

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

Building Science

Roofs

presented by 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 an unvented attic to the atmosphere.

Arrhenius Equation

For Every 10 Degree K Rise
Activation Energy Doubles

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

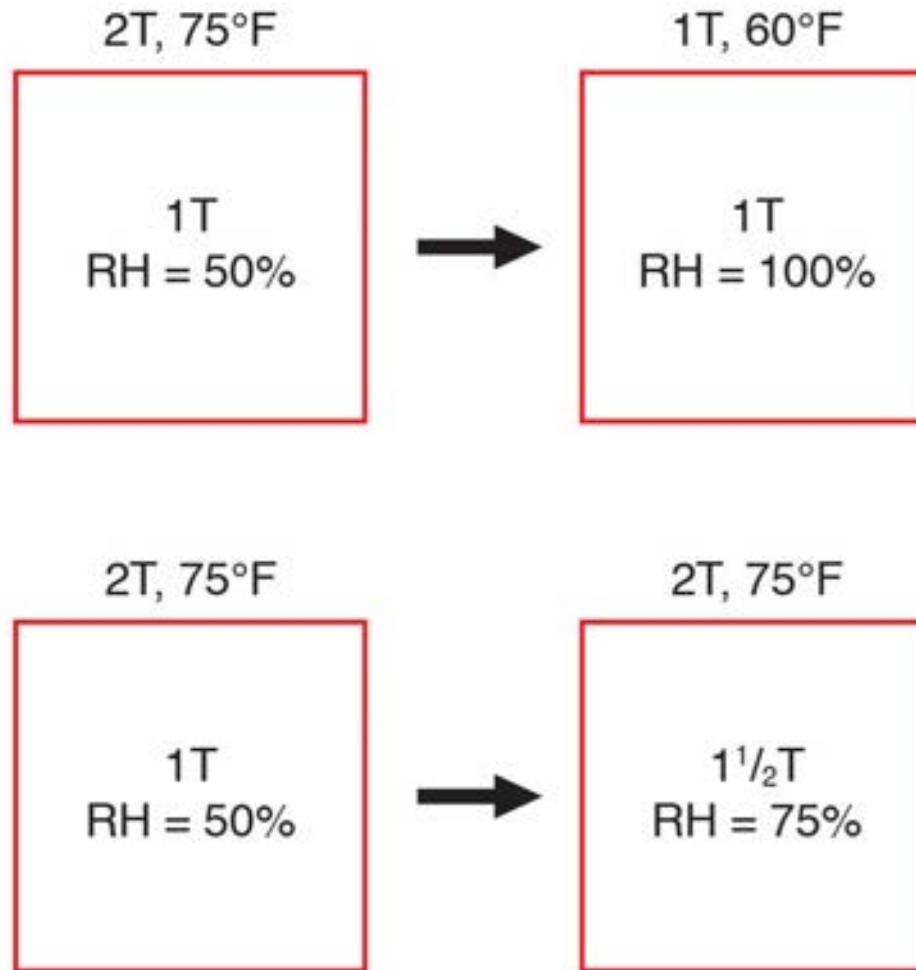
Damage Functions

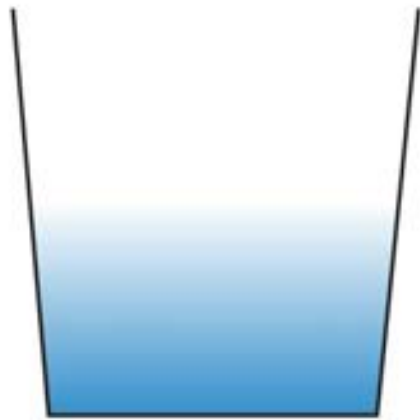
Water

Heat

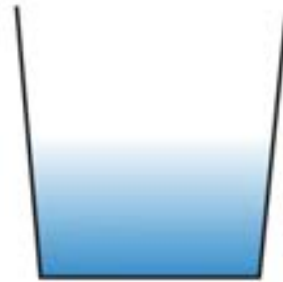
Ultra-violet Radiation

Vapor Pressure and Relative Humidity





