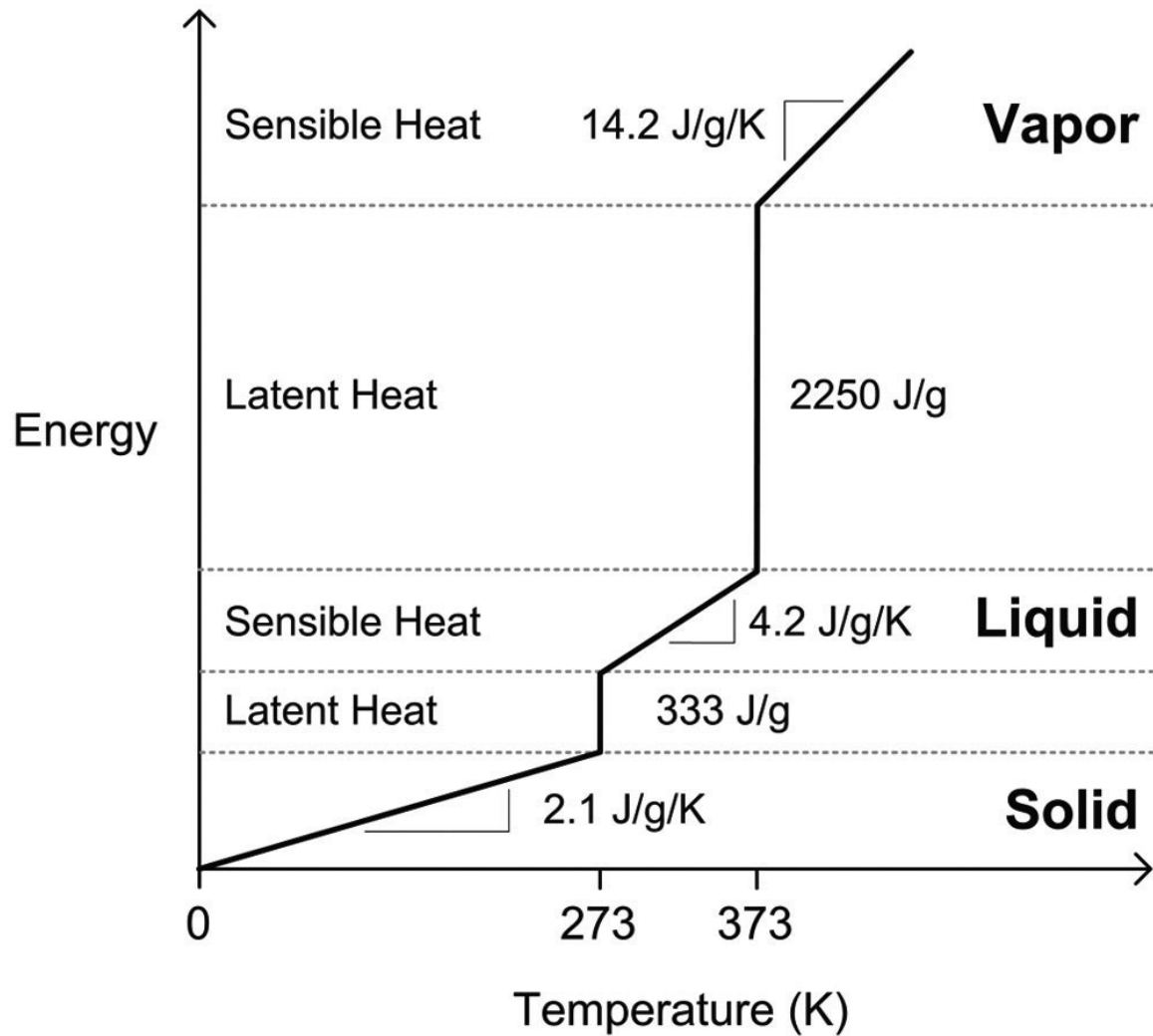










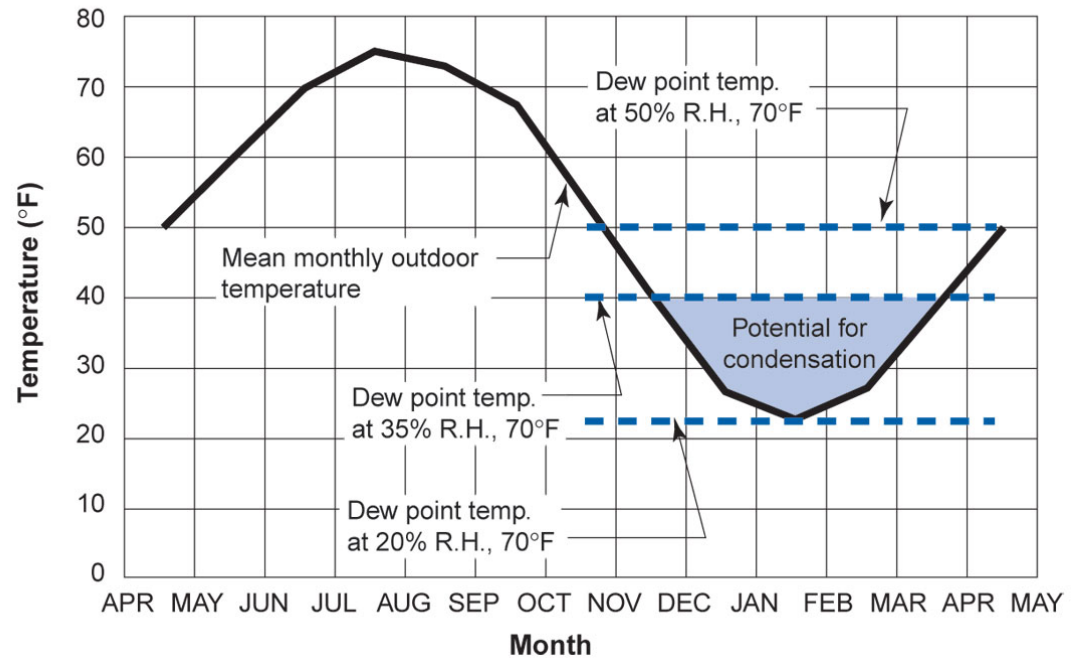
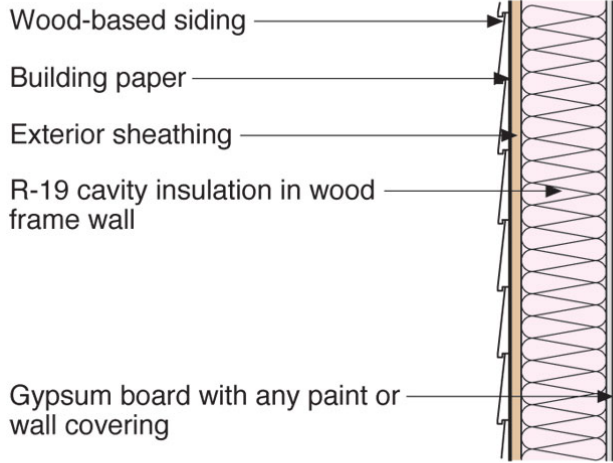


Simple linearized energy-temperature relation for water

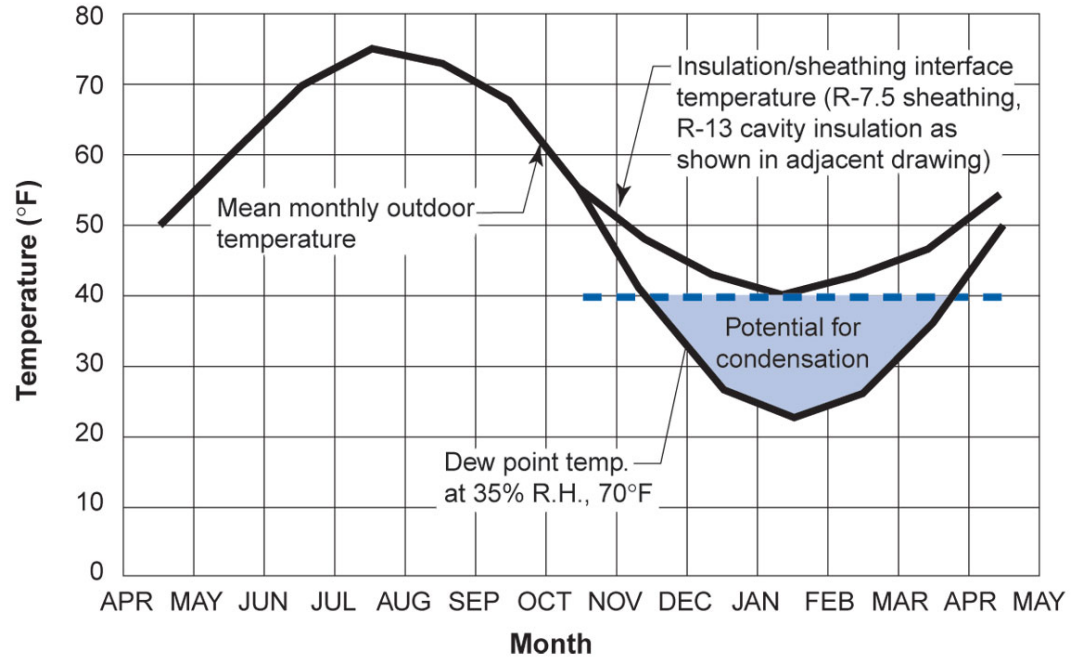
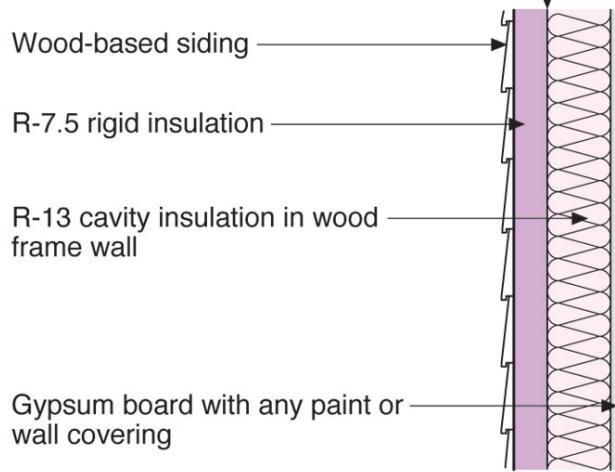
From Straube & Burnett, 2005



The inside face of the exterior sheathing is the condensing surface of interest



The inside face of the insulating sheathing is the condensing surface of interest



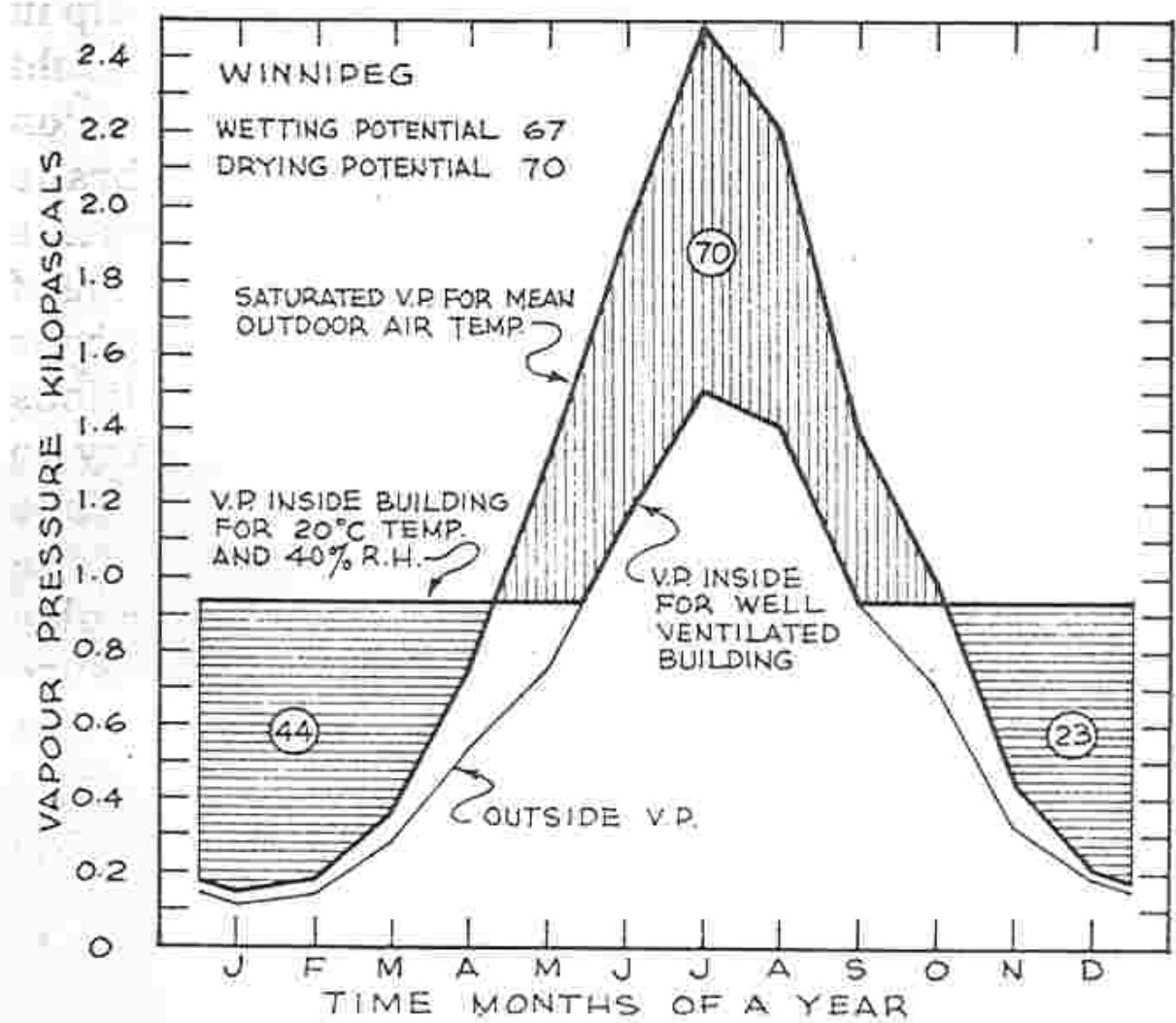
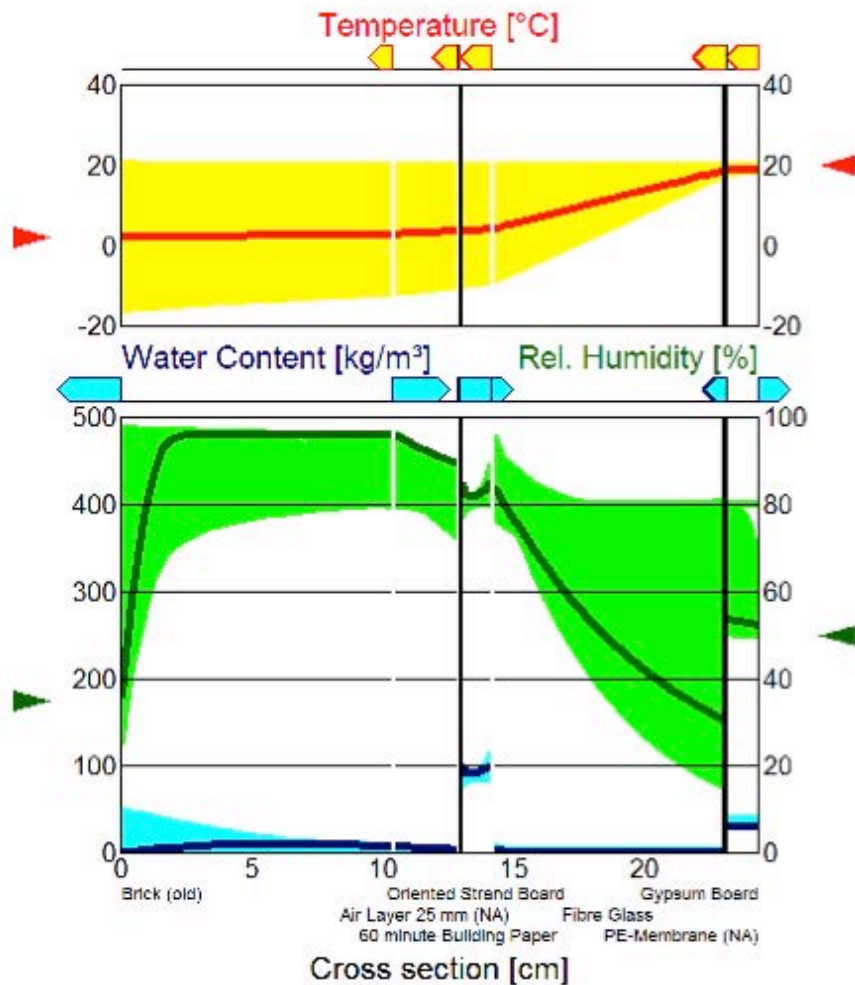


Figure 8-7. Outside vapour pressure, saturated vapour pressure and inside vapour pressure for Winnipeg.



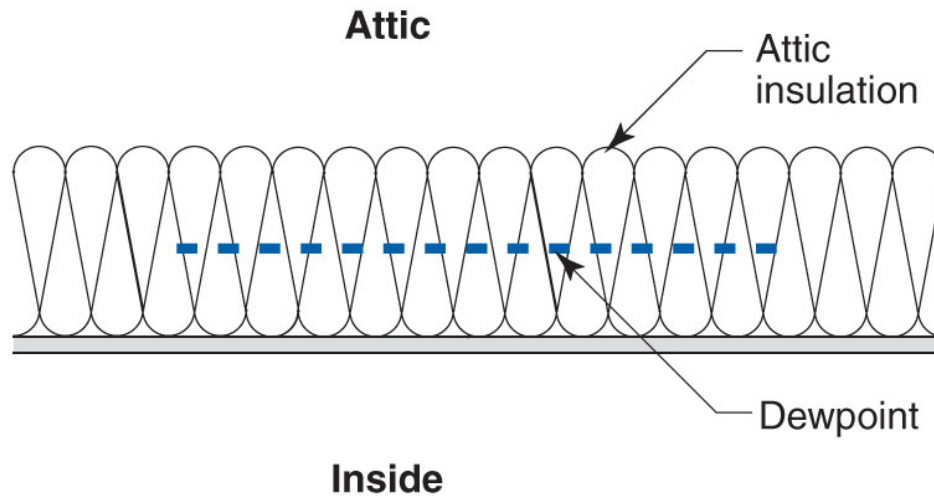
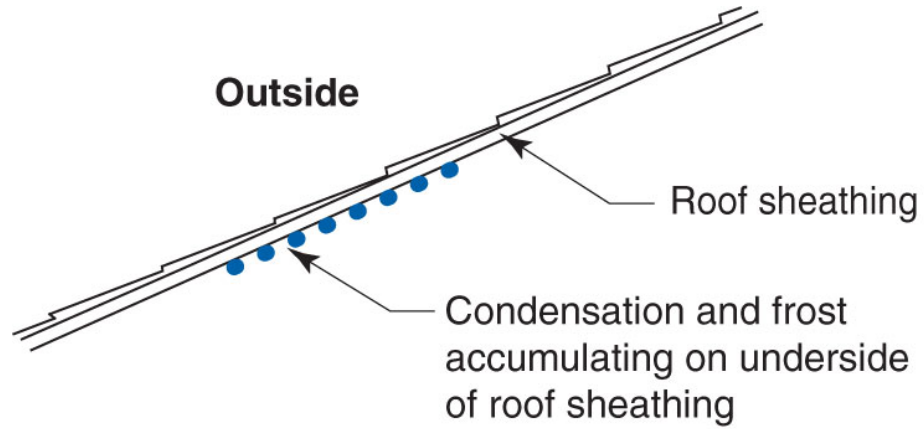
WUFI® 3.3 Pro. IBP
Run