90°F
50% RH



75°F
50% RH



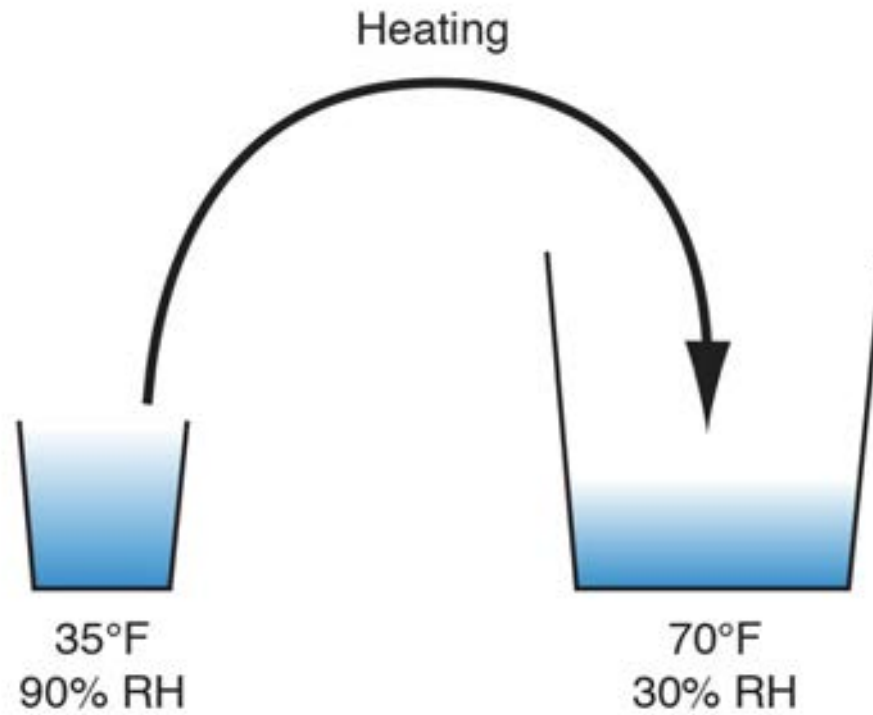
60°F
50% RH

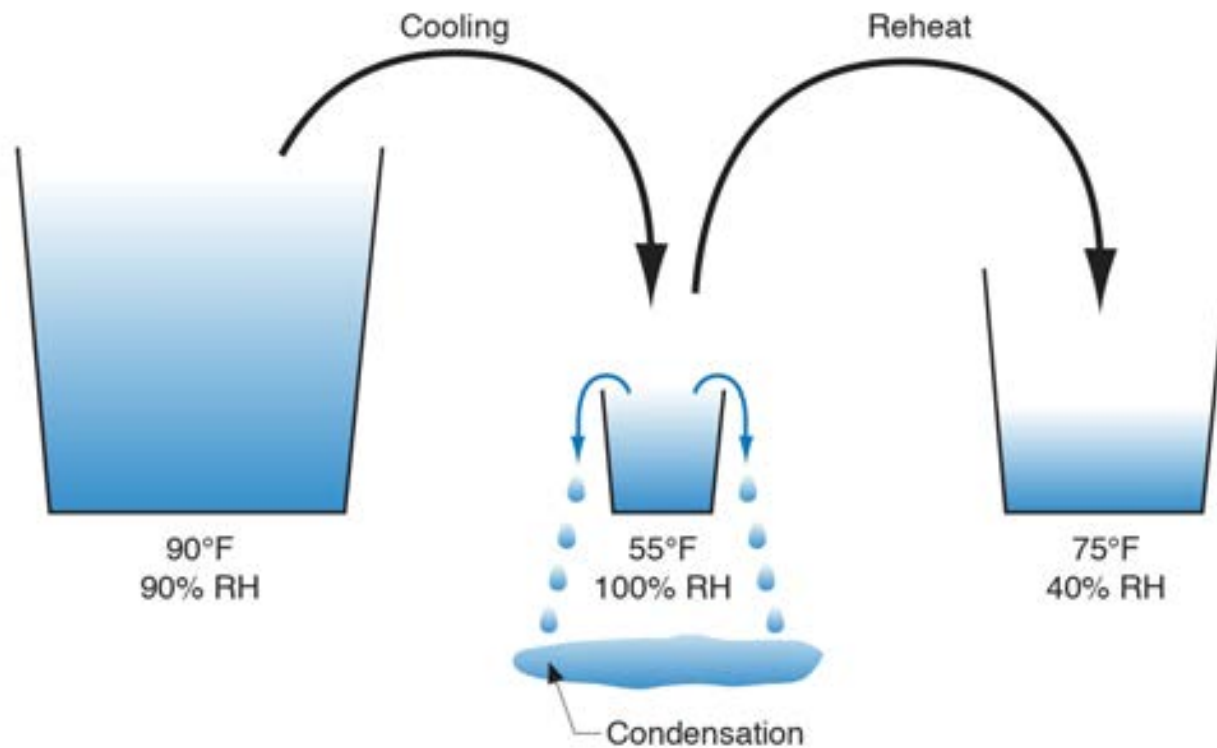


45°F
50% RH



30°F
50% RH







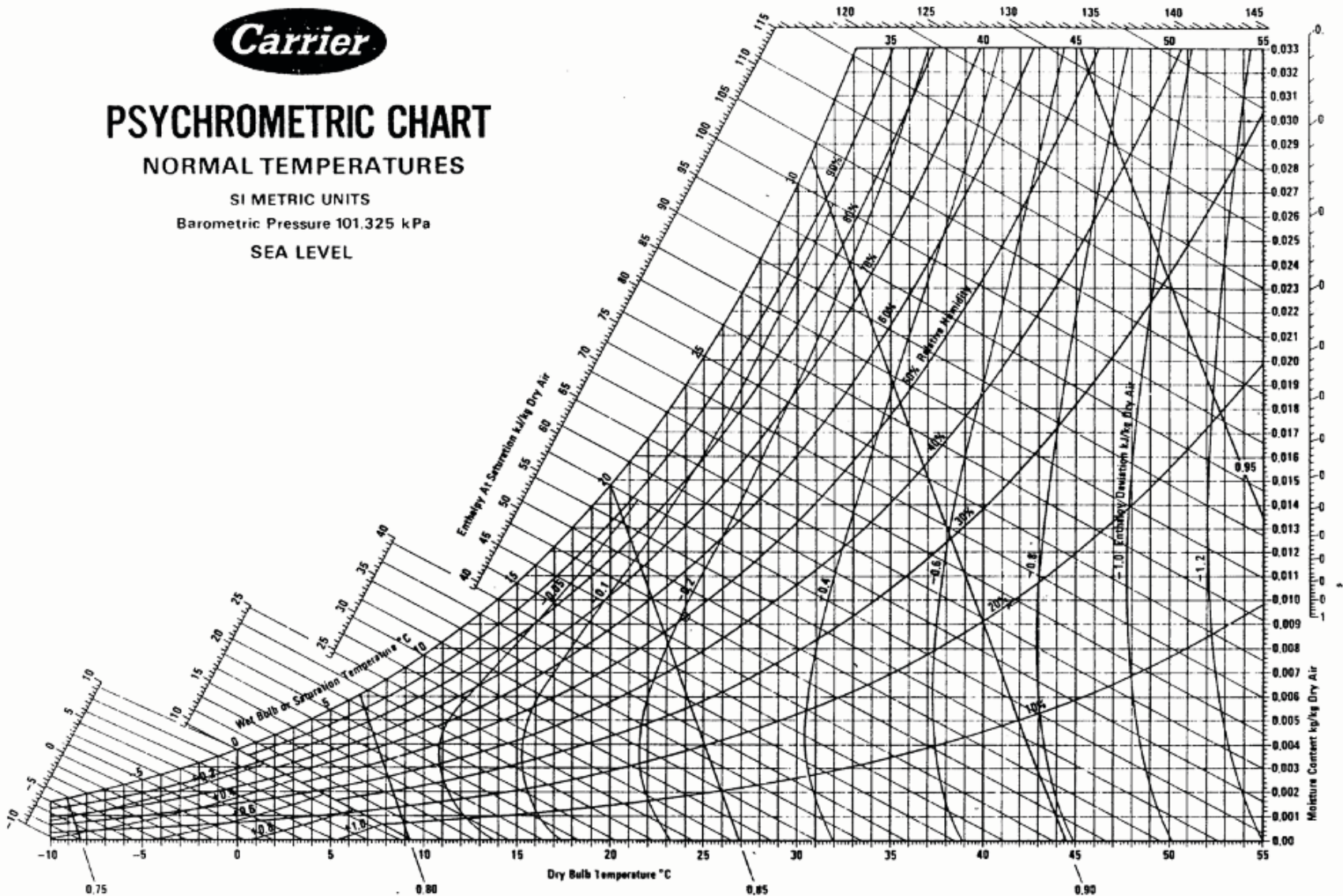
PSYCHROMETRIC CHART

NORMAL TEMPERATURES

SI METRIC UNITS

Barometric Pressure 101.325 kPa

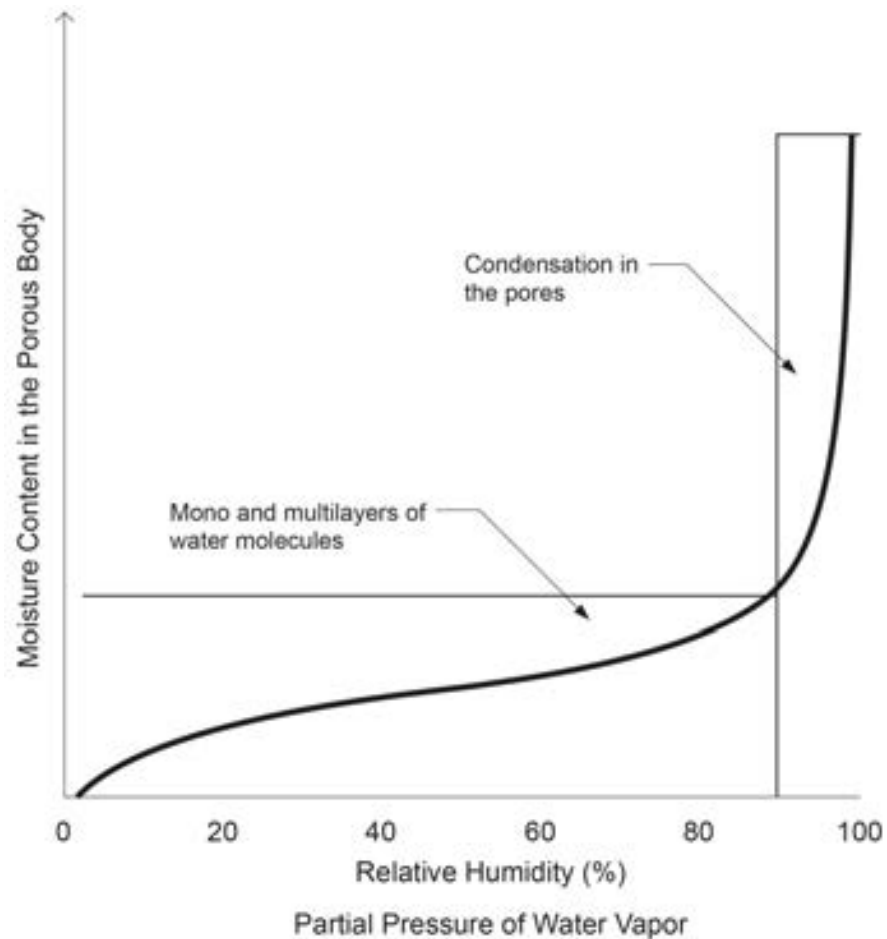
SEA LEVEL



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

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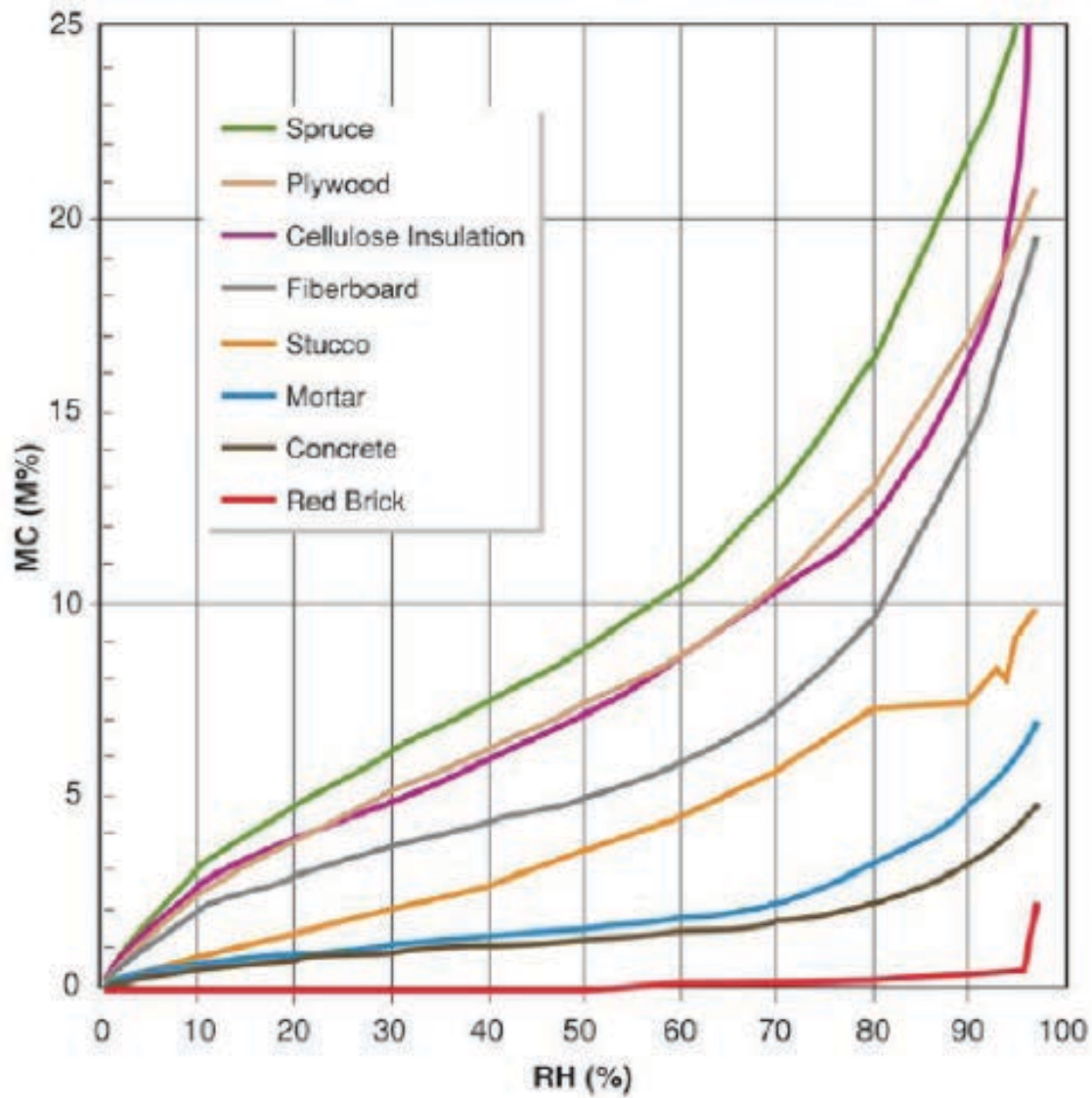
Sorption Isotherms