16 Feb
2001

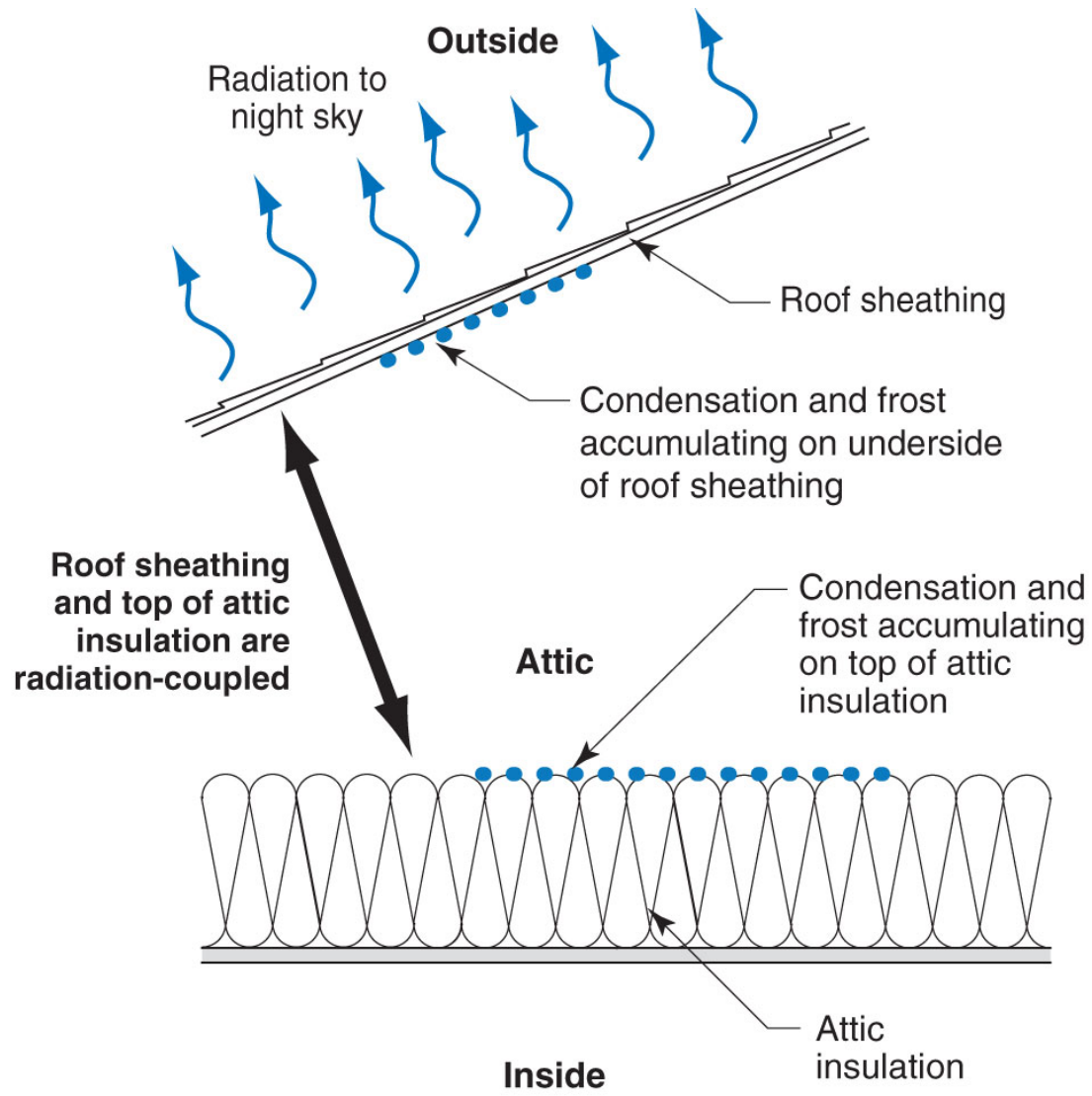
100%

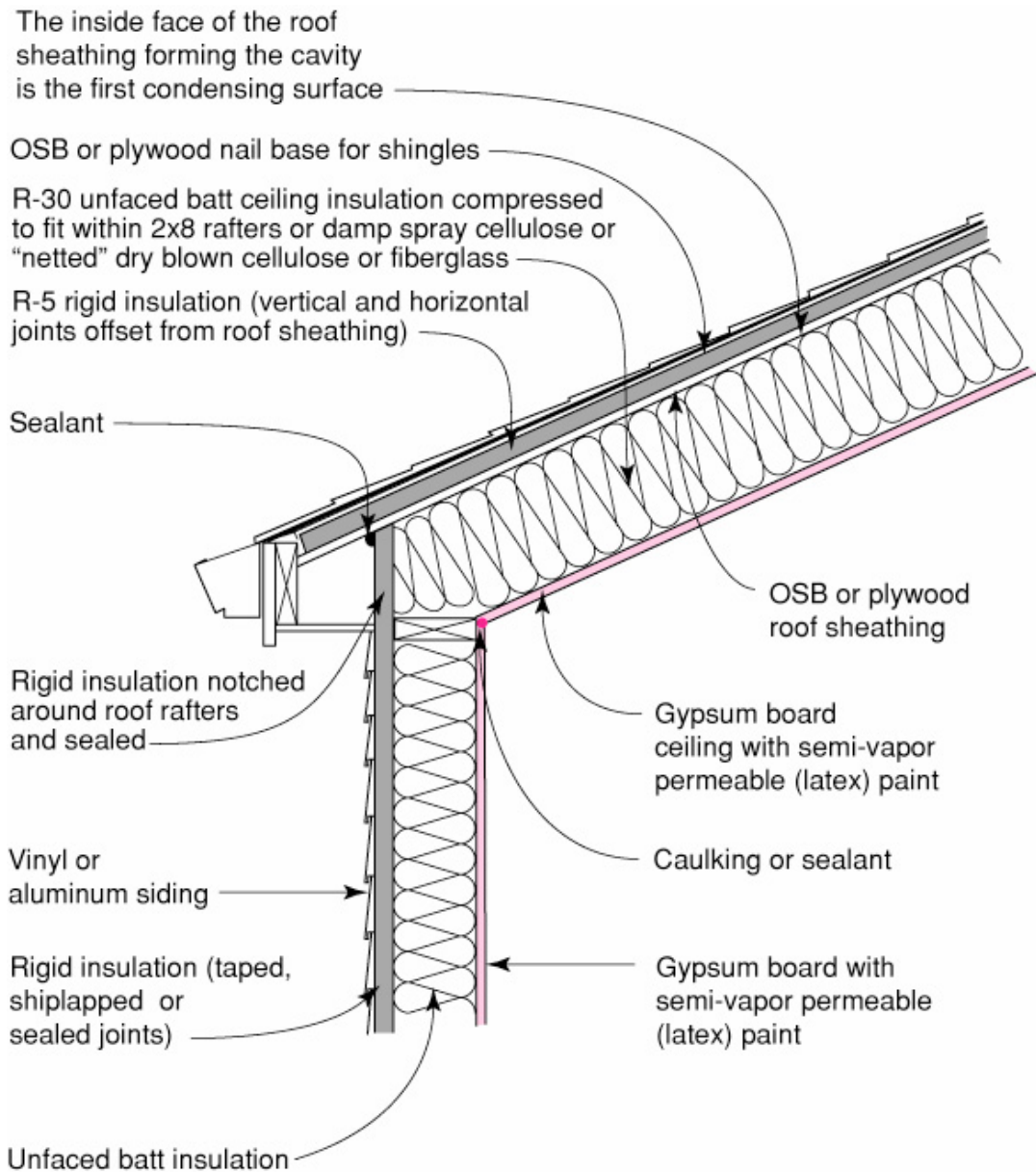
0% 100%

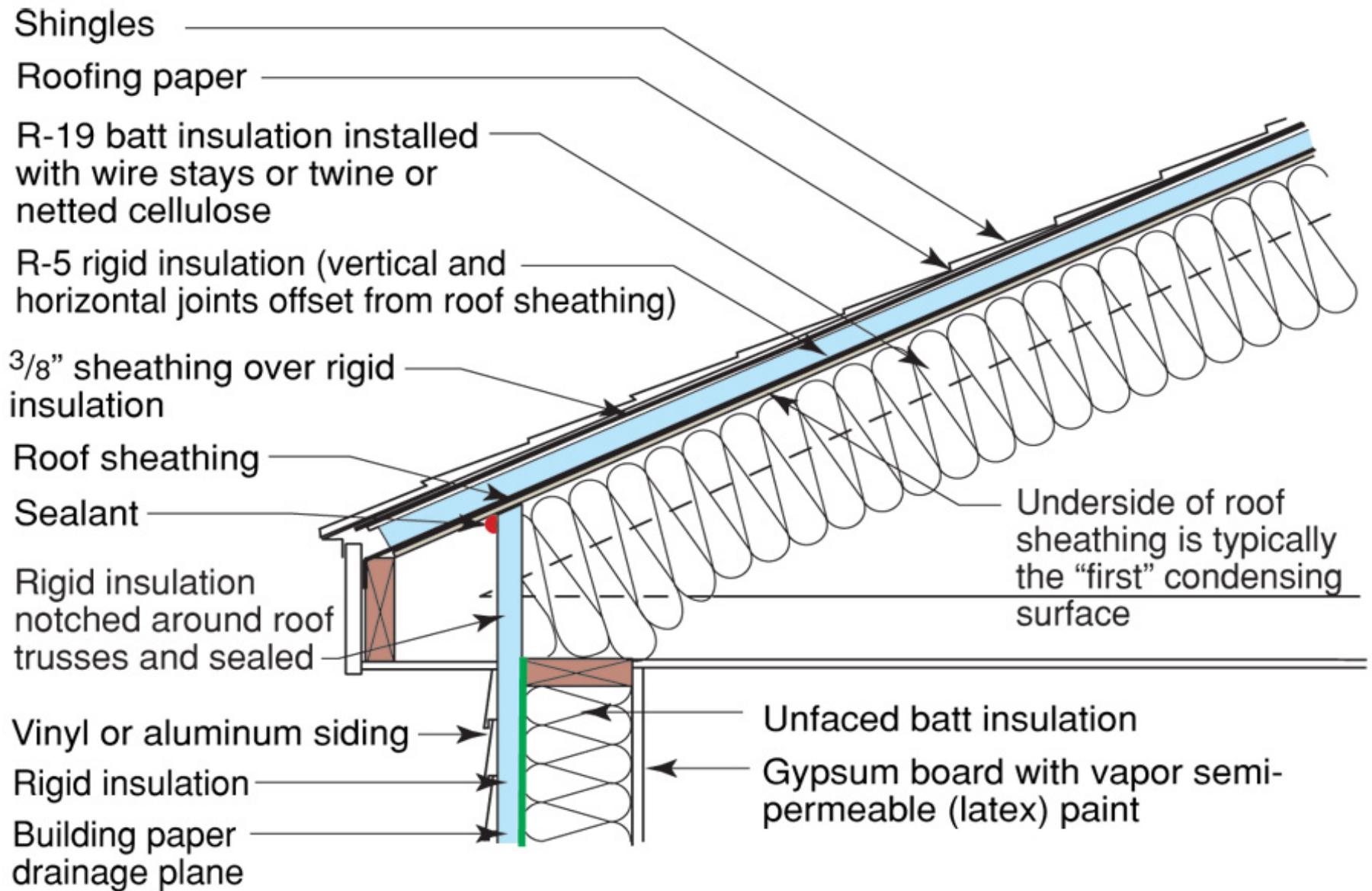
100%

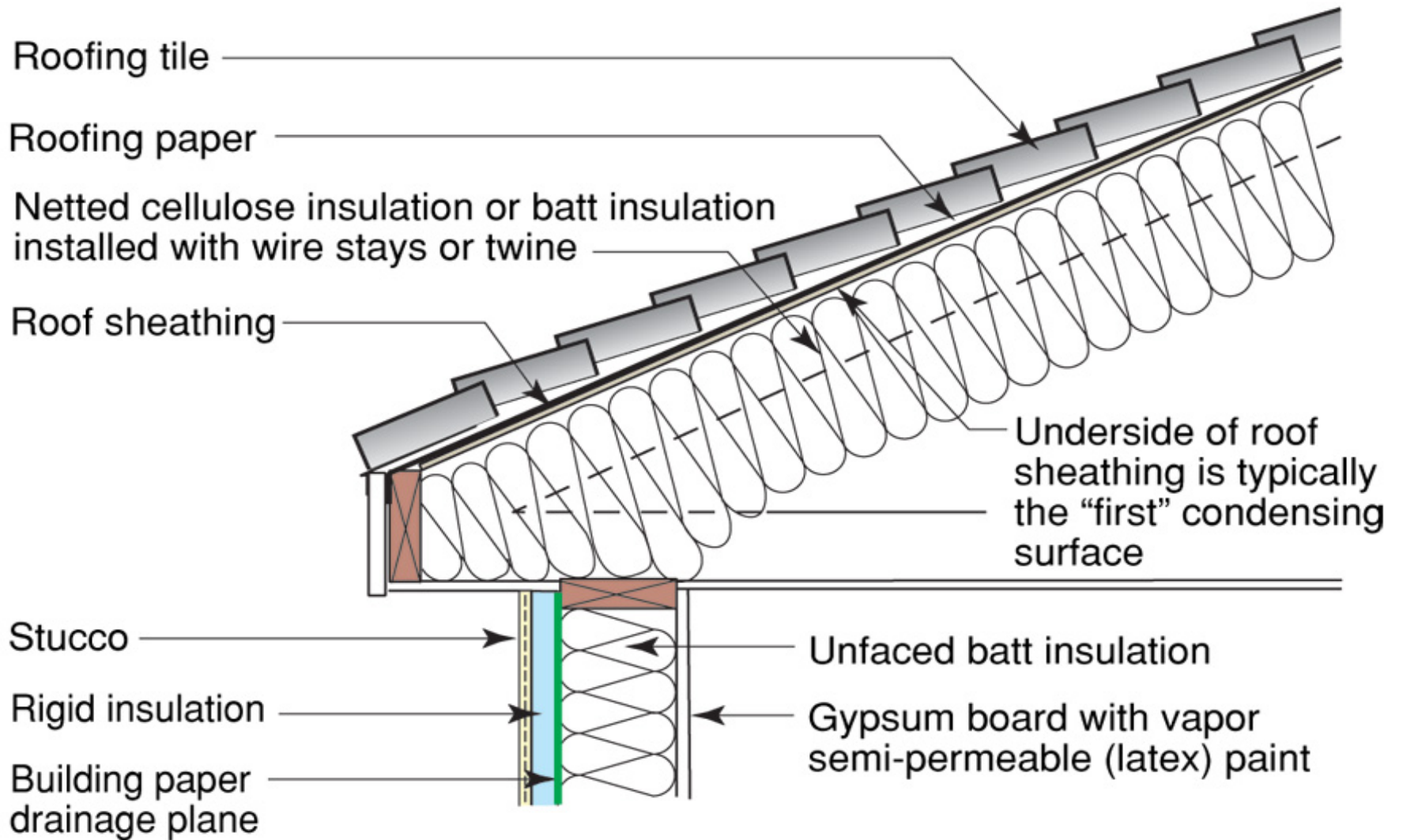








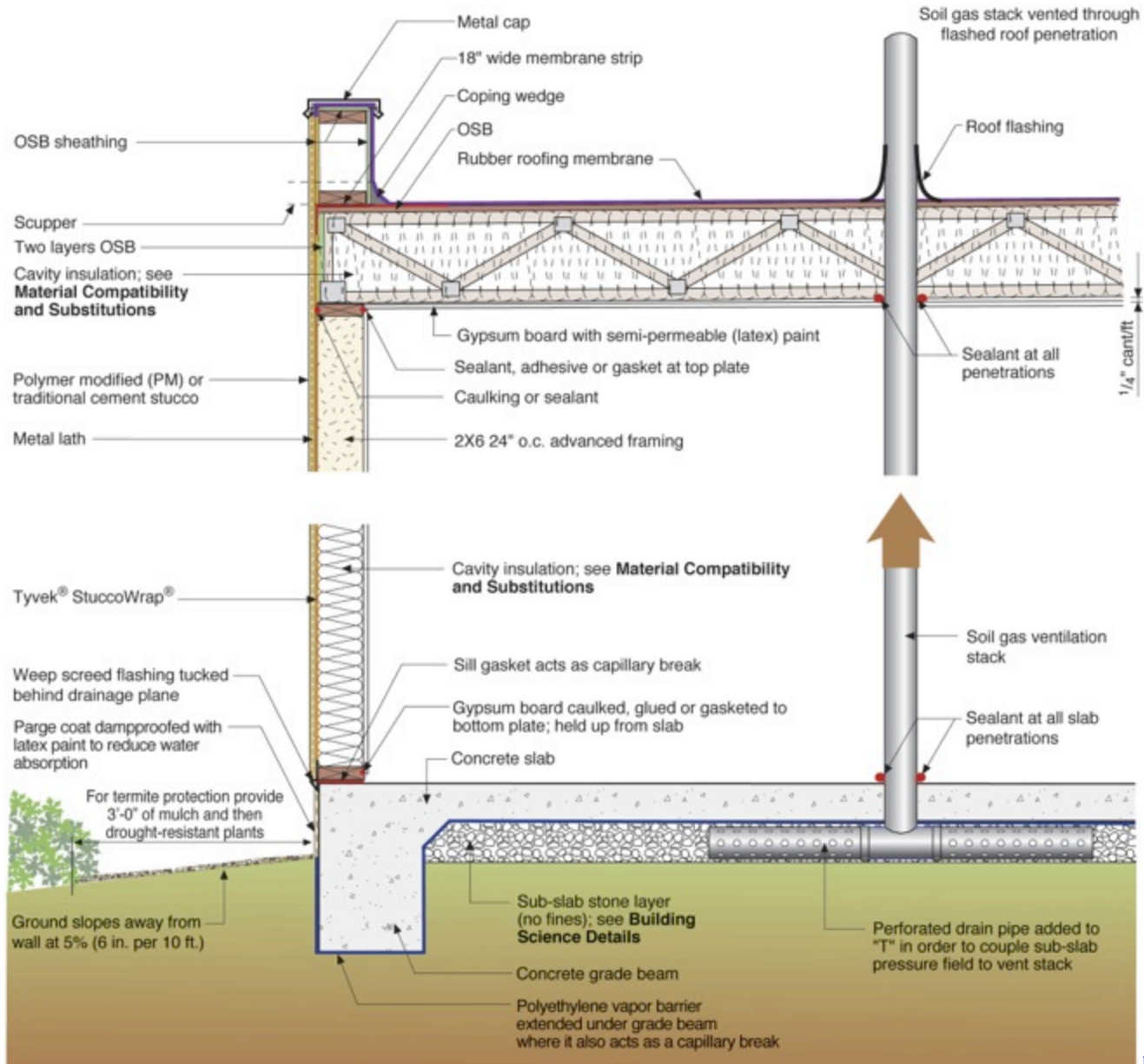










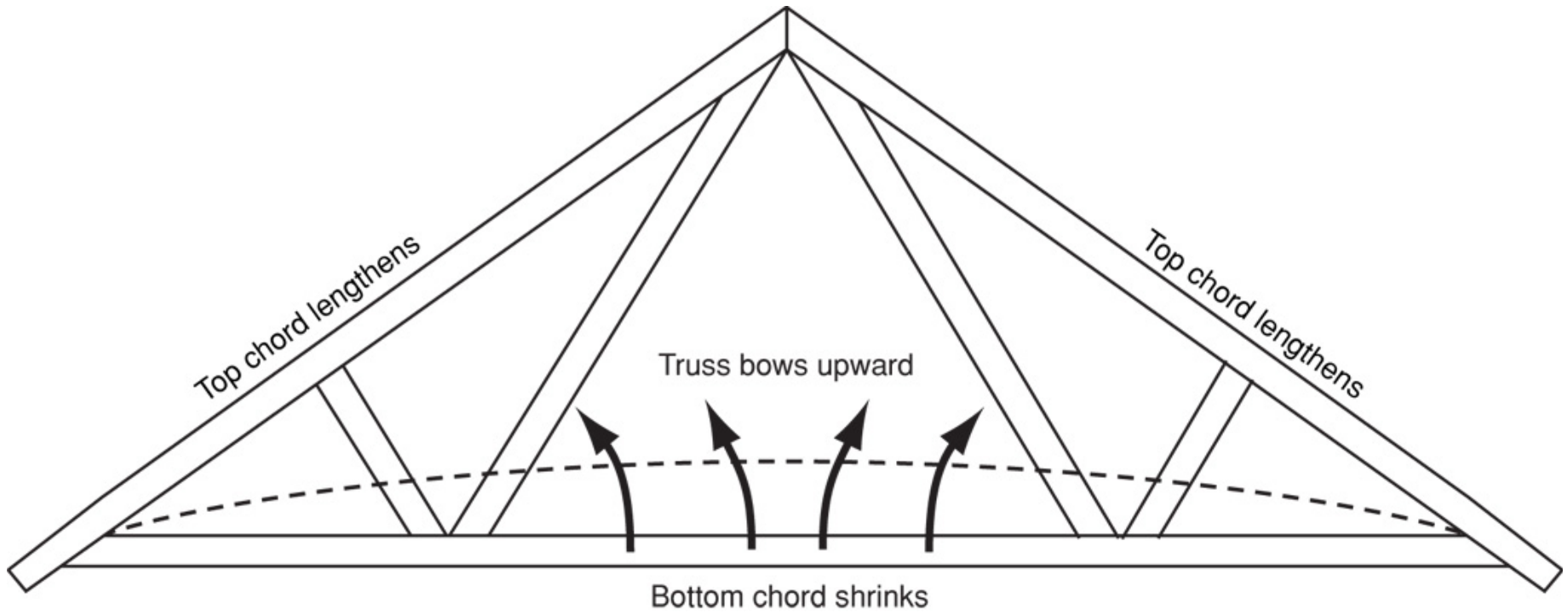


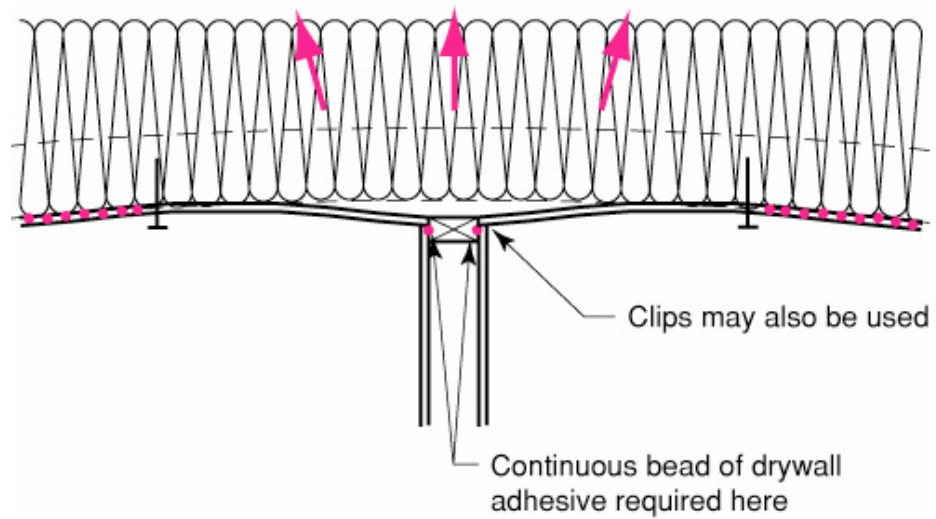
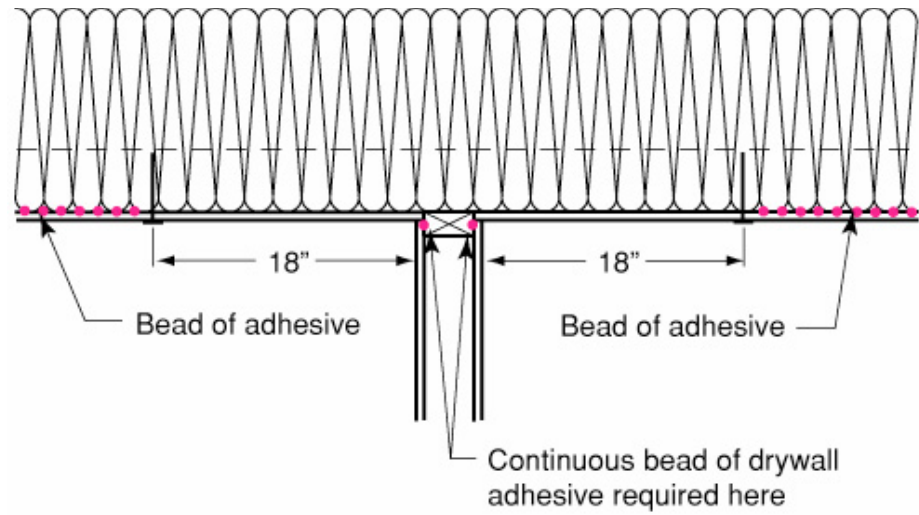
Truss Uplift

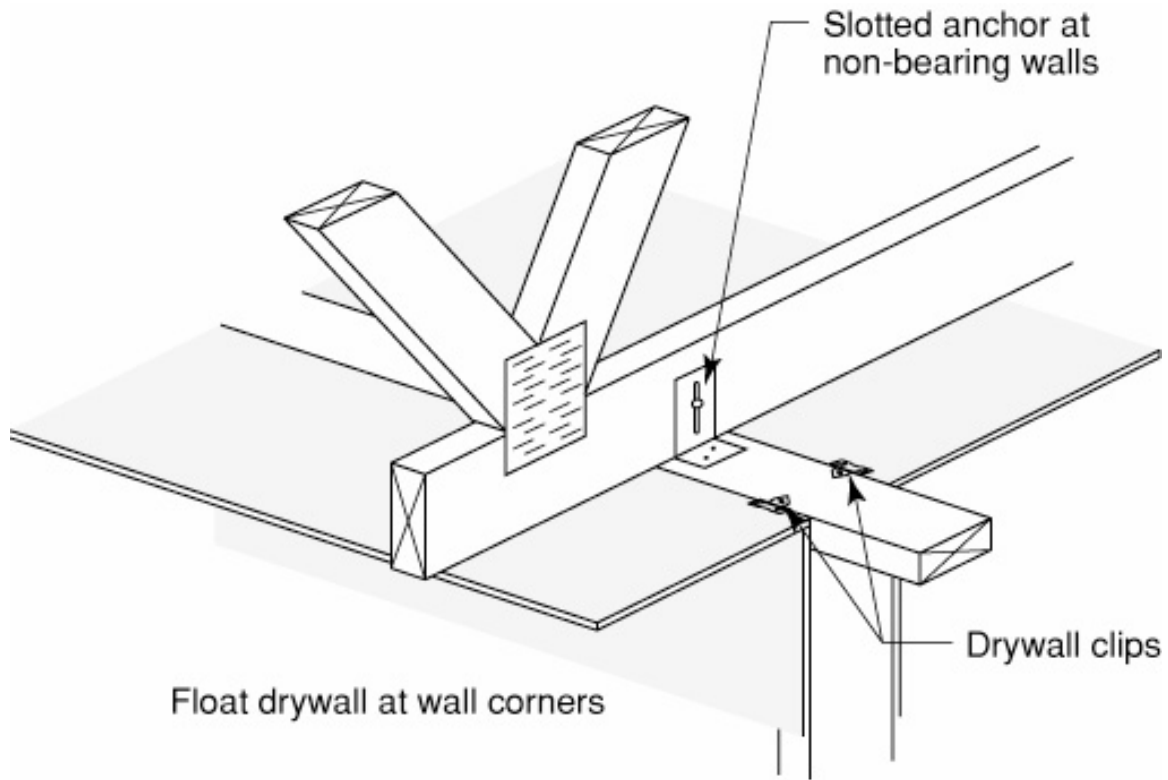






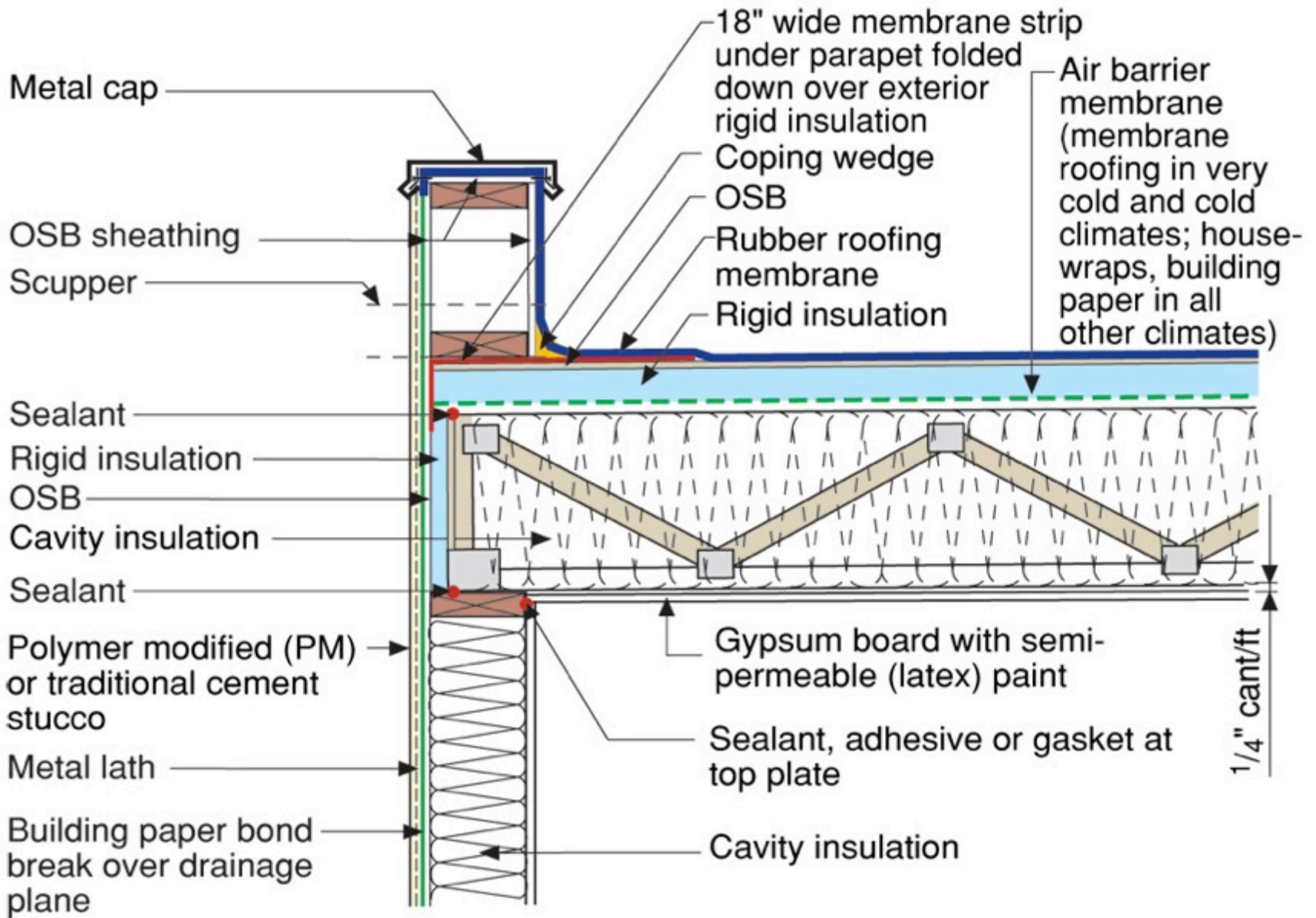


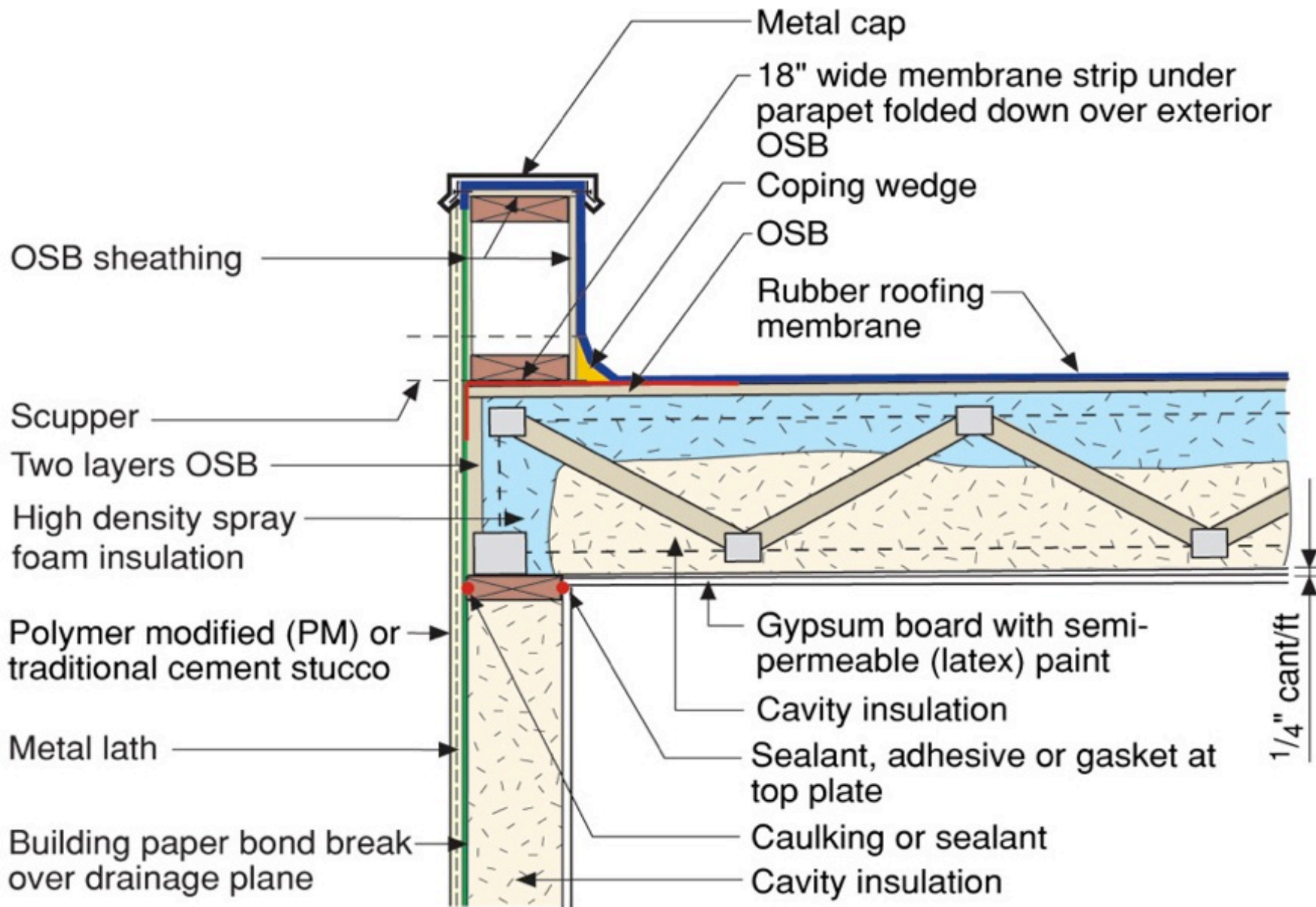


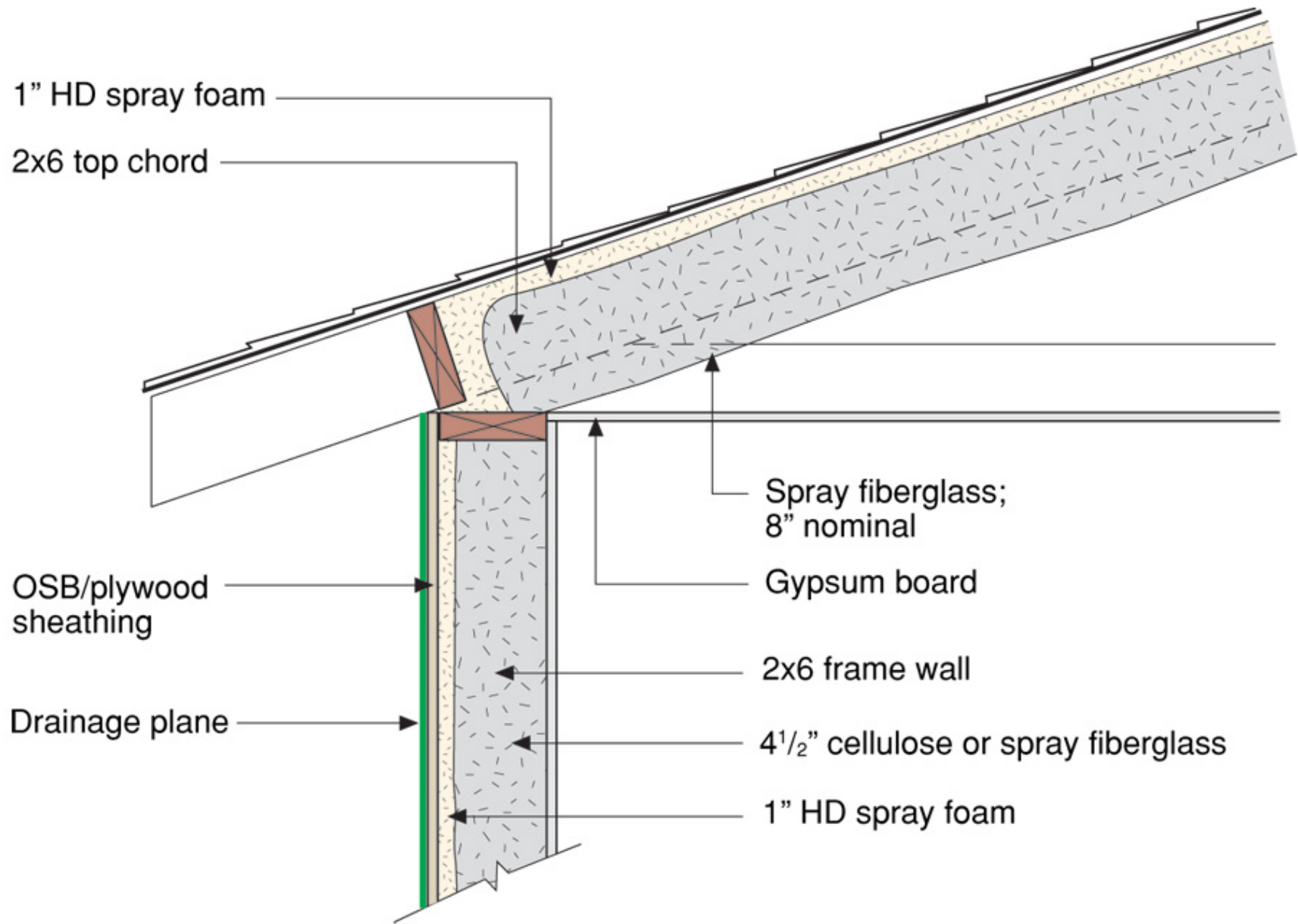


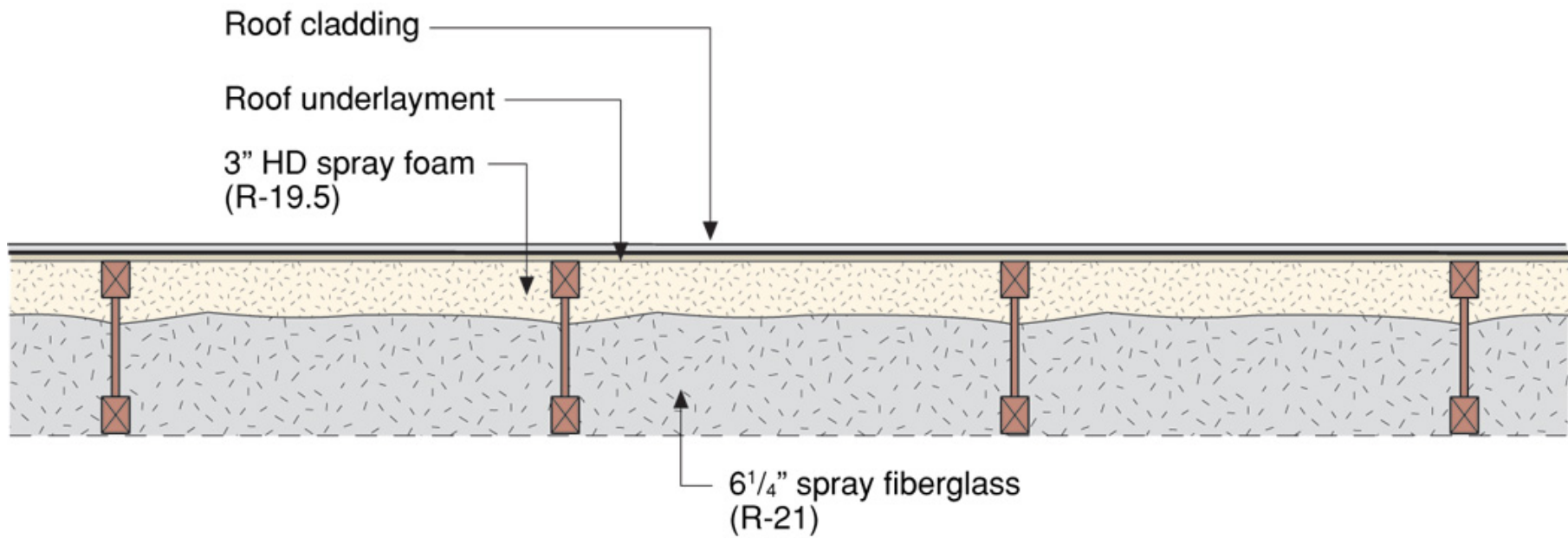


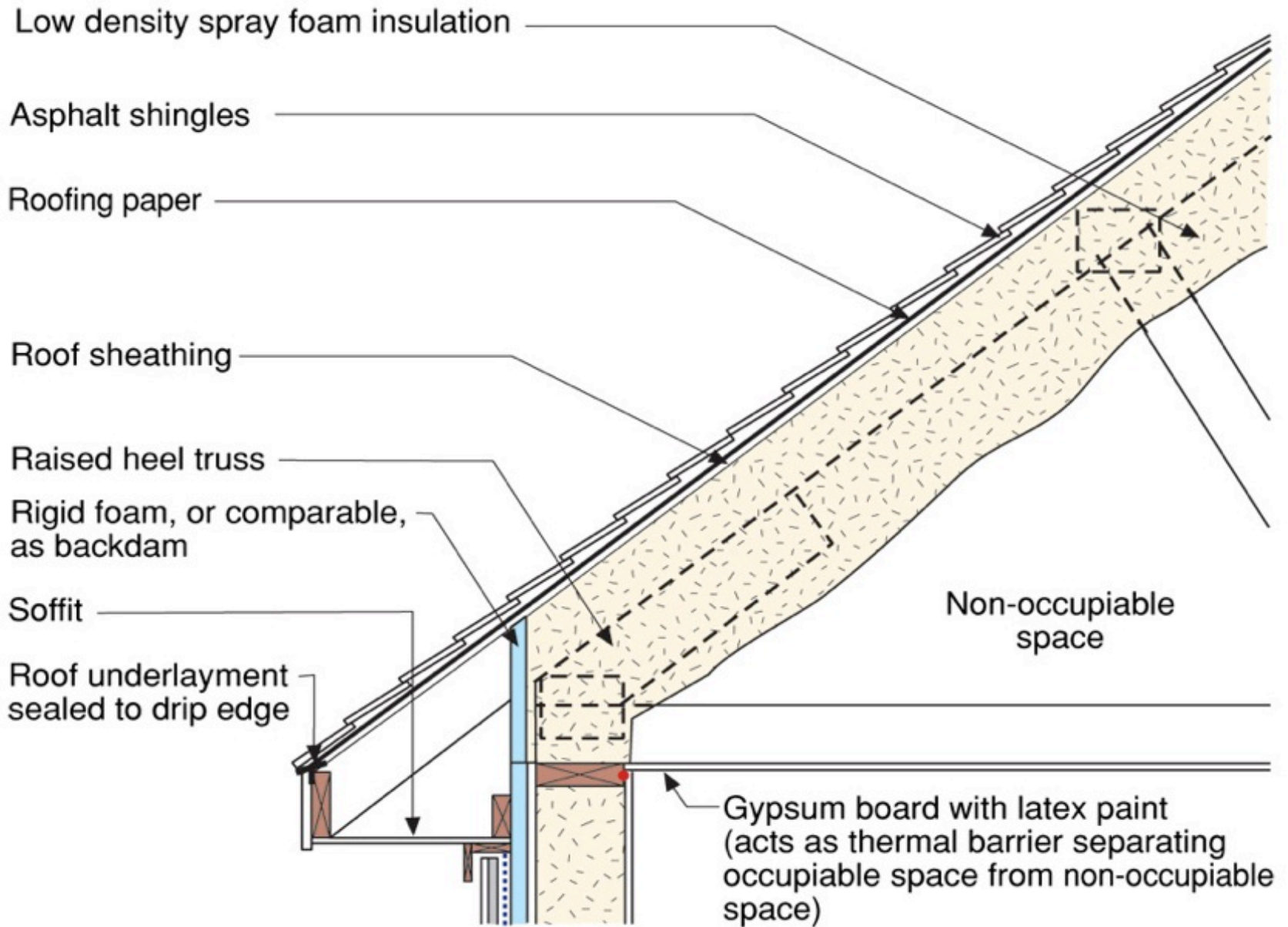














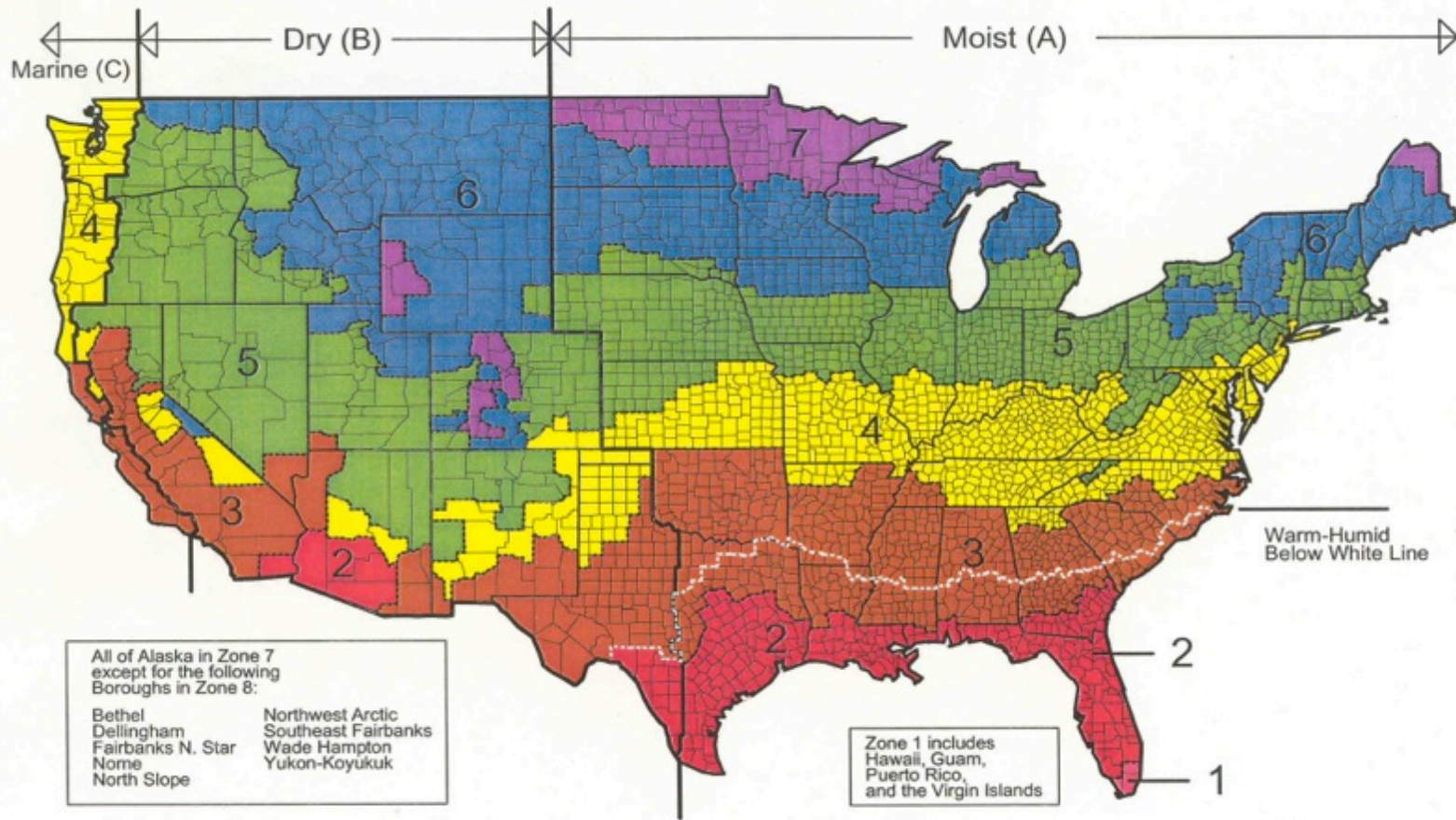








Map of DOE's Proposed Climate Zones



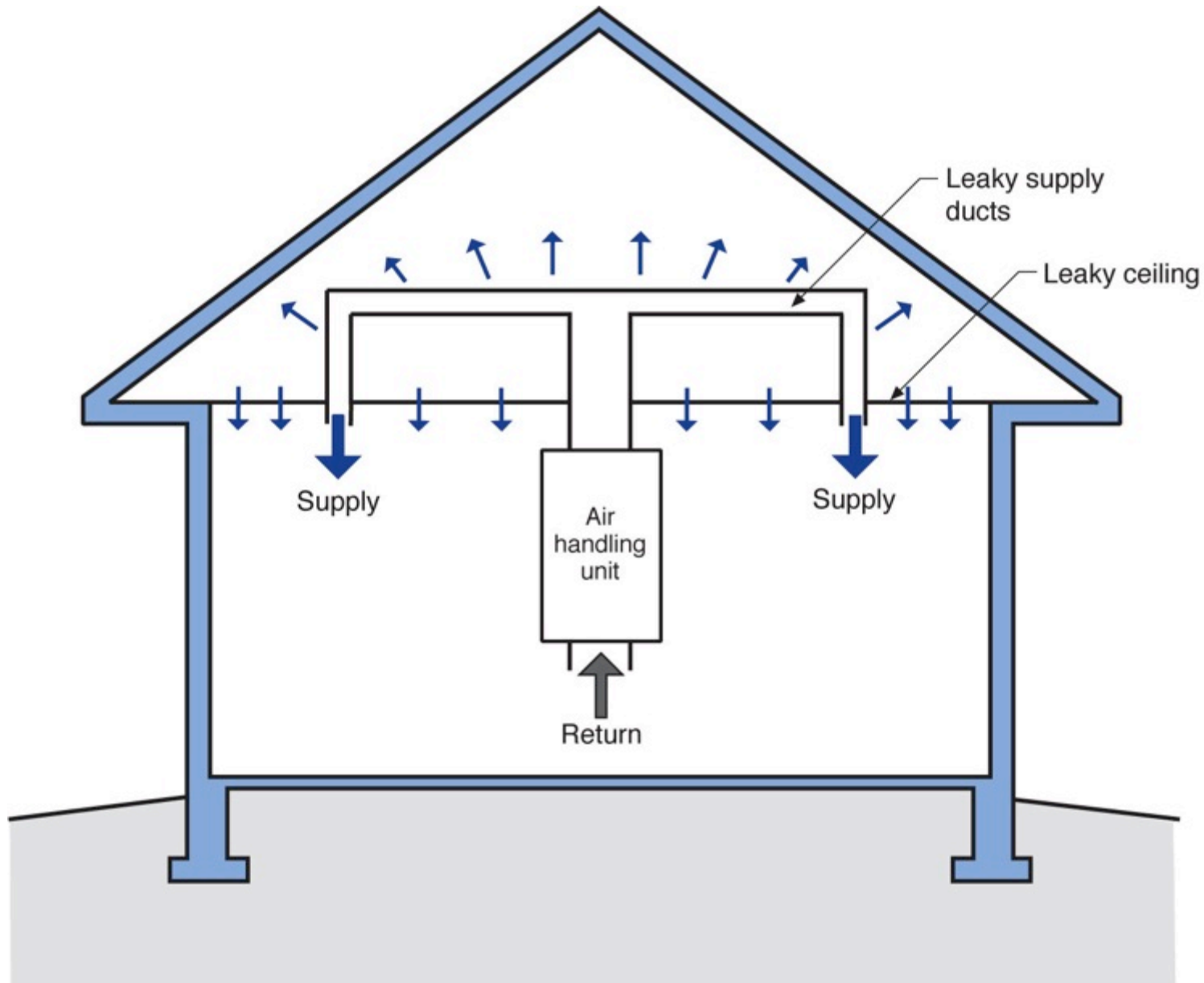
March 24, 2003







Conditioned Attics Not Unvented Attics

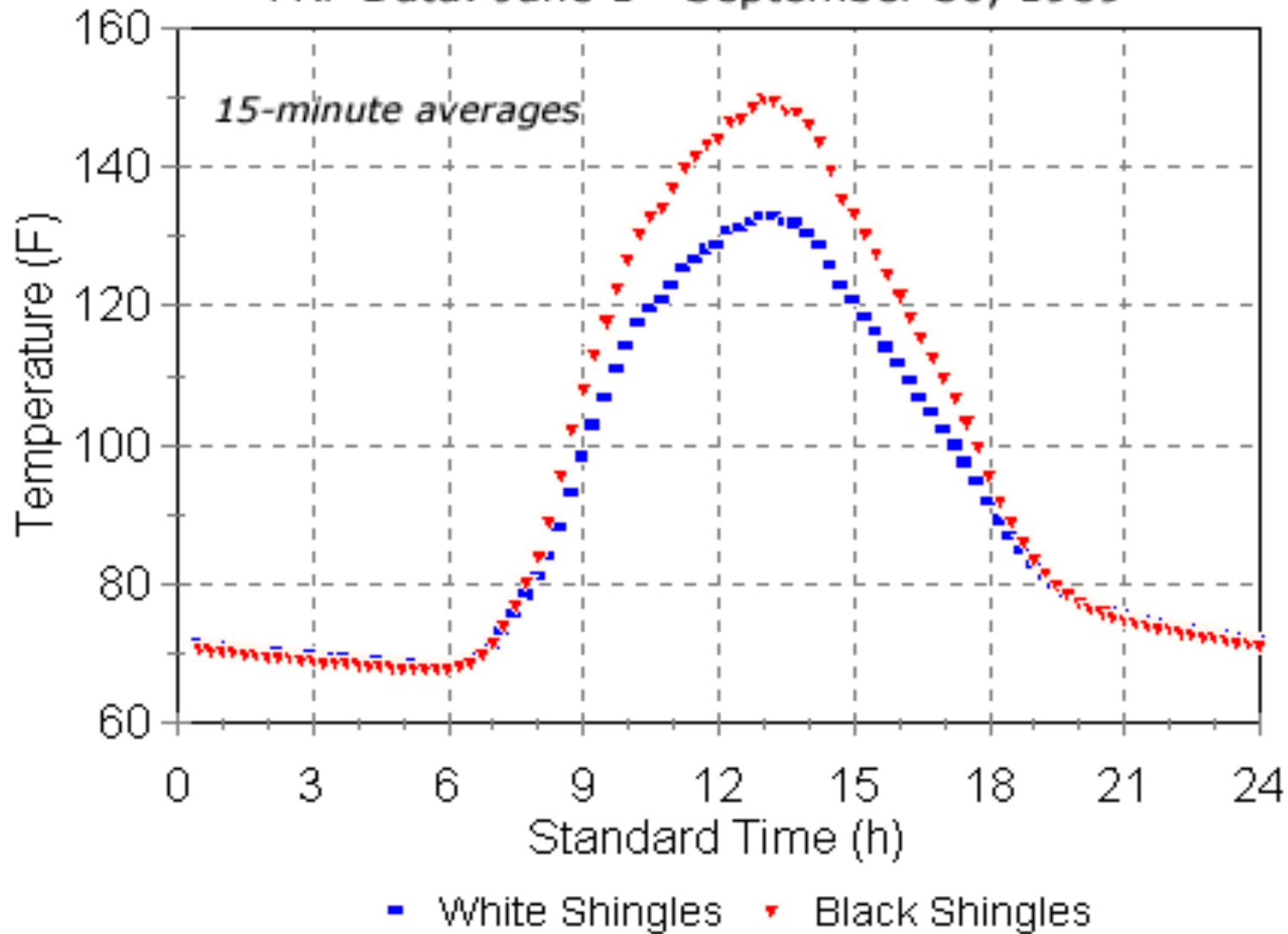