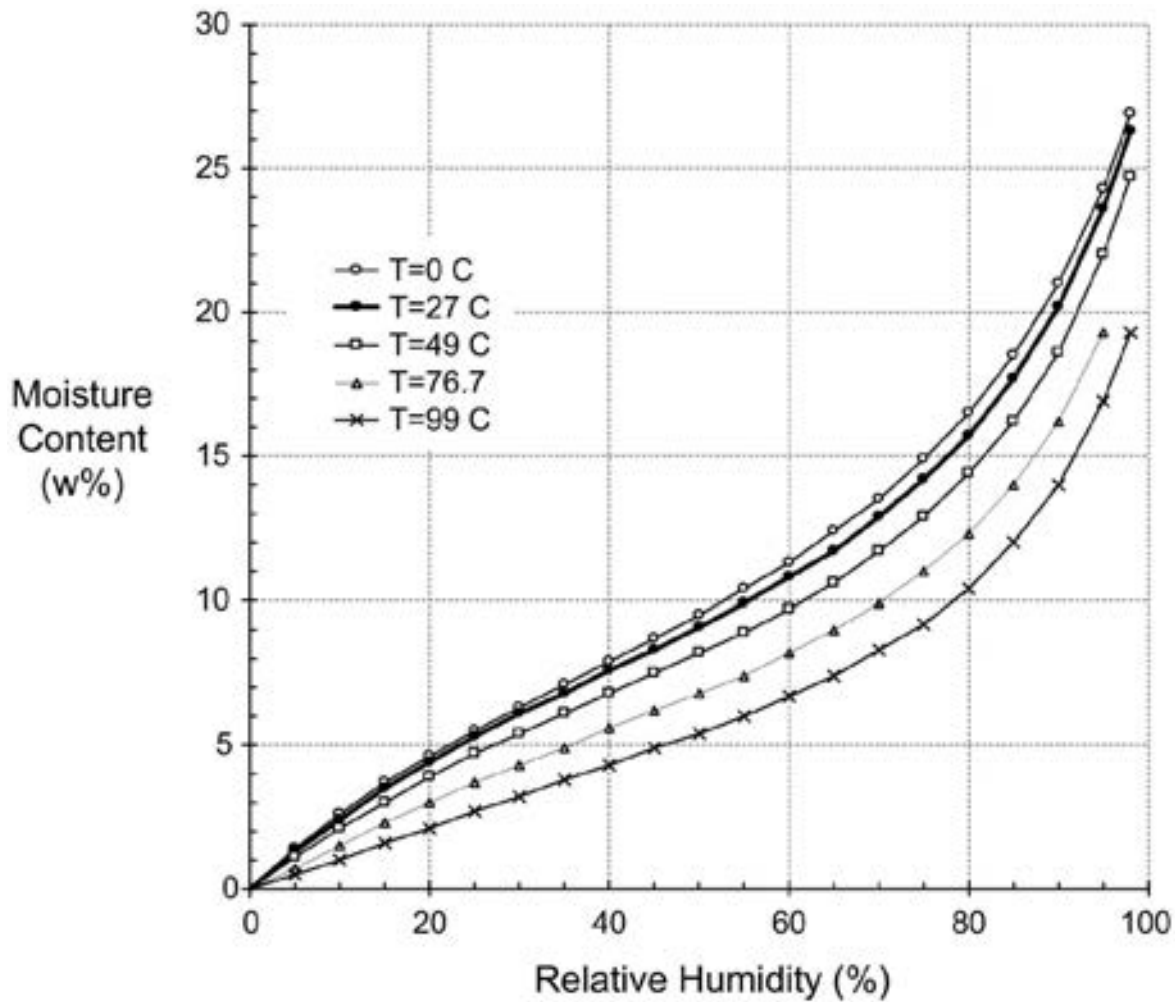


Change in the storage of moisture in a porous building material as the partial pressure of water vapor in the ambient air increases from zero to full saturation value at a given temperature.

Sorption Curve

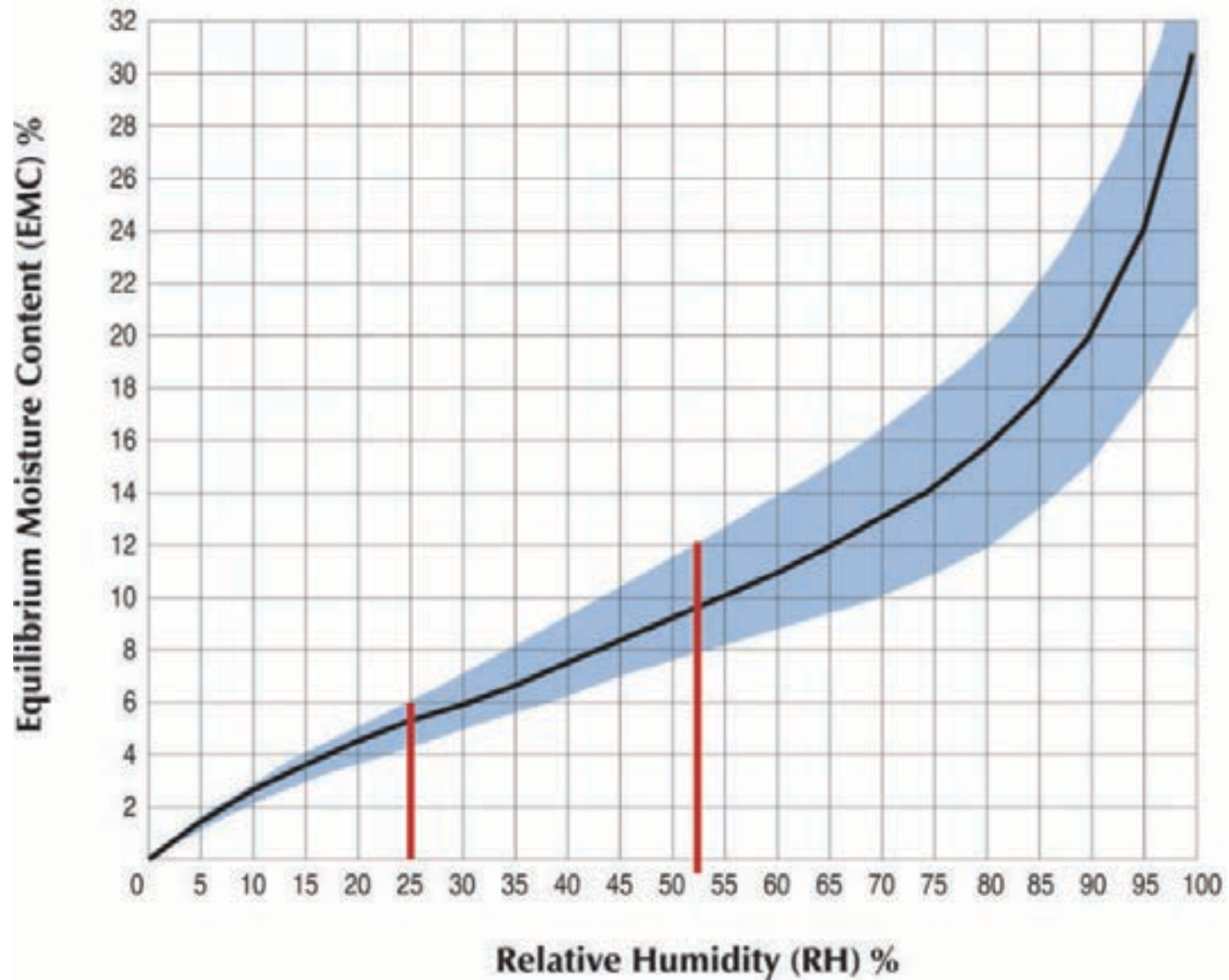
From M.K. Kumaran, ASTM MNL 18-2nd Edition,
Moisture Control in Buildings, 2009