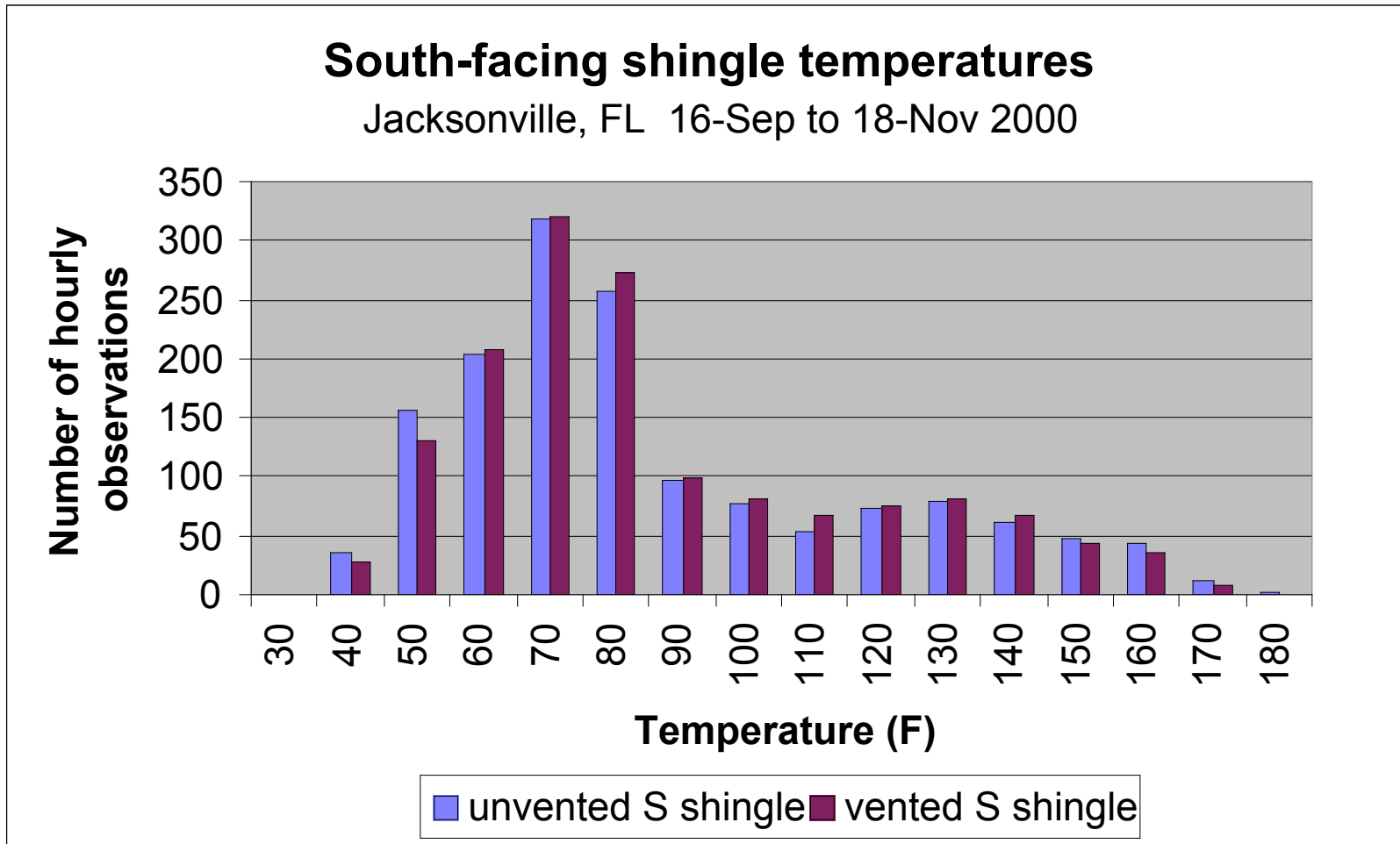
Conditioned Attics Not Unvented Attics Need Supply Air

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

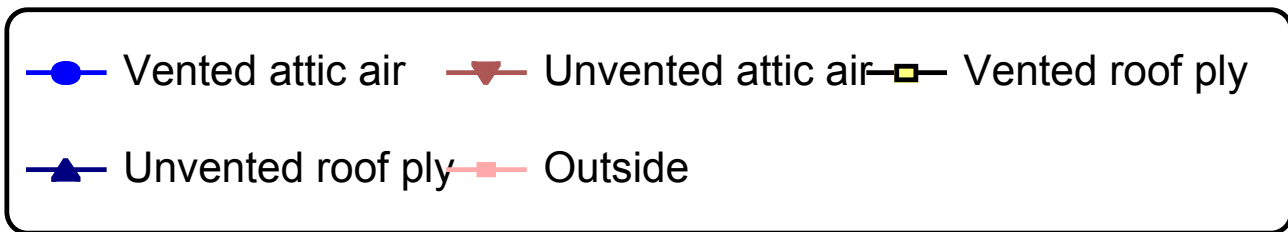
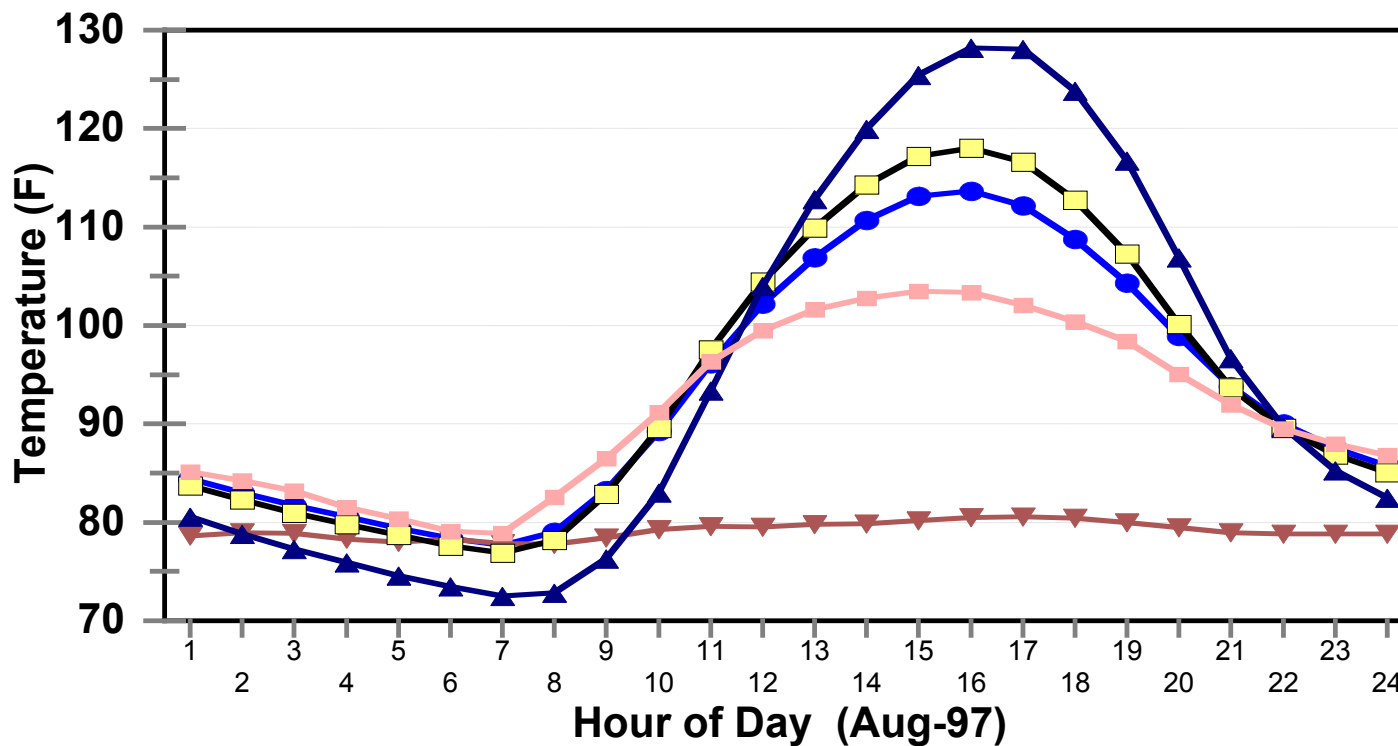
FRF Data: June 1 - September 30, 1989



Vented vs. unvented shingle temperatures

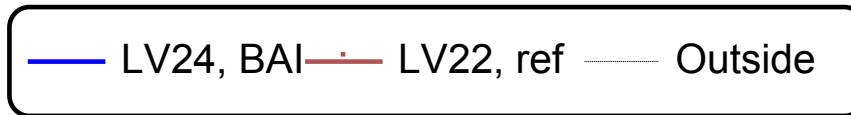
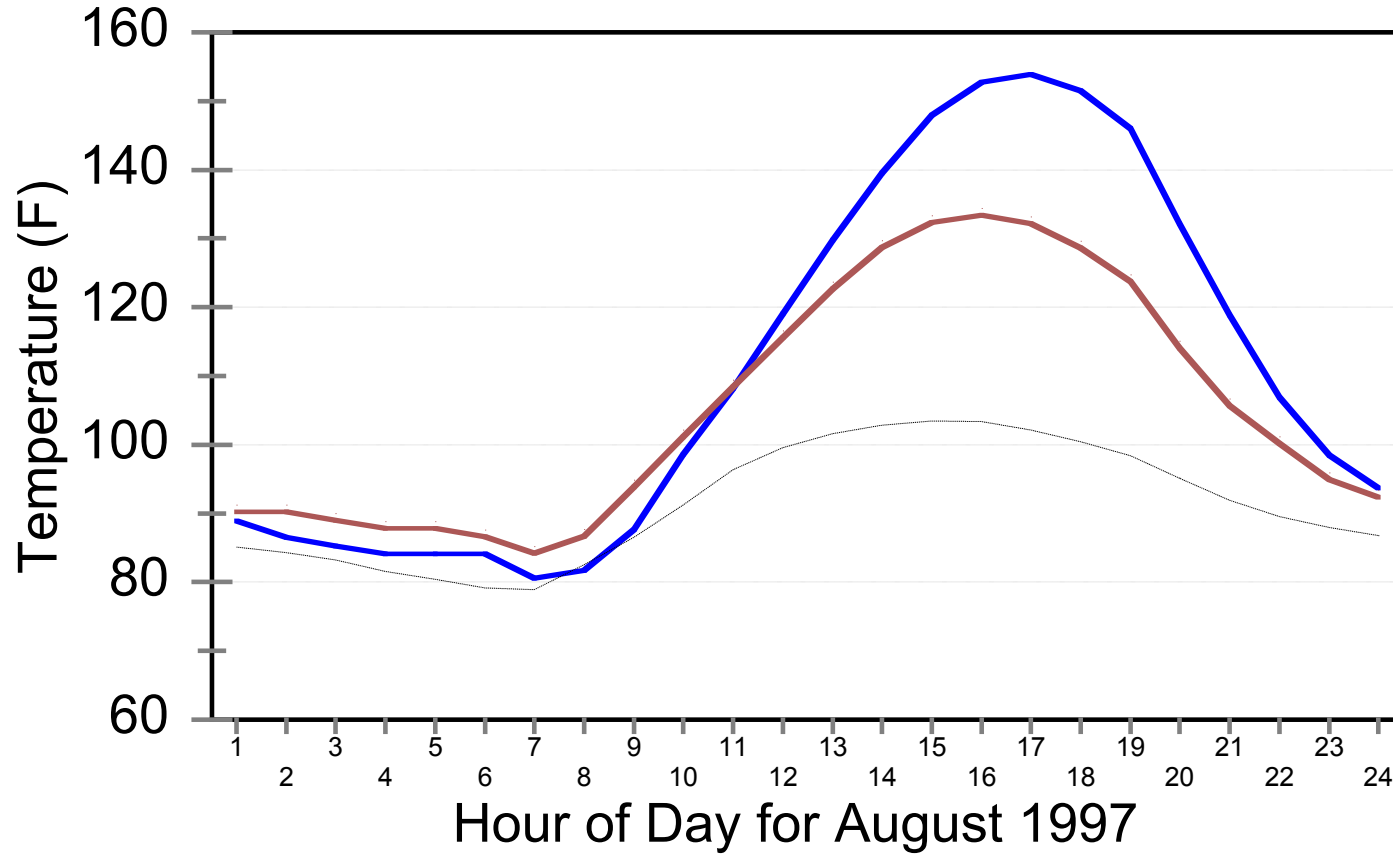


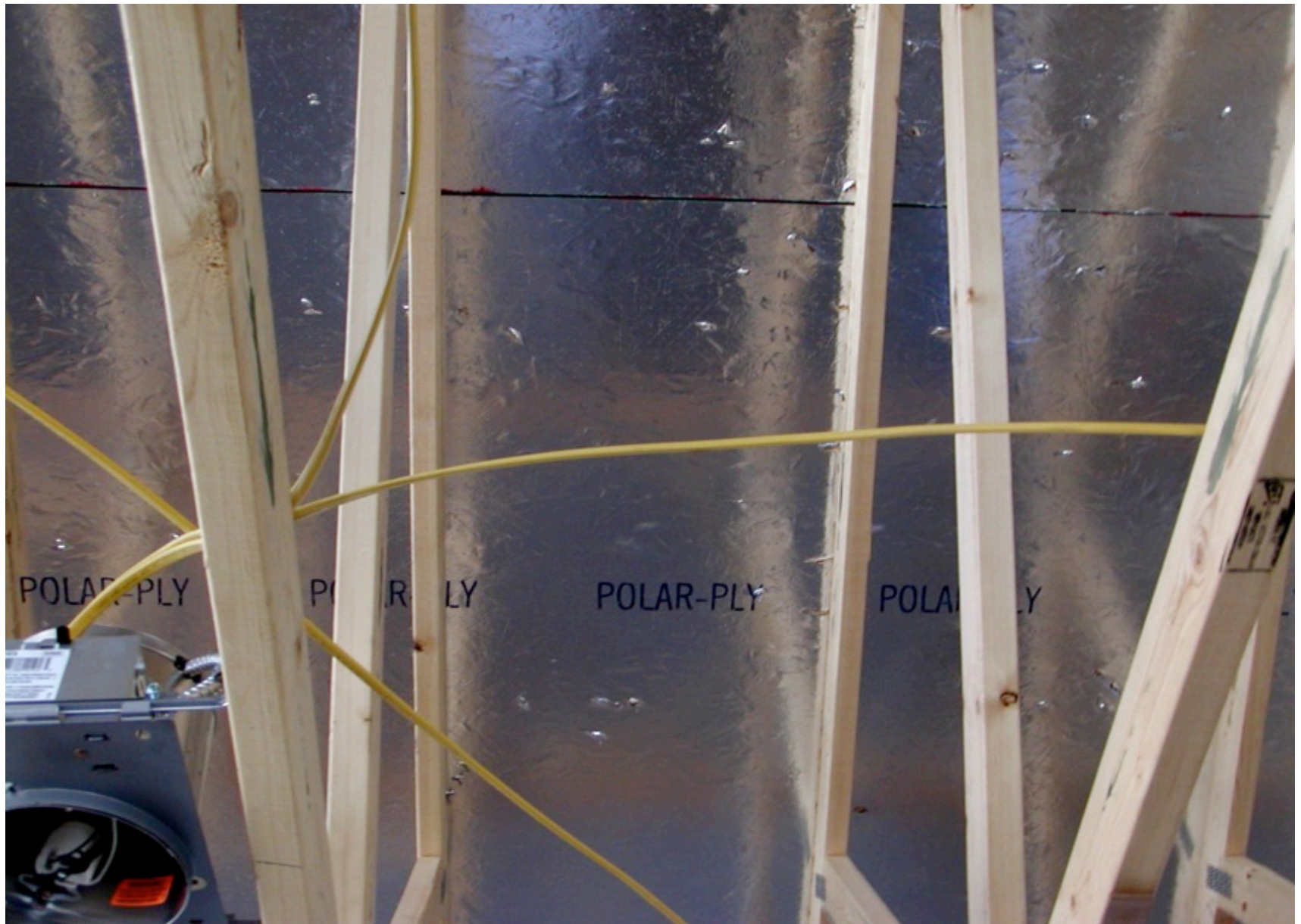
Average Temperatures Vented and Unvented Attics, Aug-97



Hourly Maximim Roof Deck Temperature

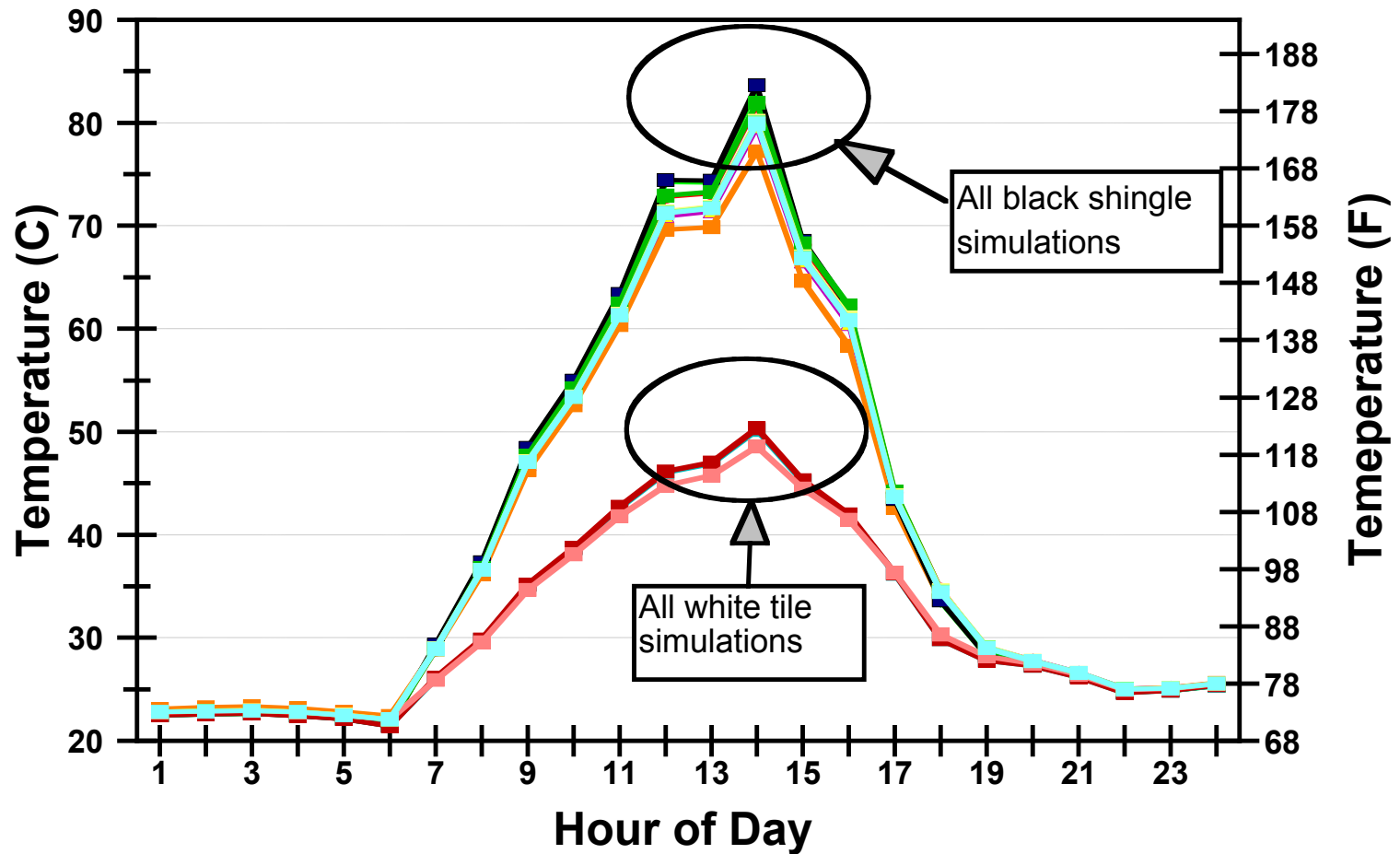
LV24 and LV22





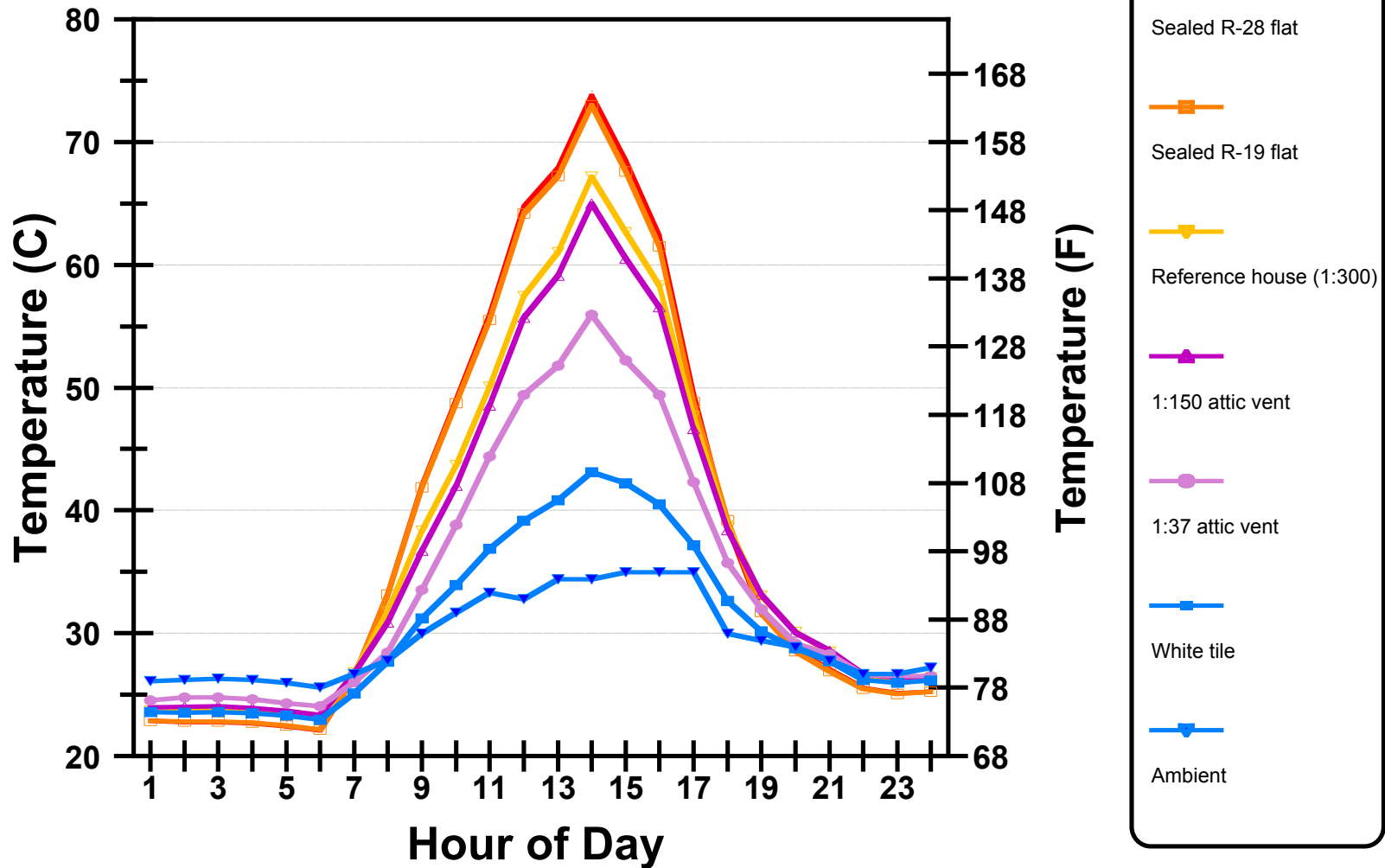
Roof Shingle Temperature

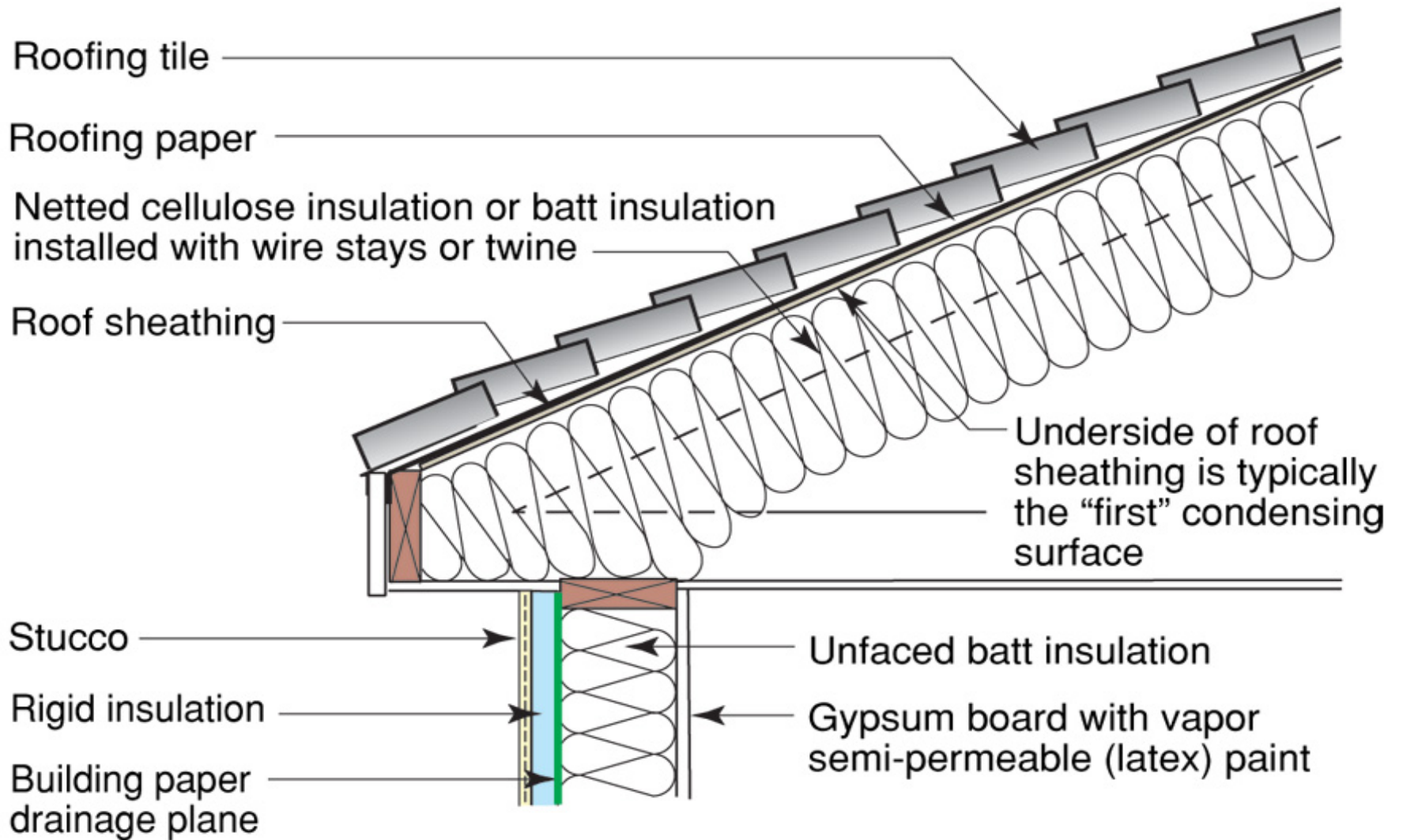
FSEC 3.0: Orlando, 1-Aug

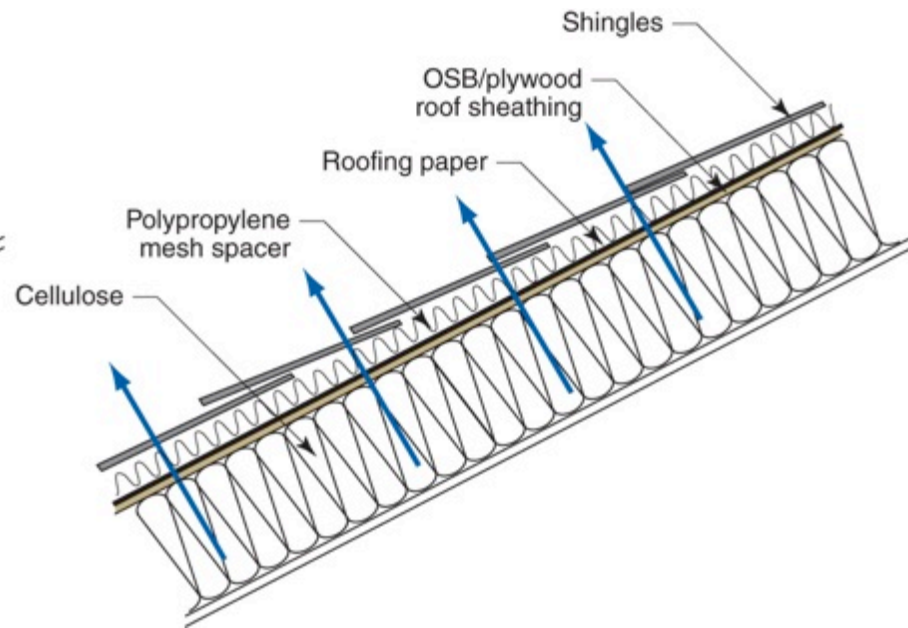
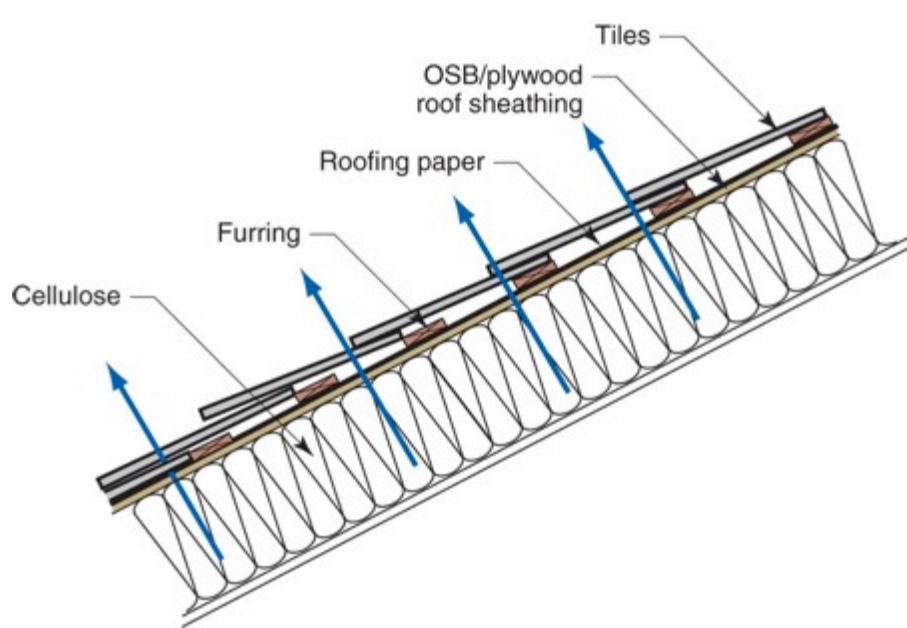