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

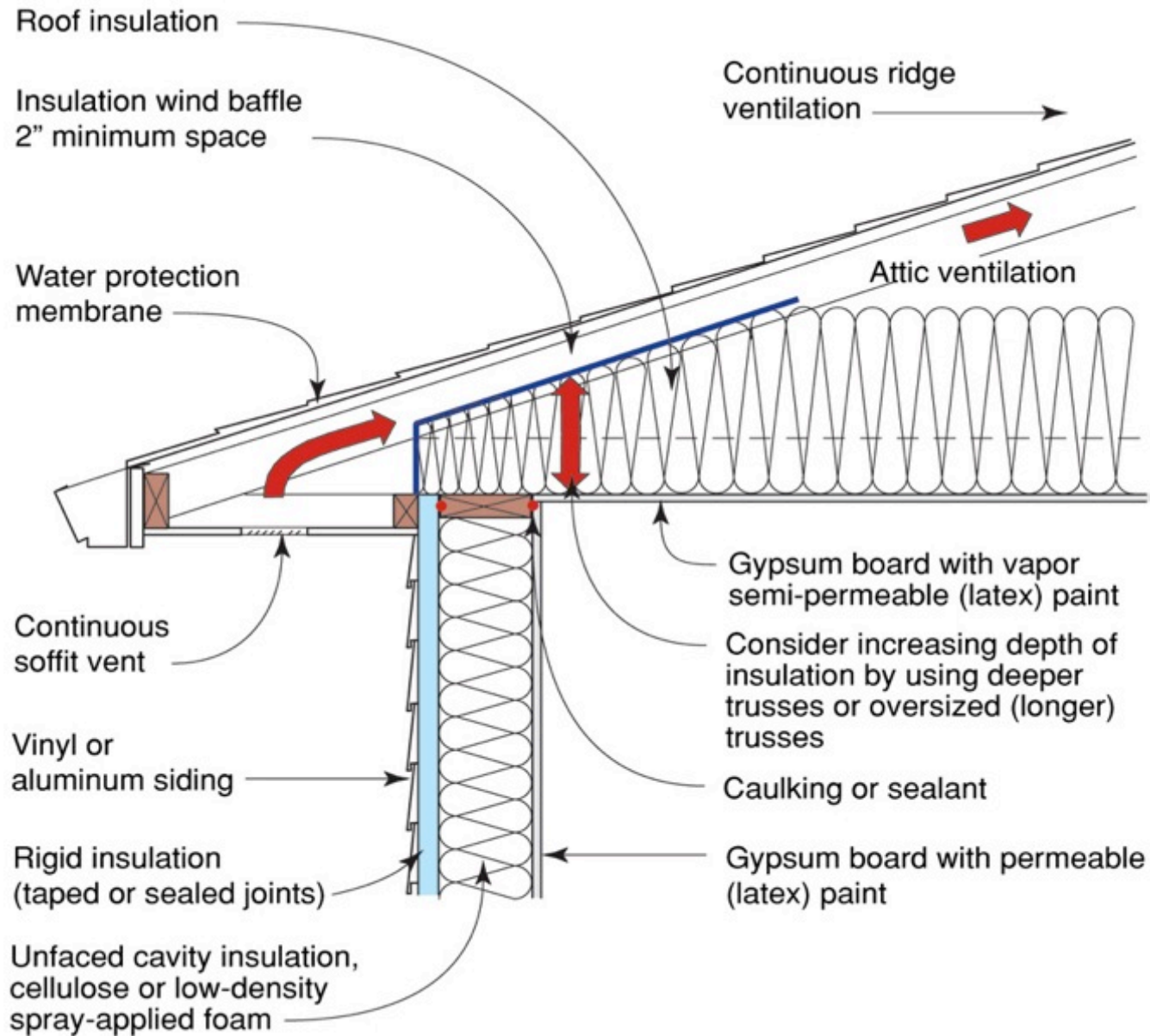


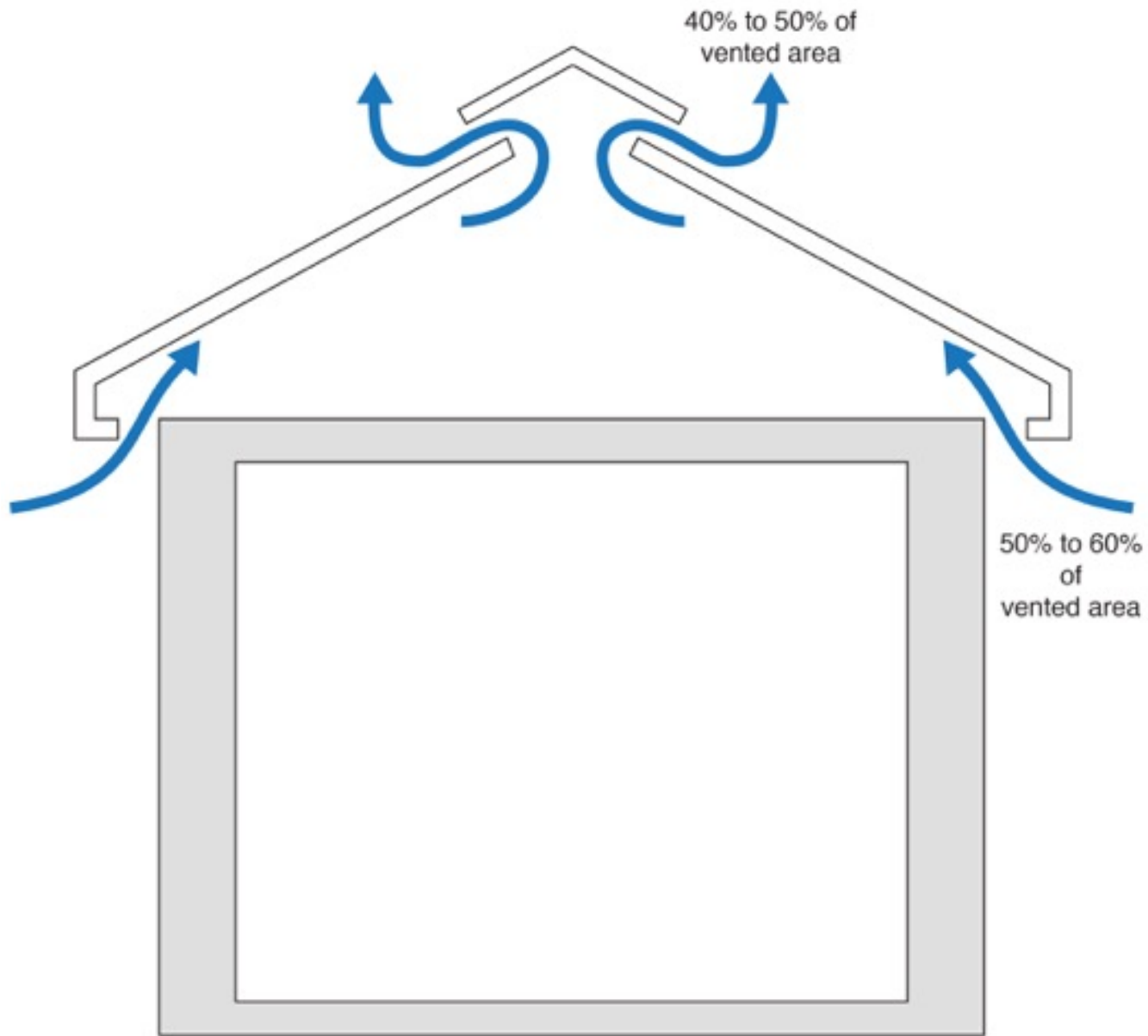


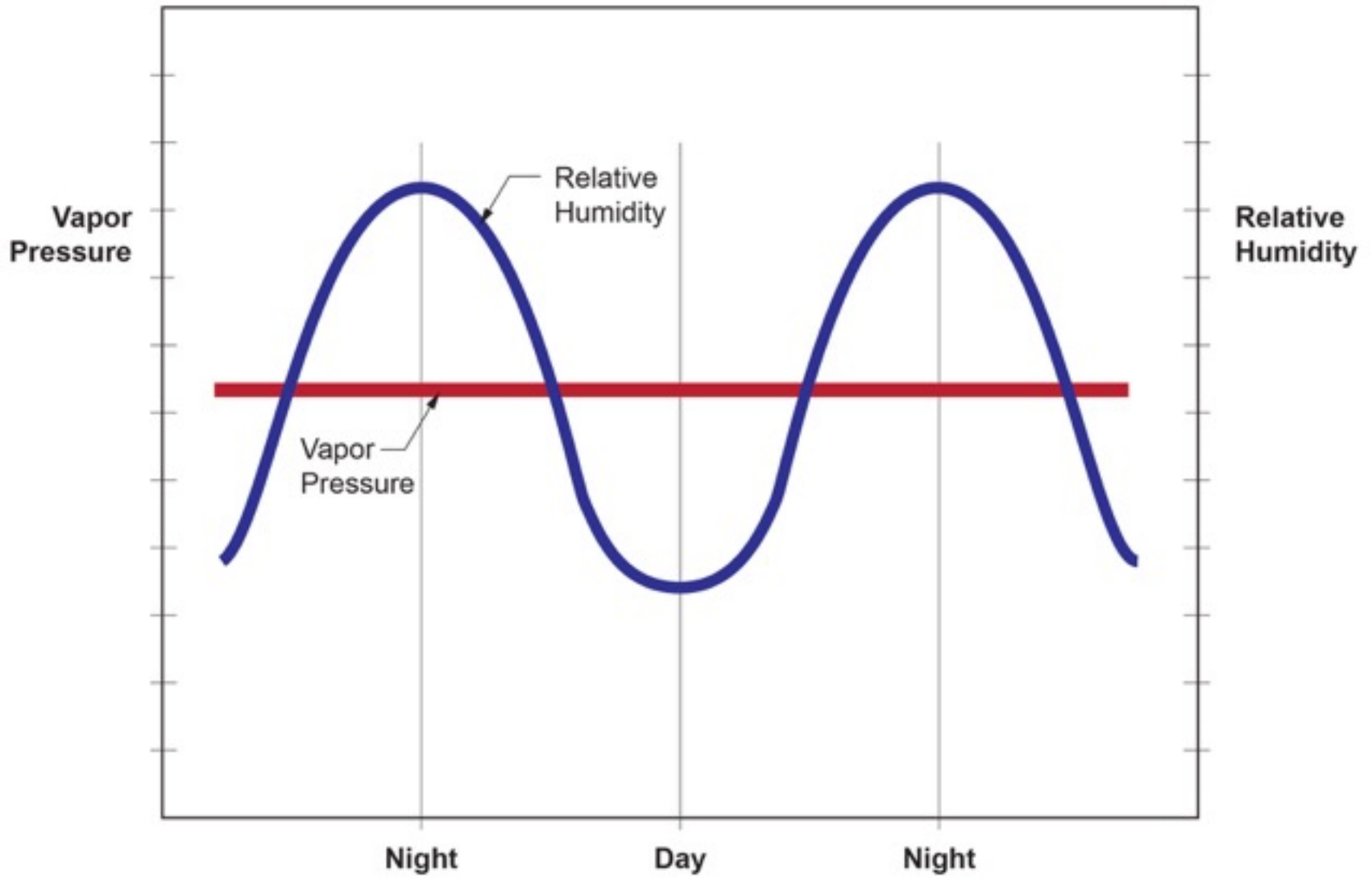
Exposure

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

Vented Attics Are Climate Dependant





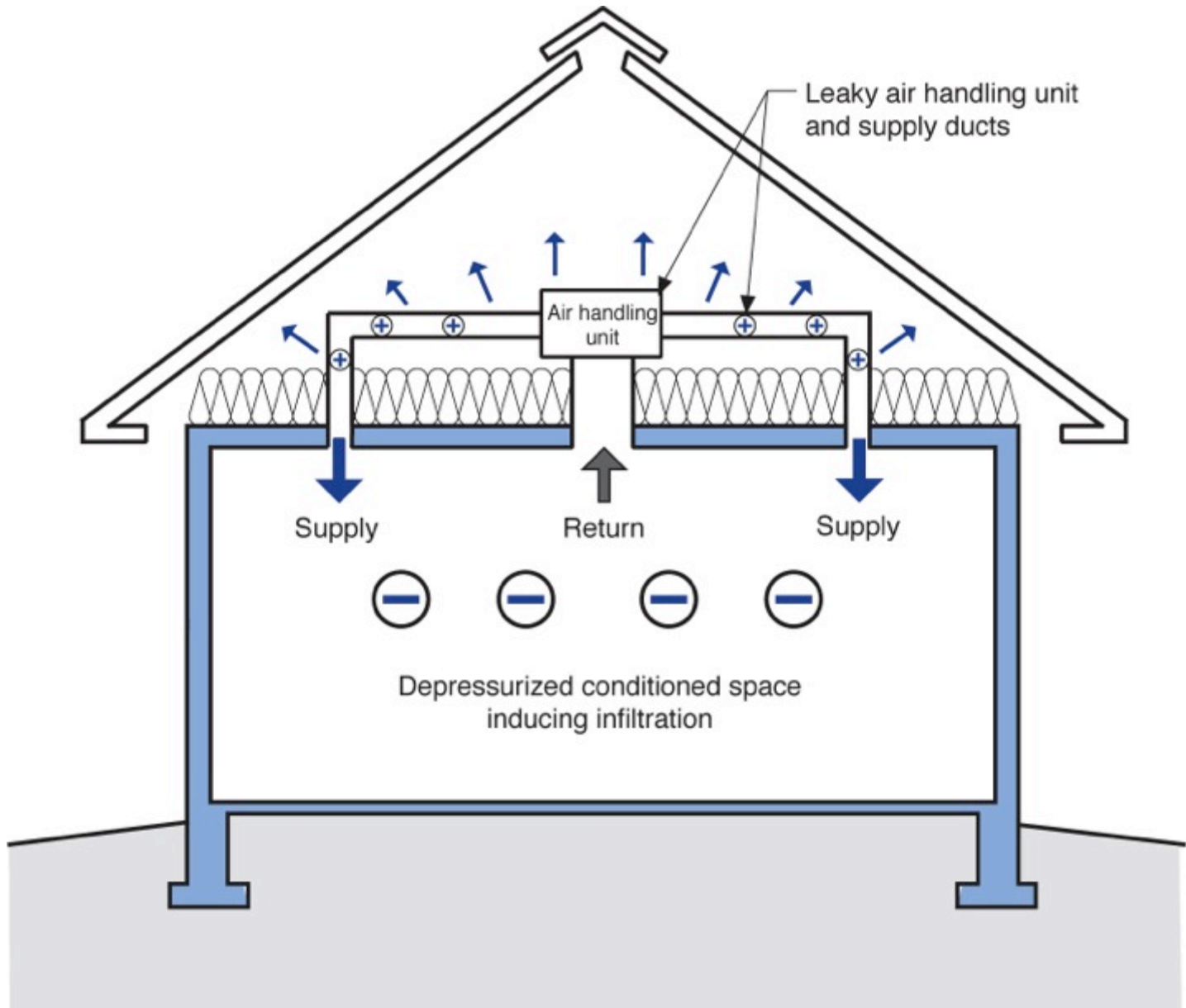


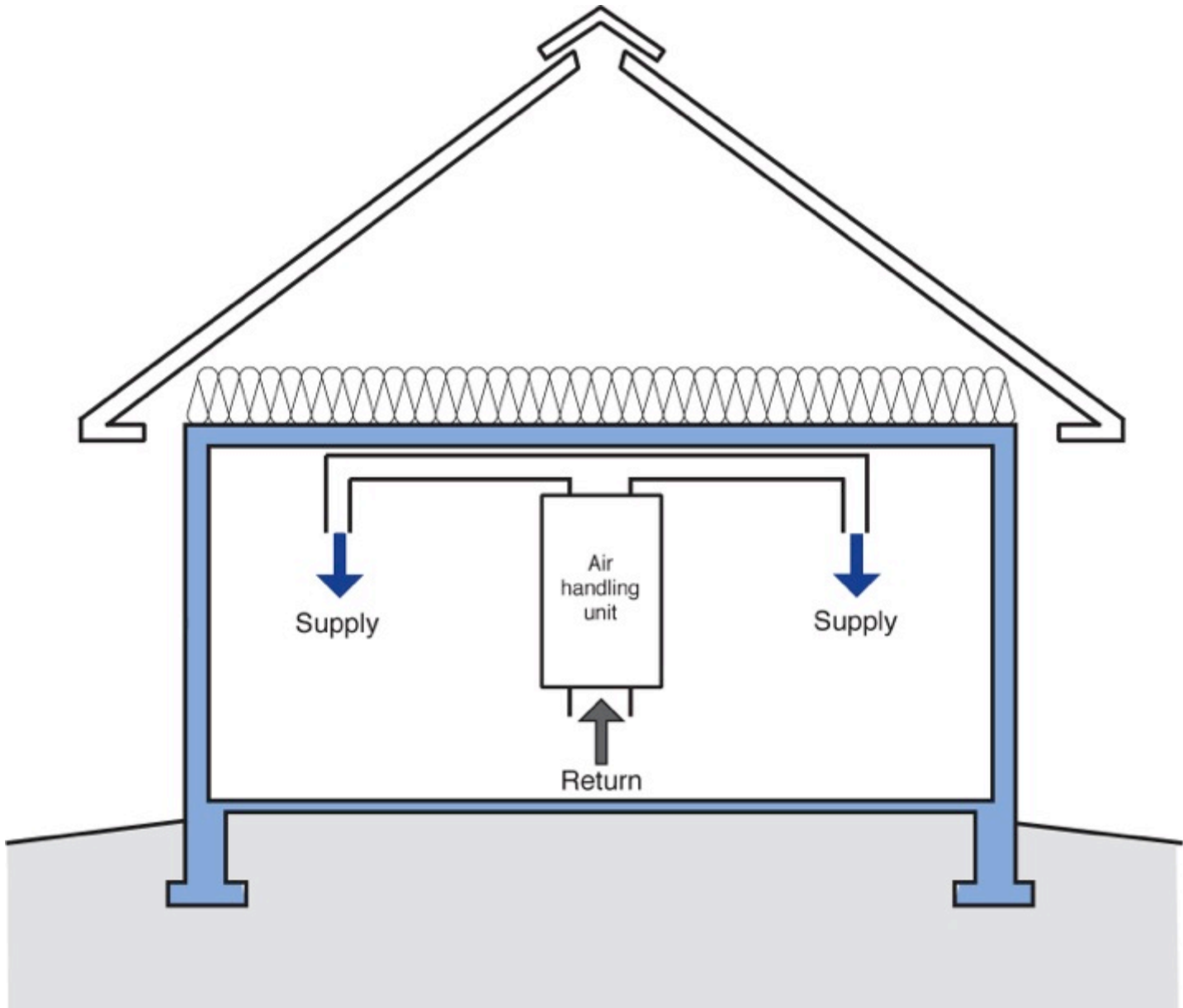
Houses With Vented Attics Suck

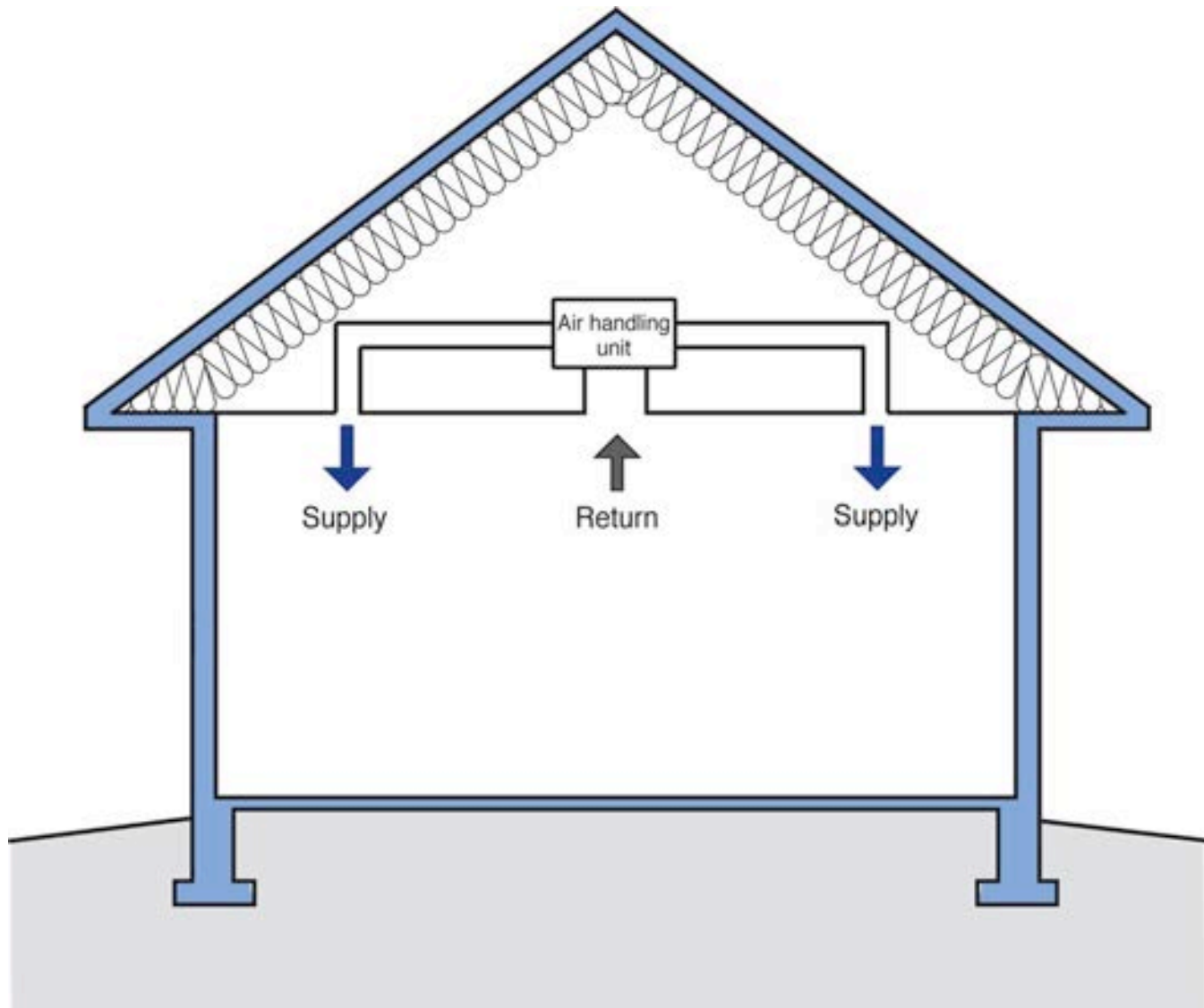
Houses With Vented Attics Suck
Not all the Time.....but.....