Bottom of Roof Plywood Temperature

FSEC 3.0: Orlando, 1-Aug







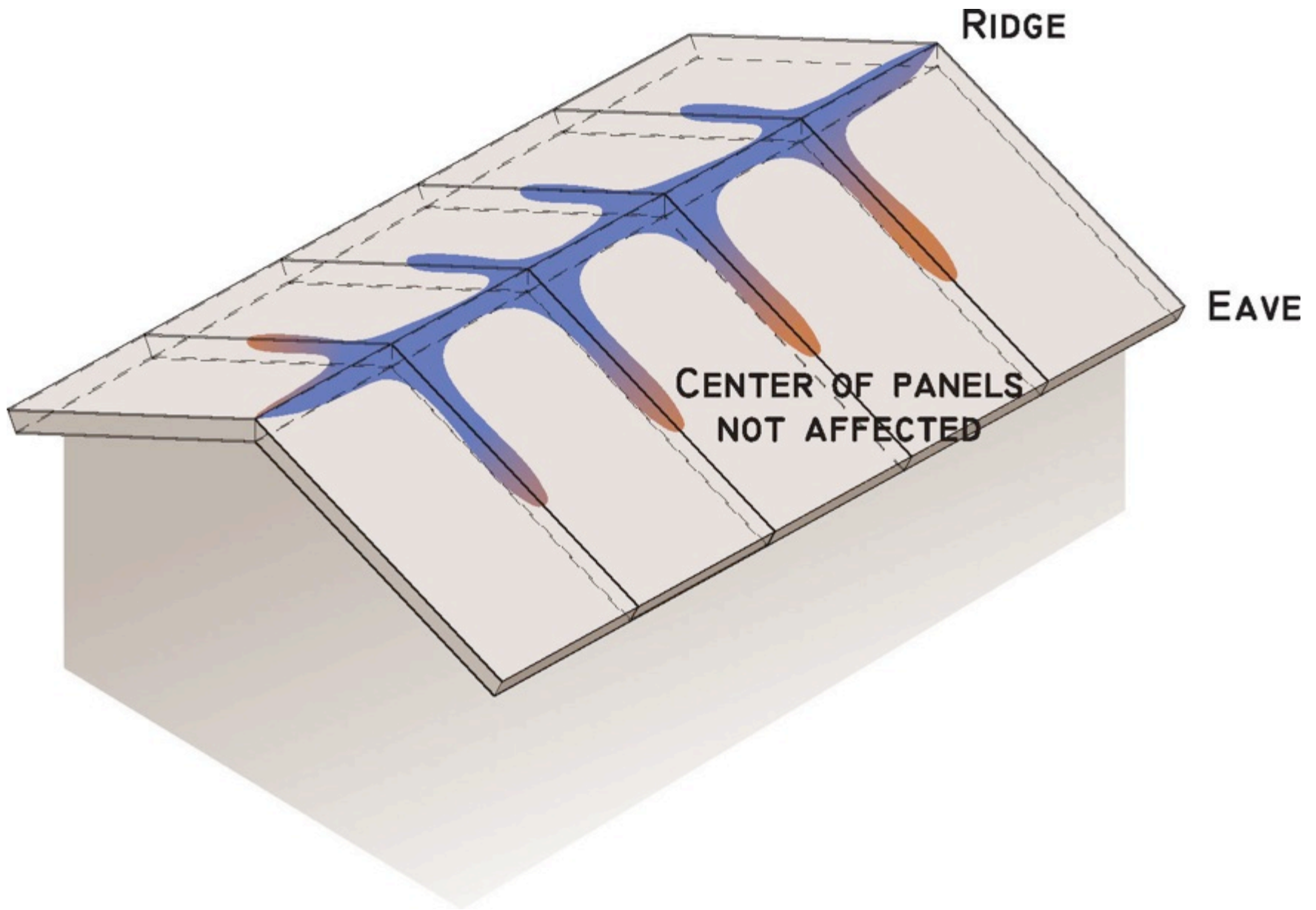


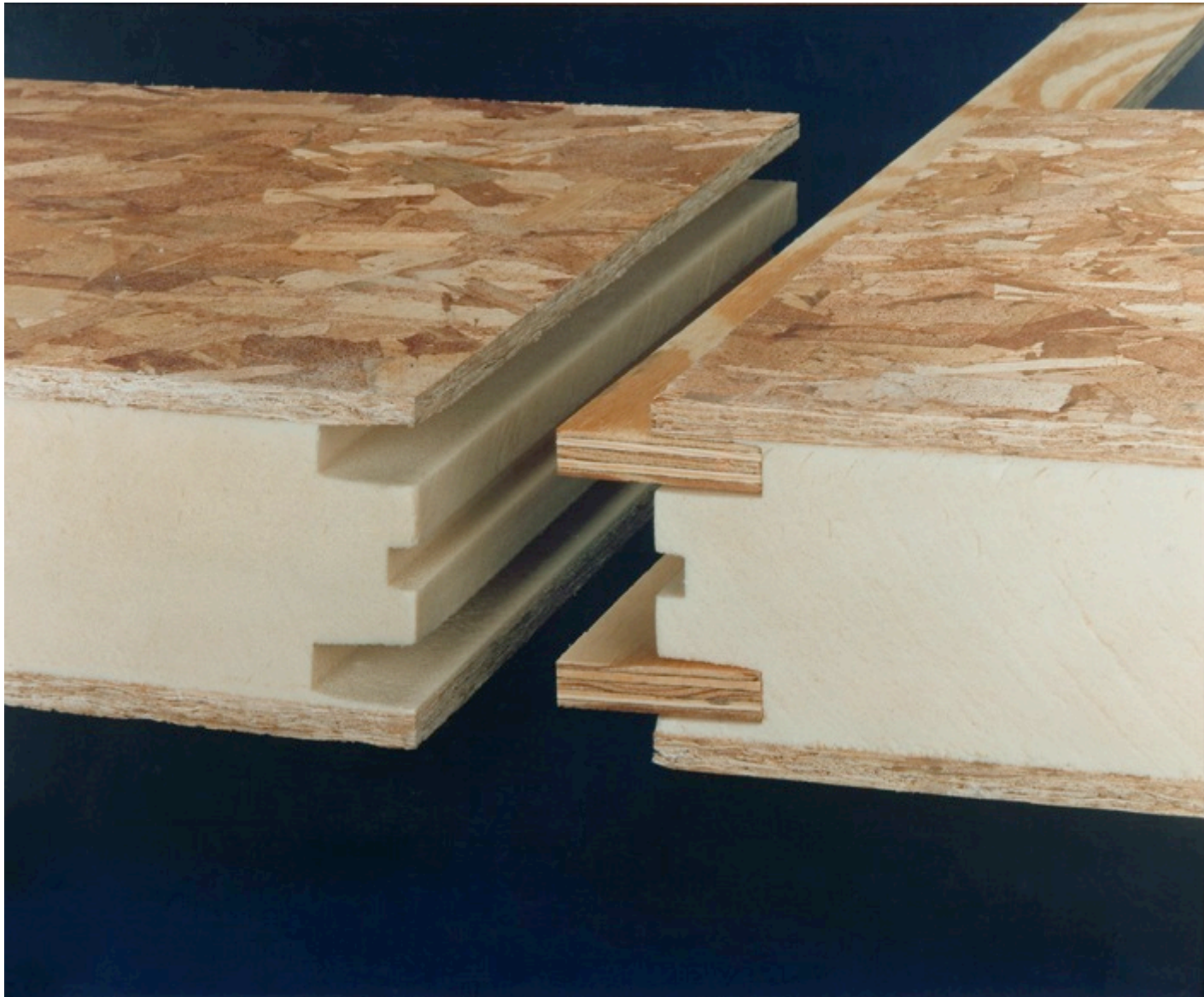












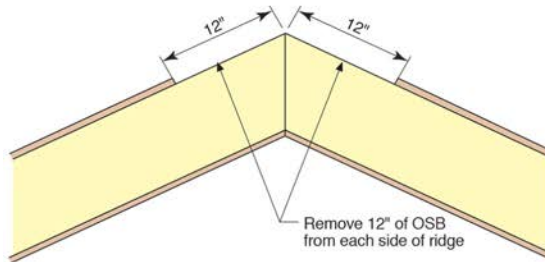






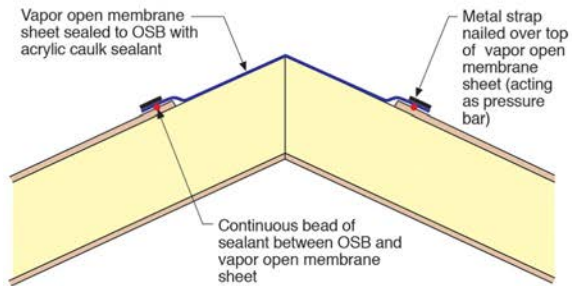
Step 1

- Remove strip of OSB from each side of ridge



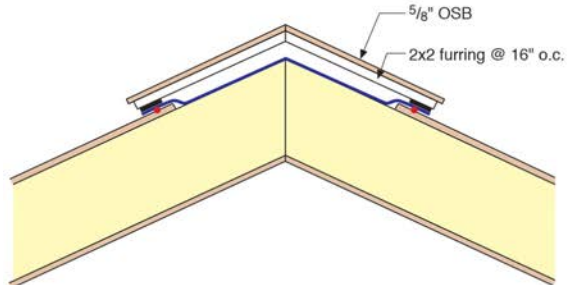
Step 2

- 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









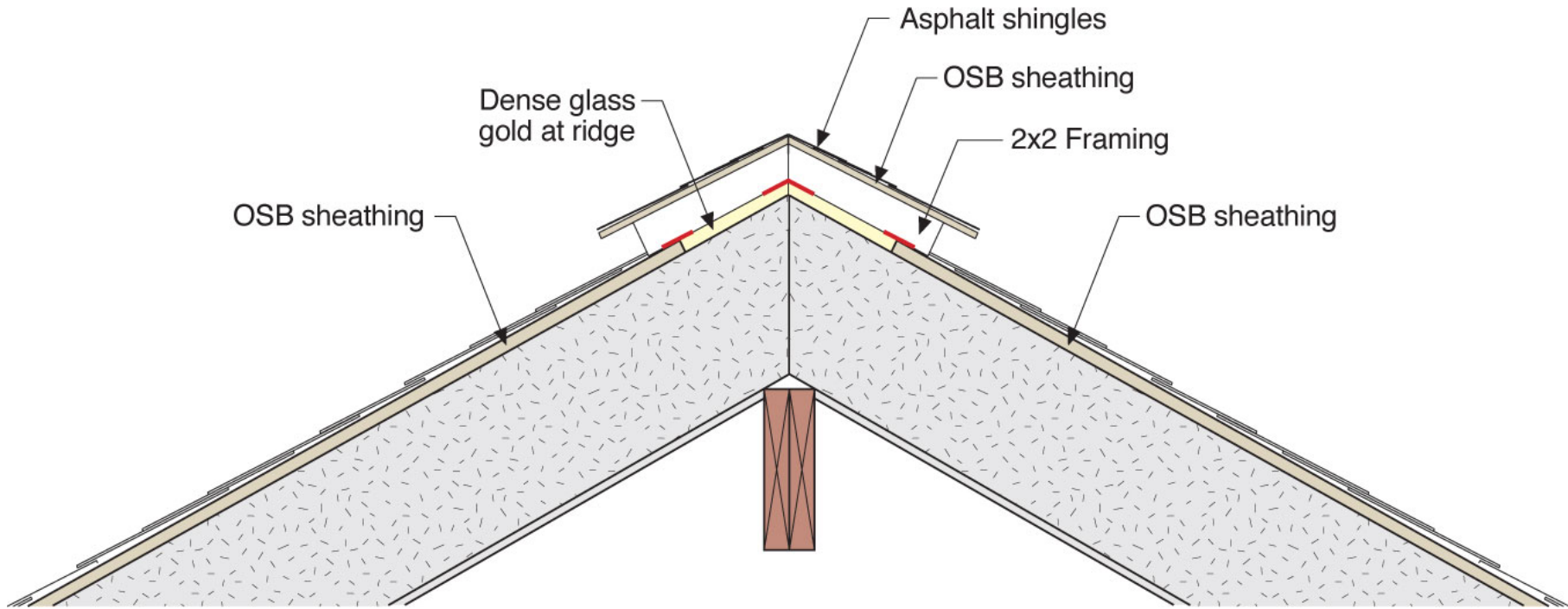


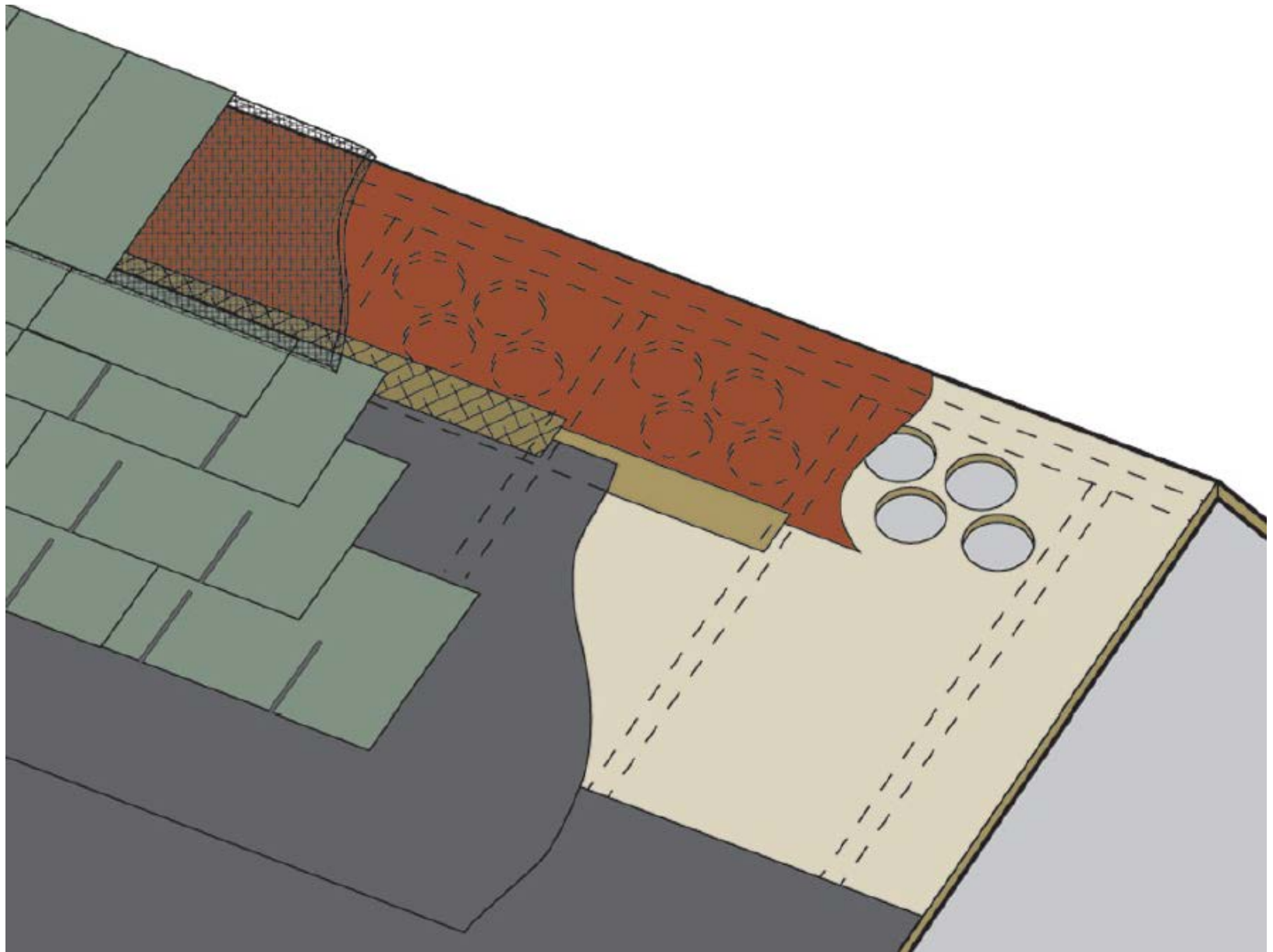


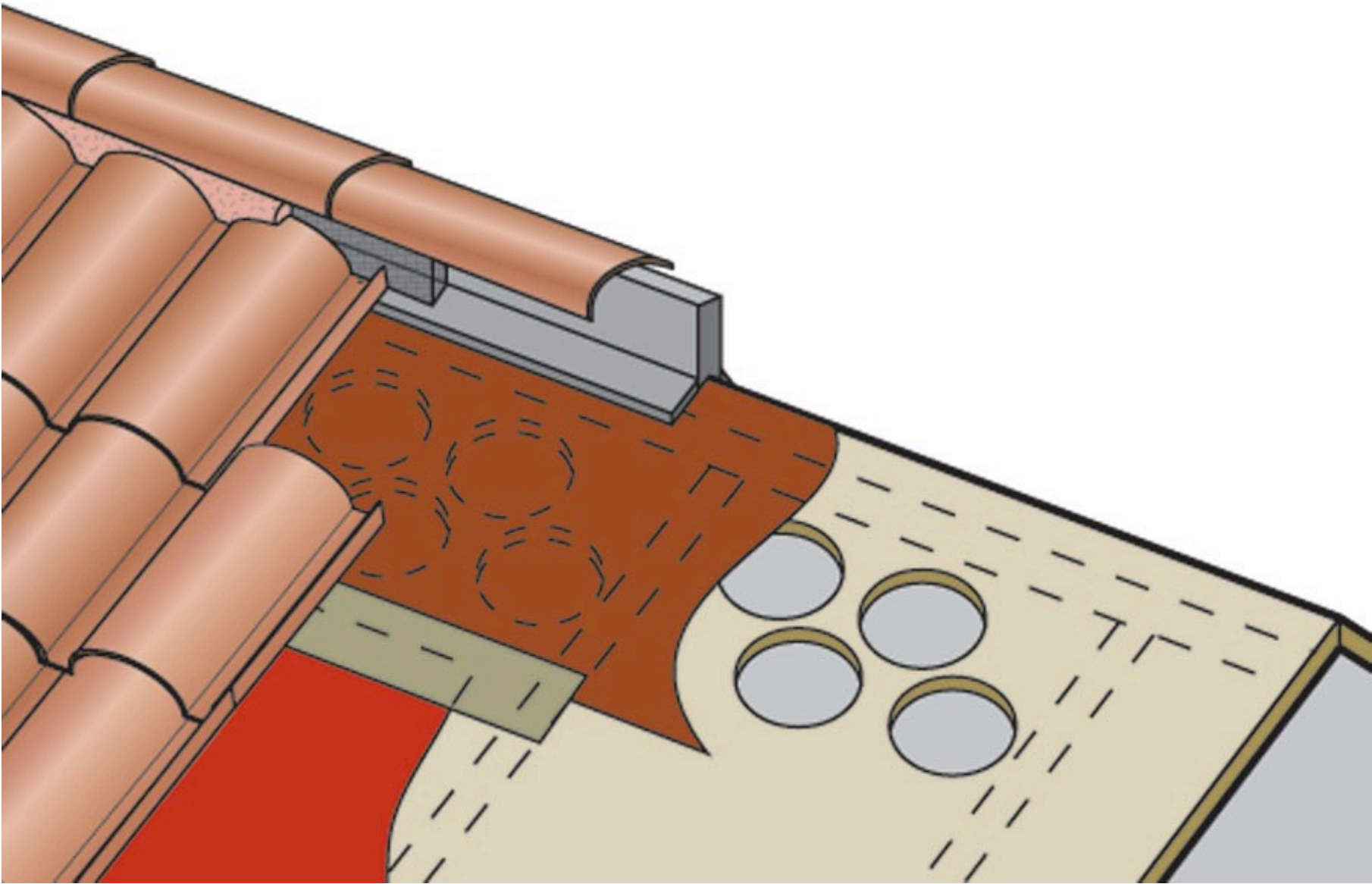