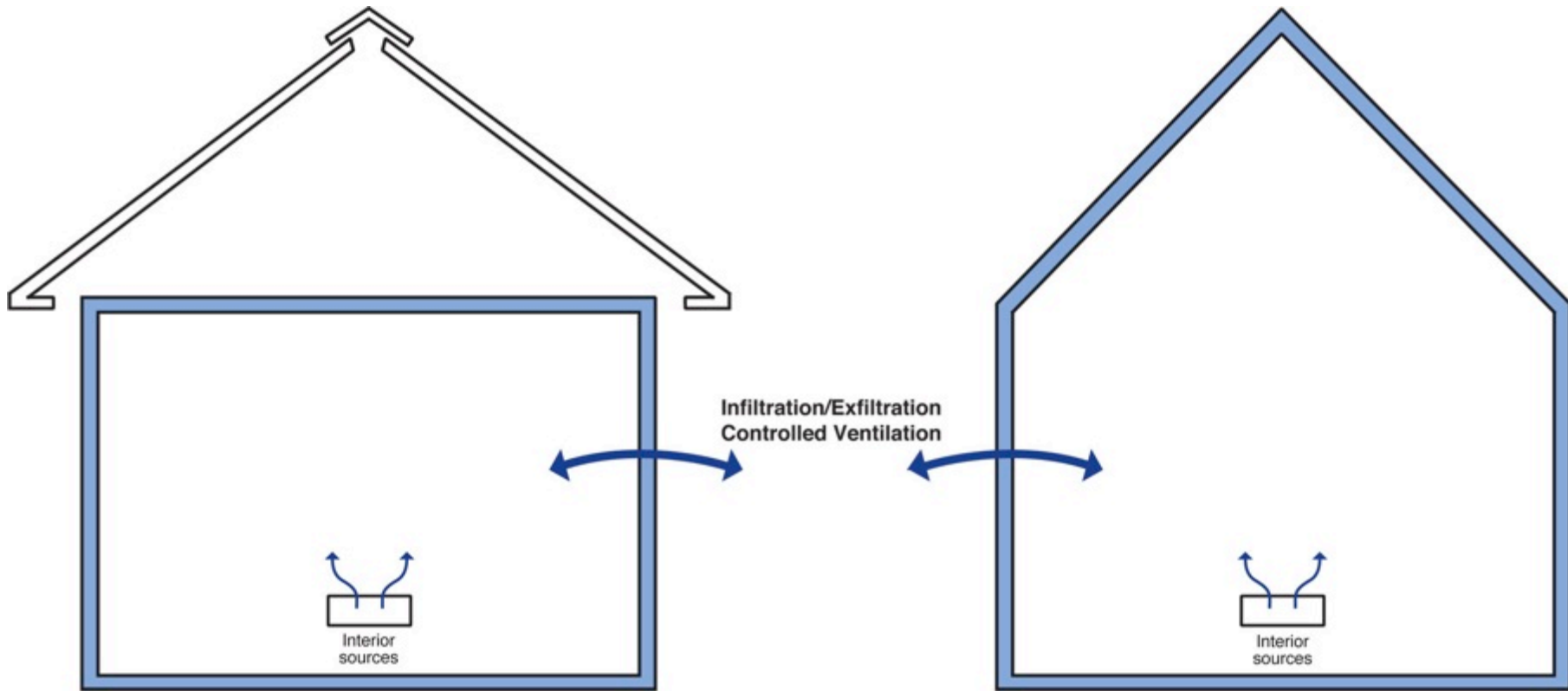


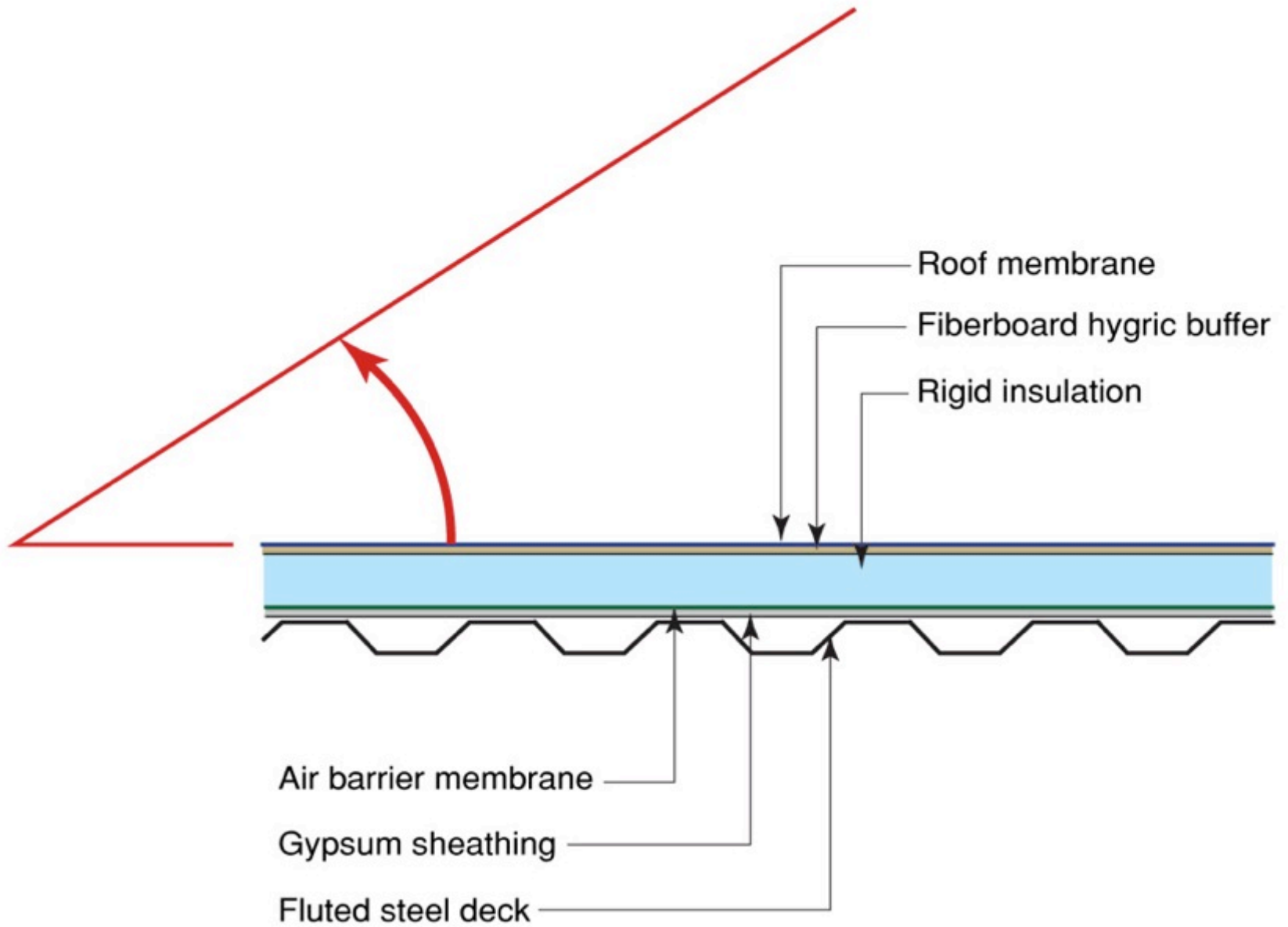


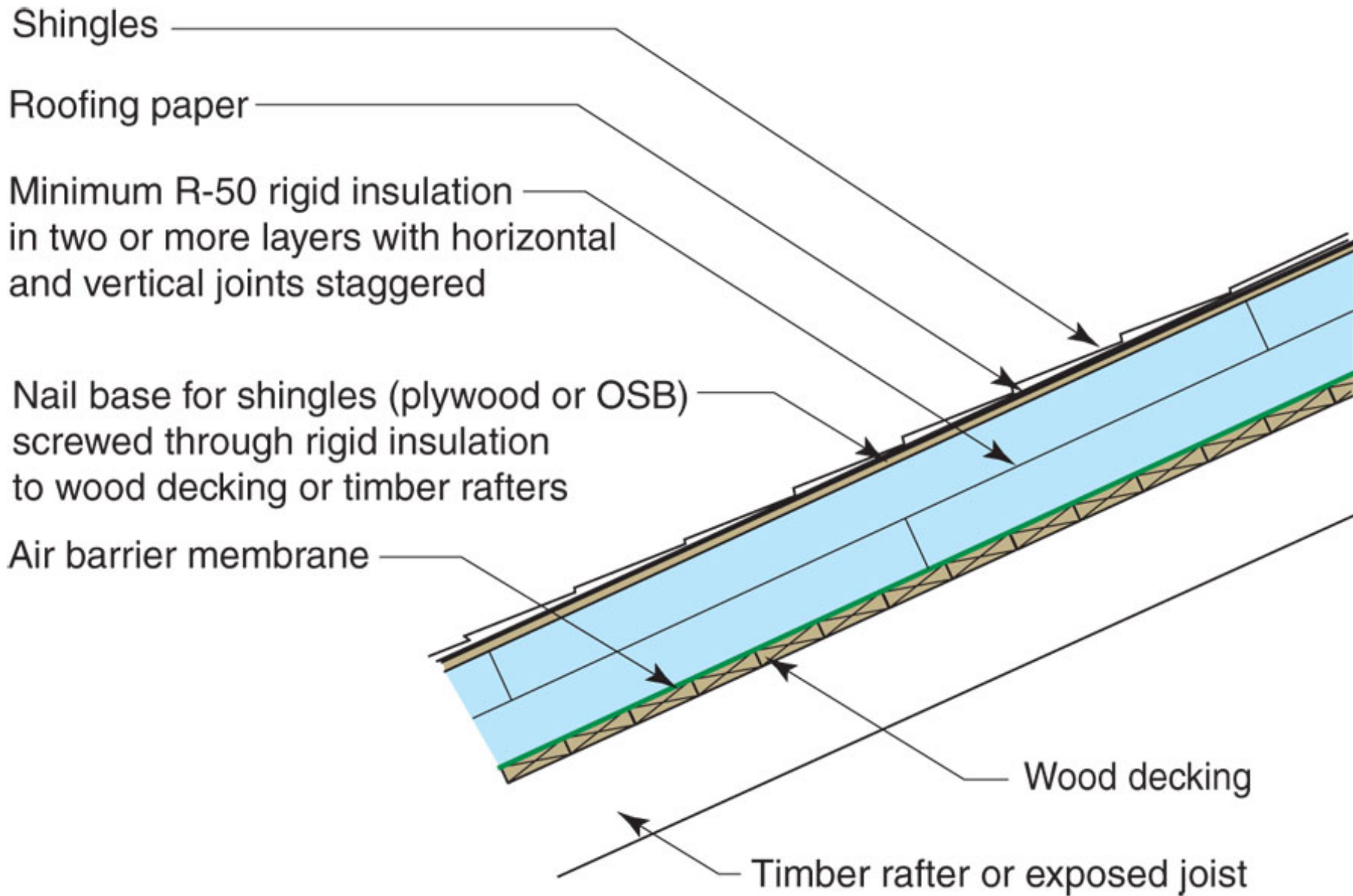


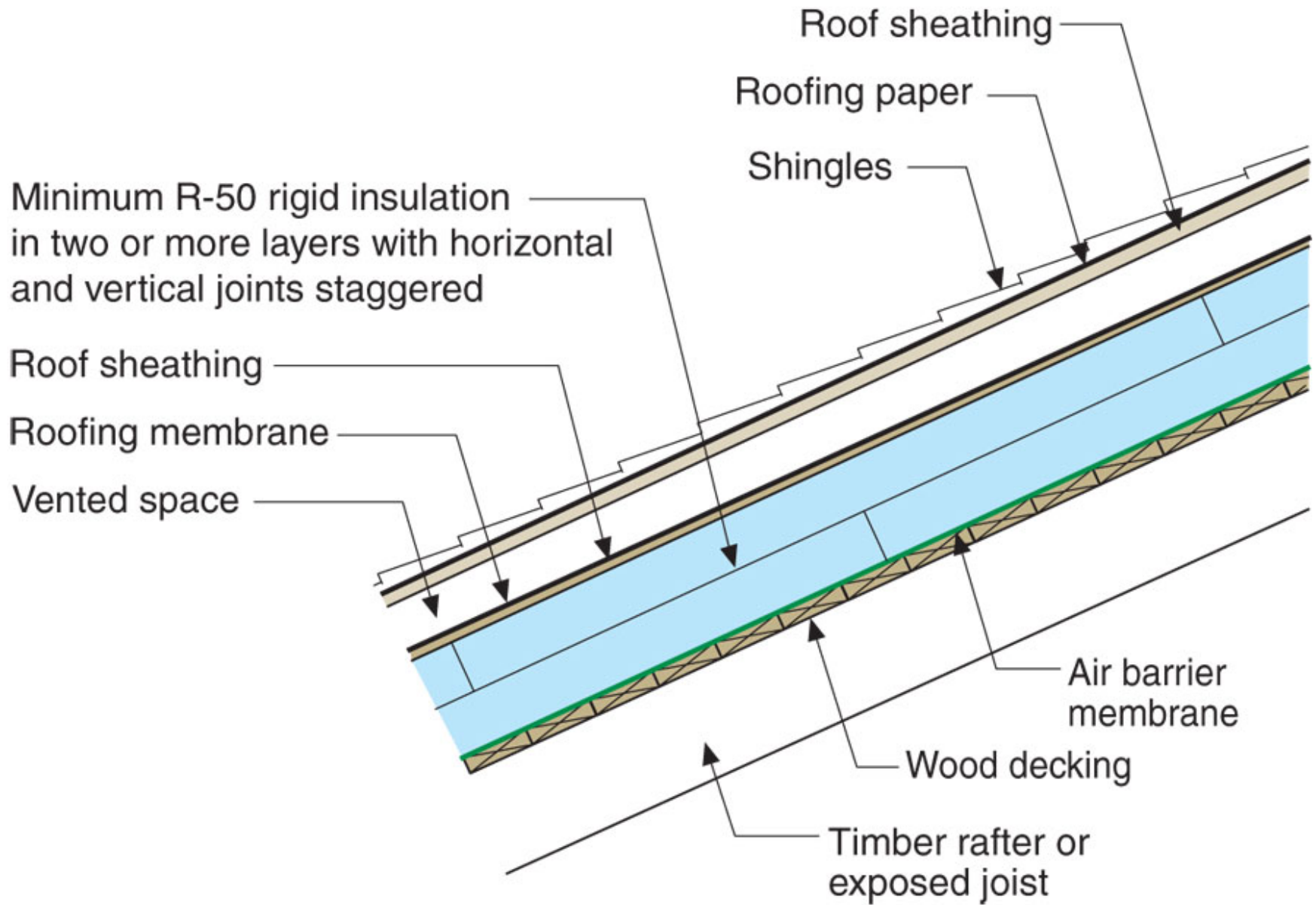


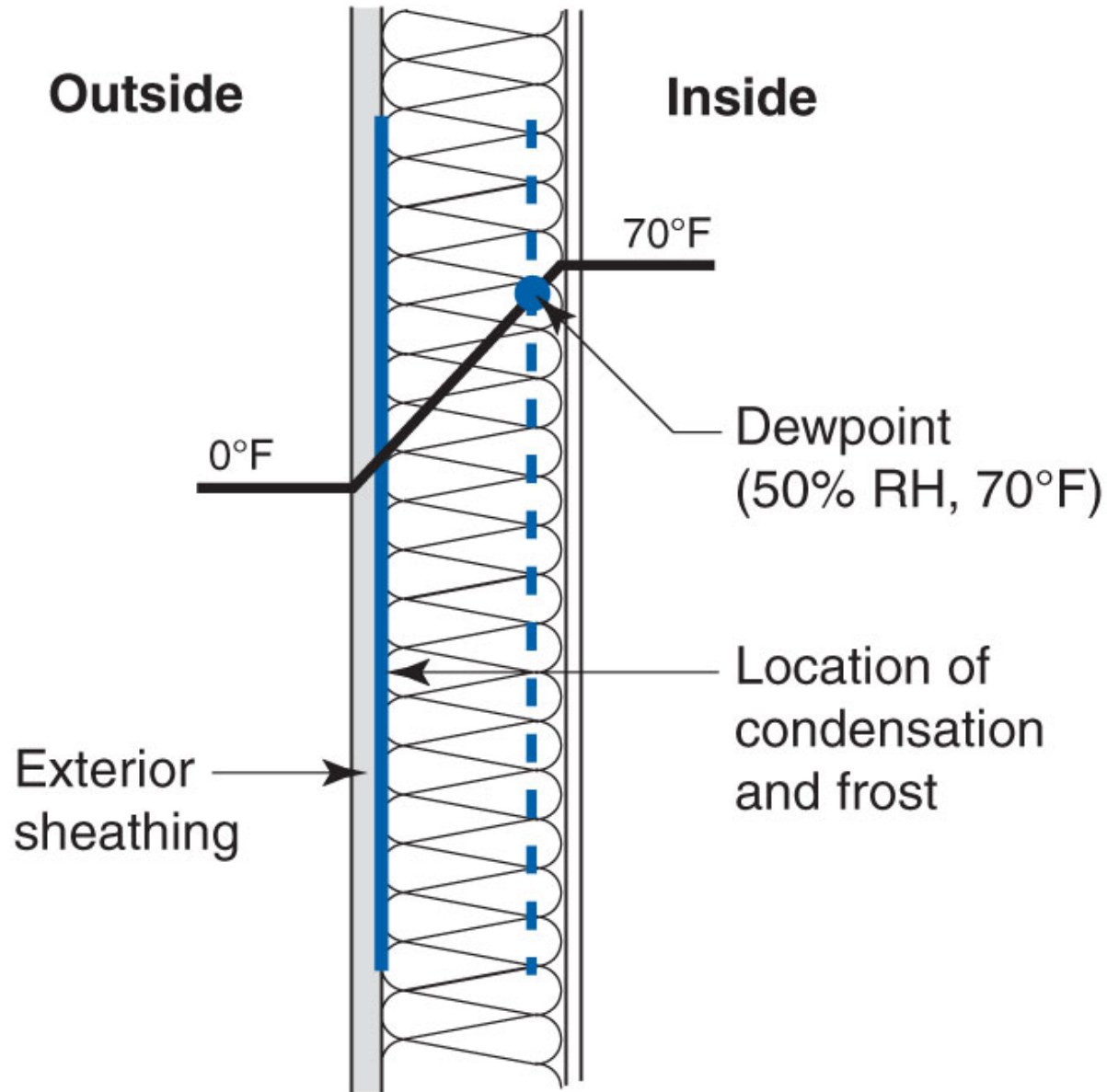




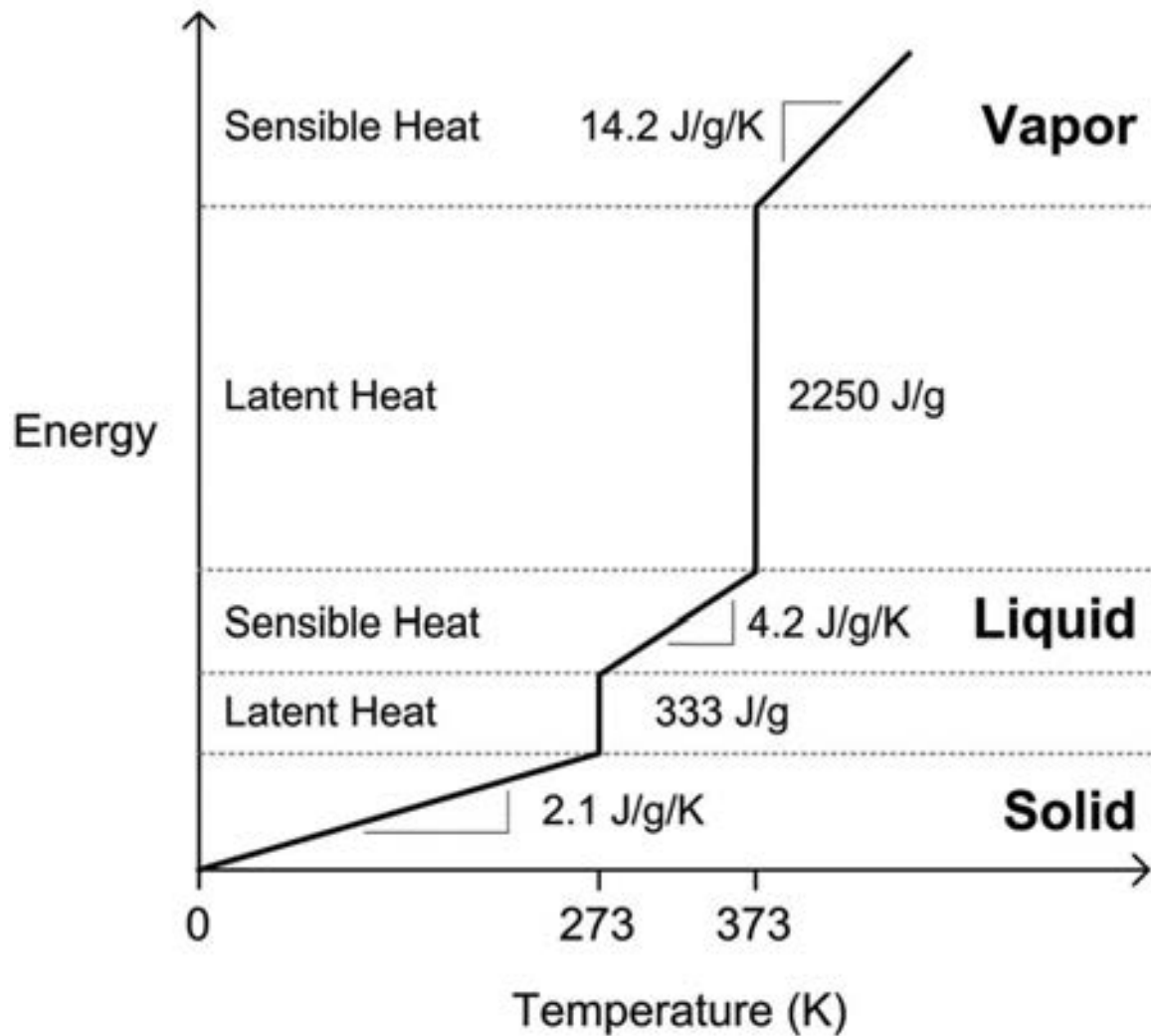






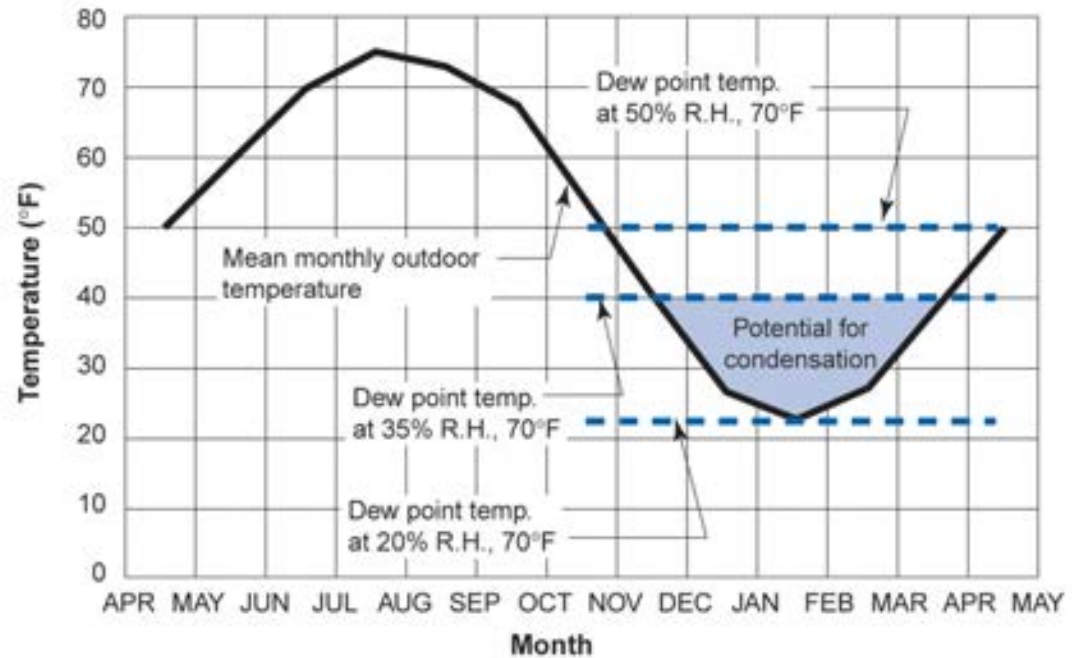
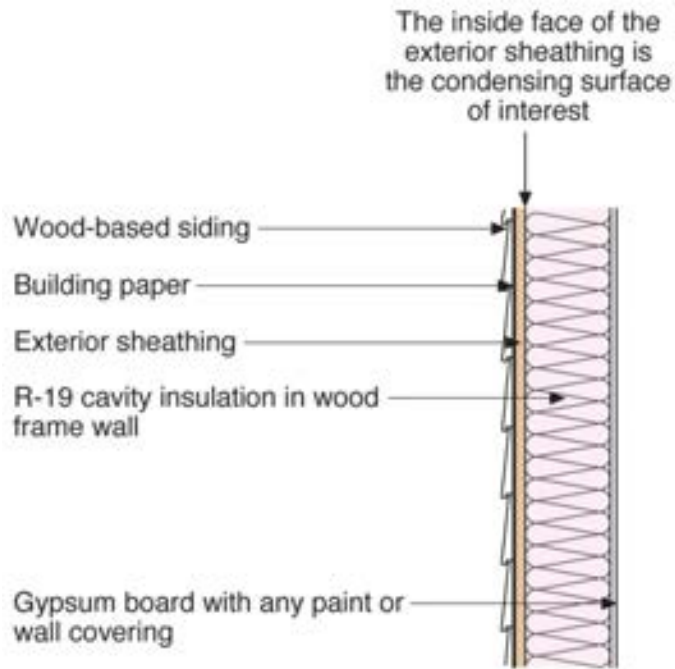