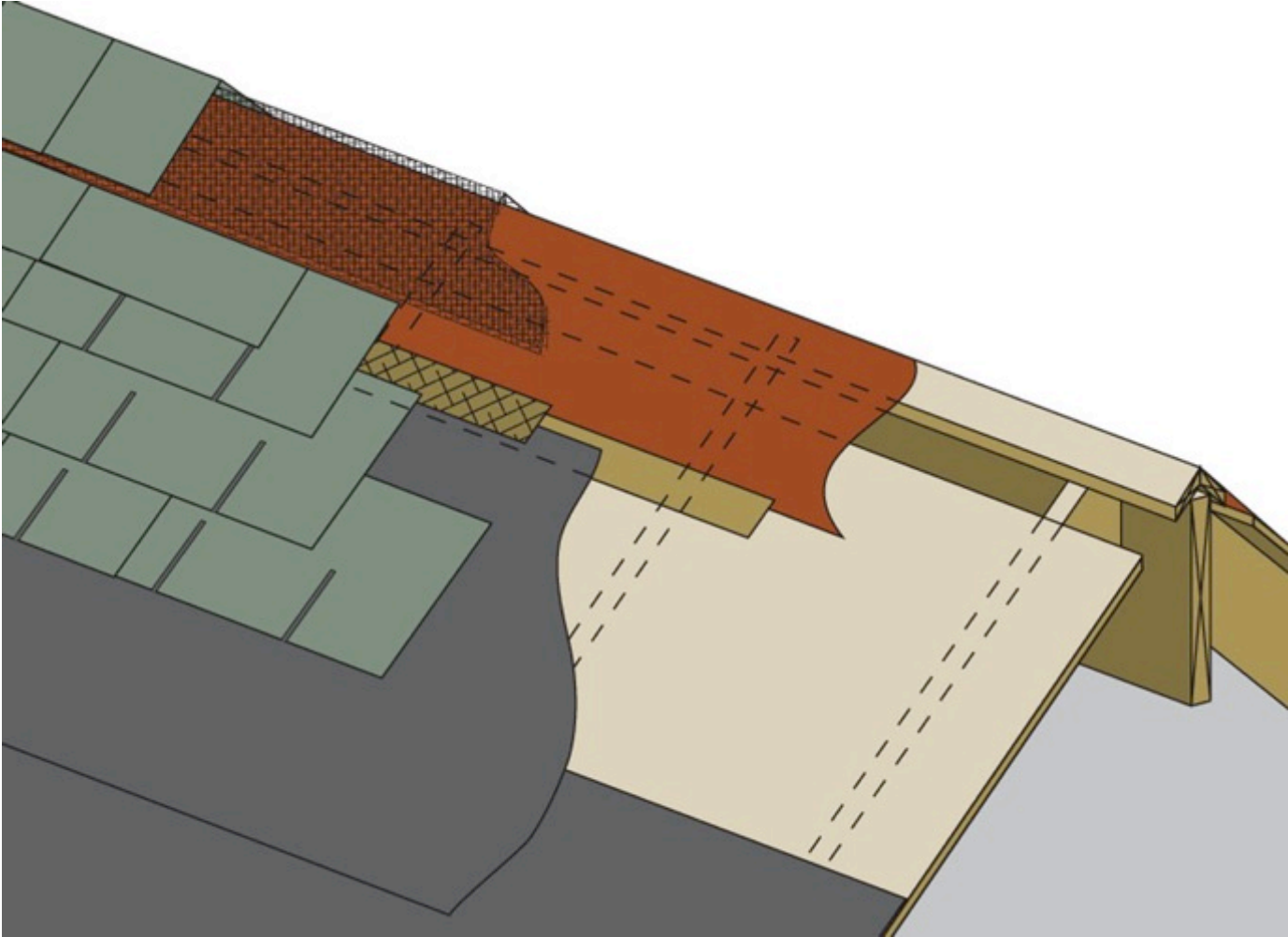


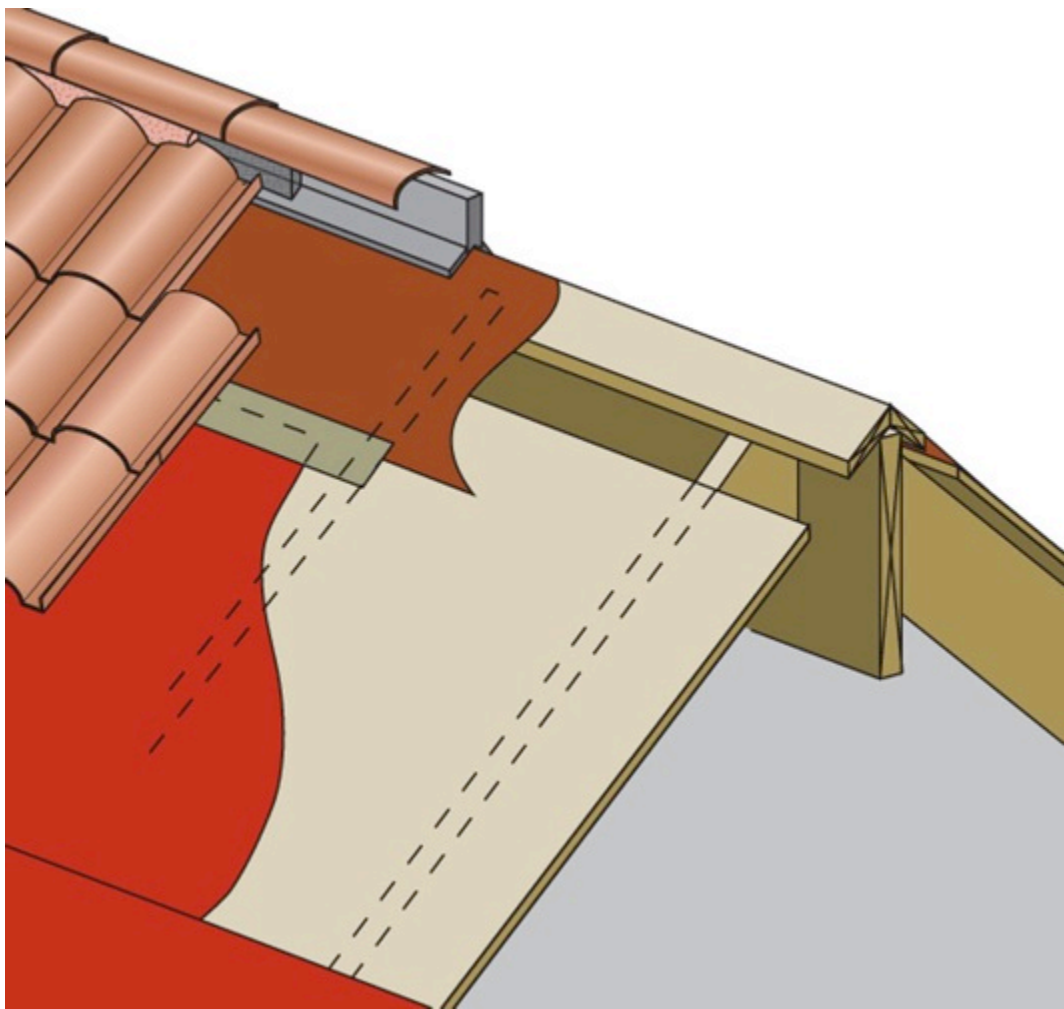






























Sweating Ducts

Sweating Ducts

Light Colored Roofs

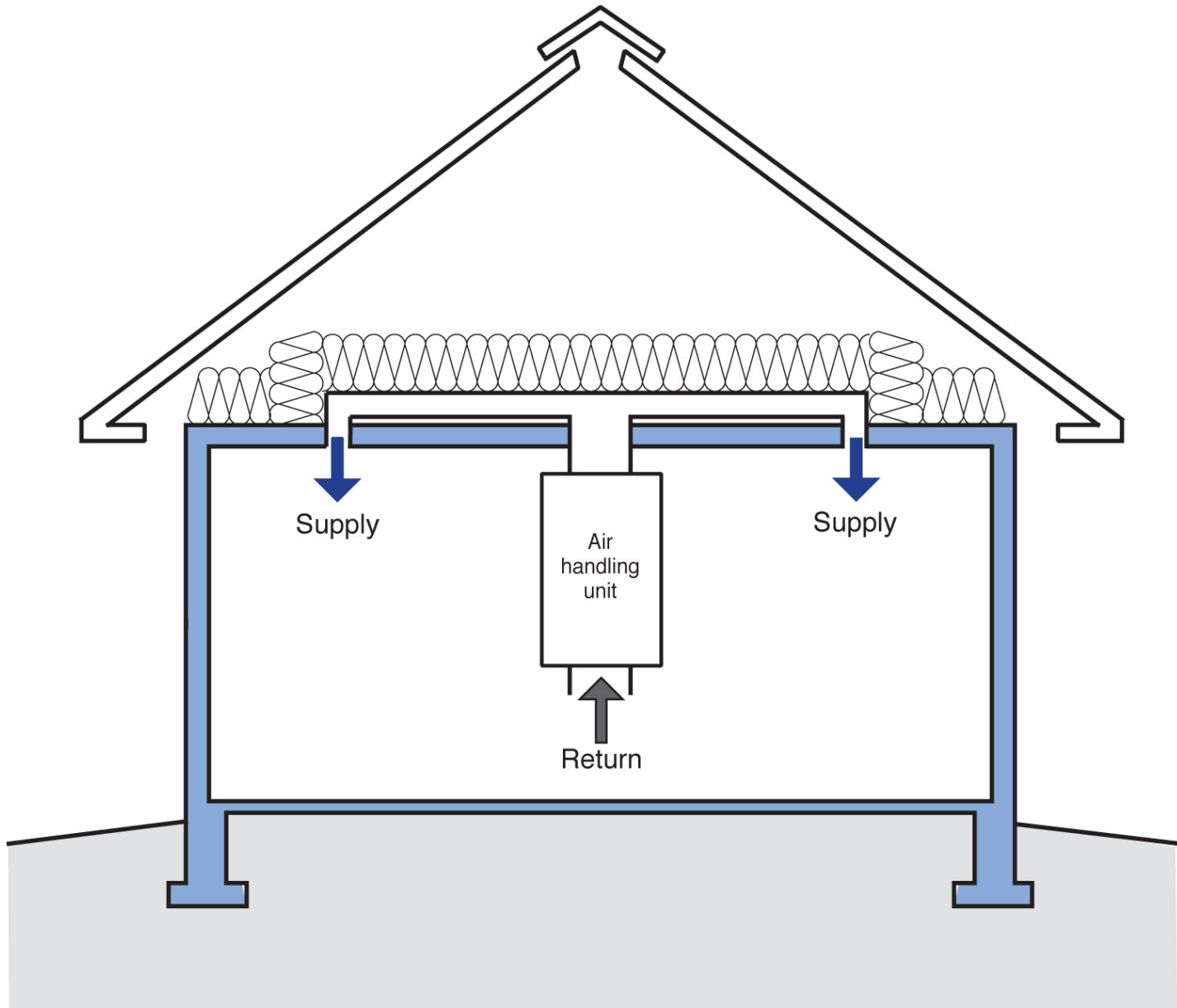
Cool Roofs

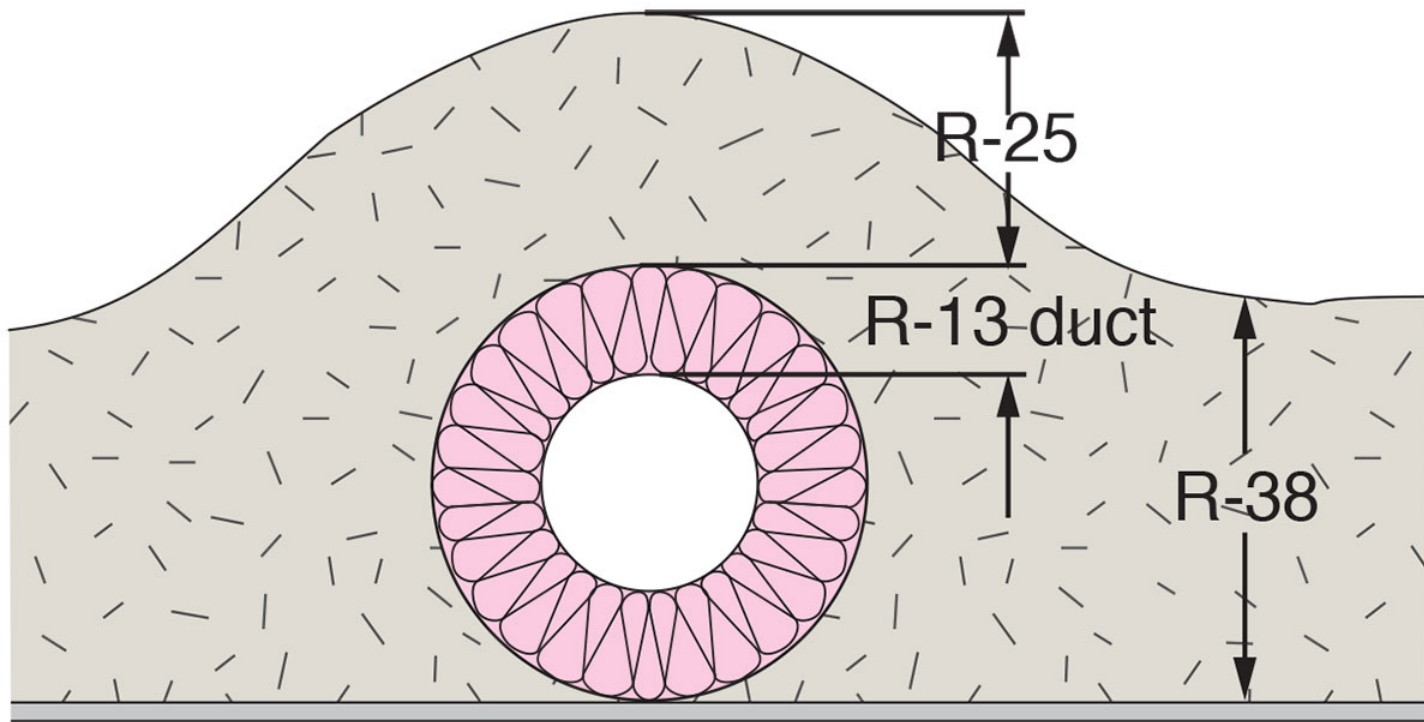
Radiant Barriers

ACCA Manual J, S and D

Ductwork Attic Dehumidification System

Burying Ducts

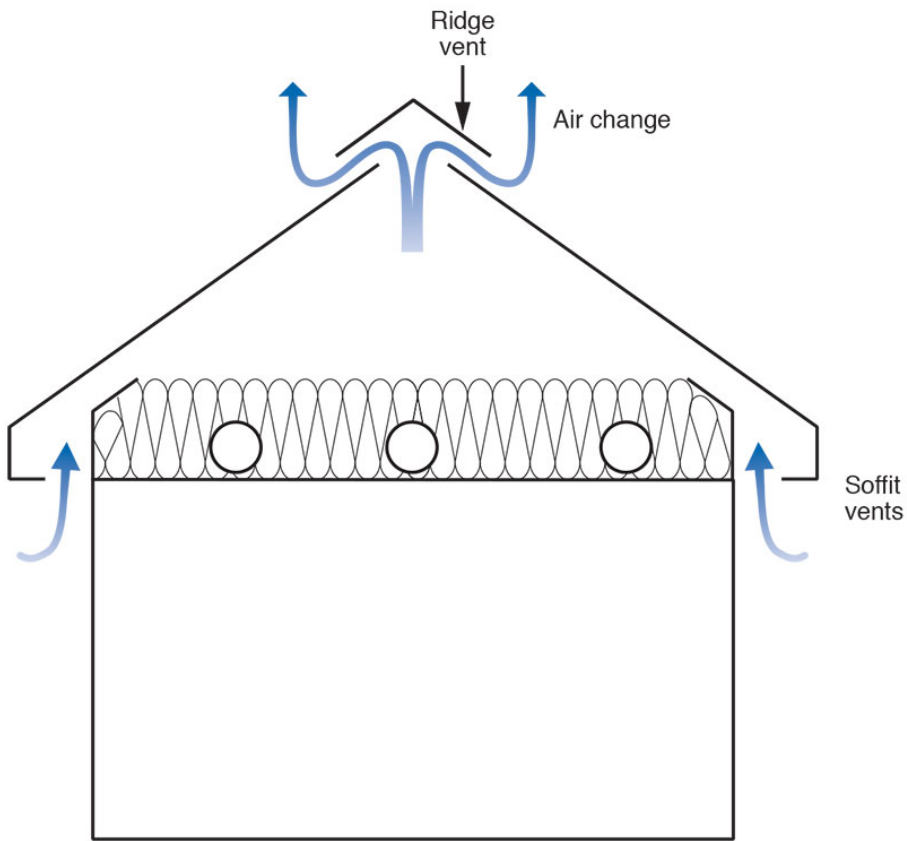




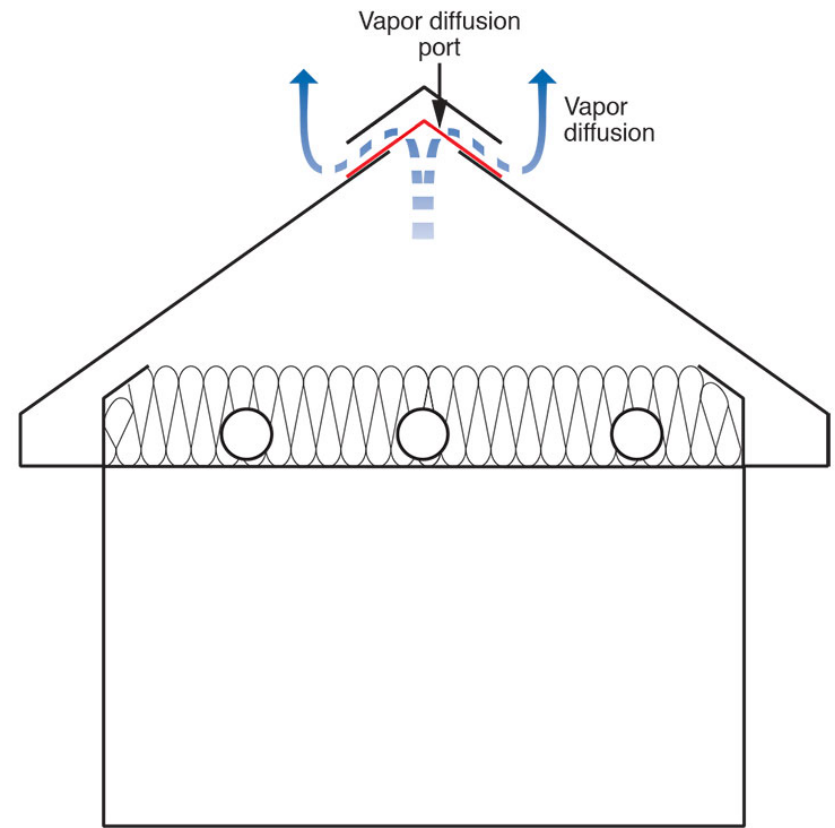








Classic vented attic



Unvented attic with vapor diffusion port