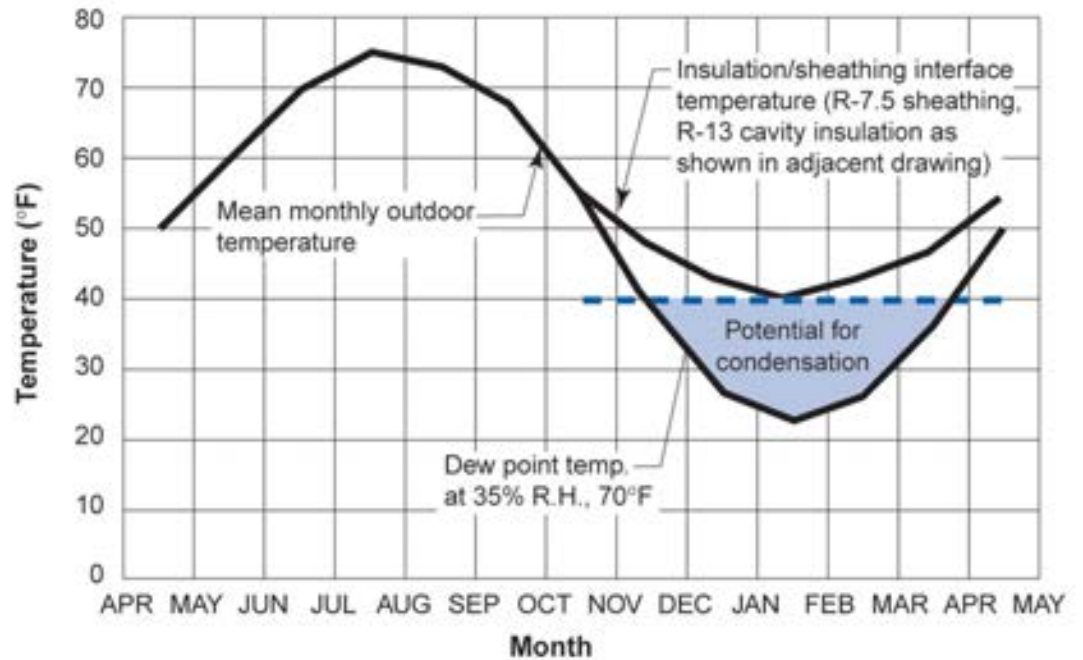
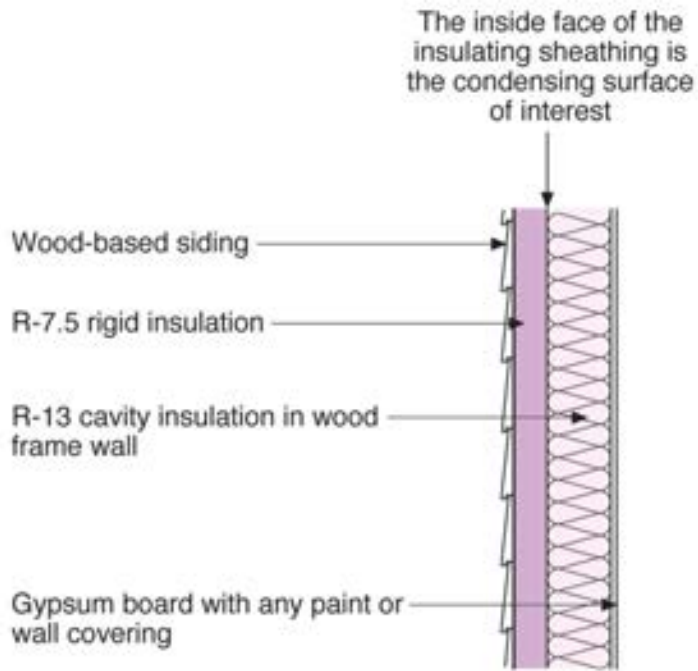




Simple linearized energy-temperature relation for water
 From Straube & Burnett, 2005







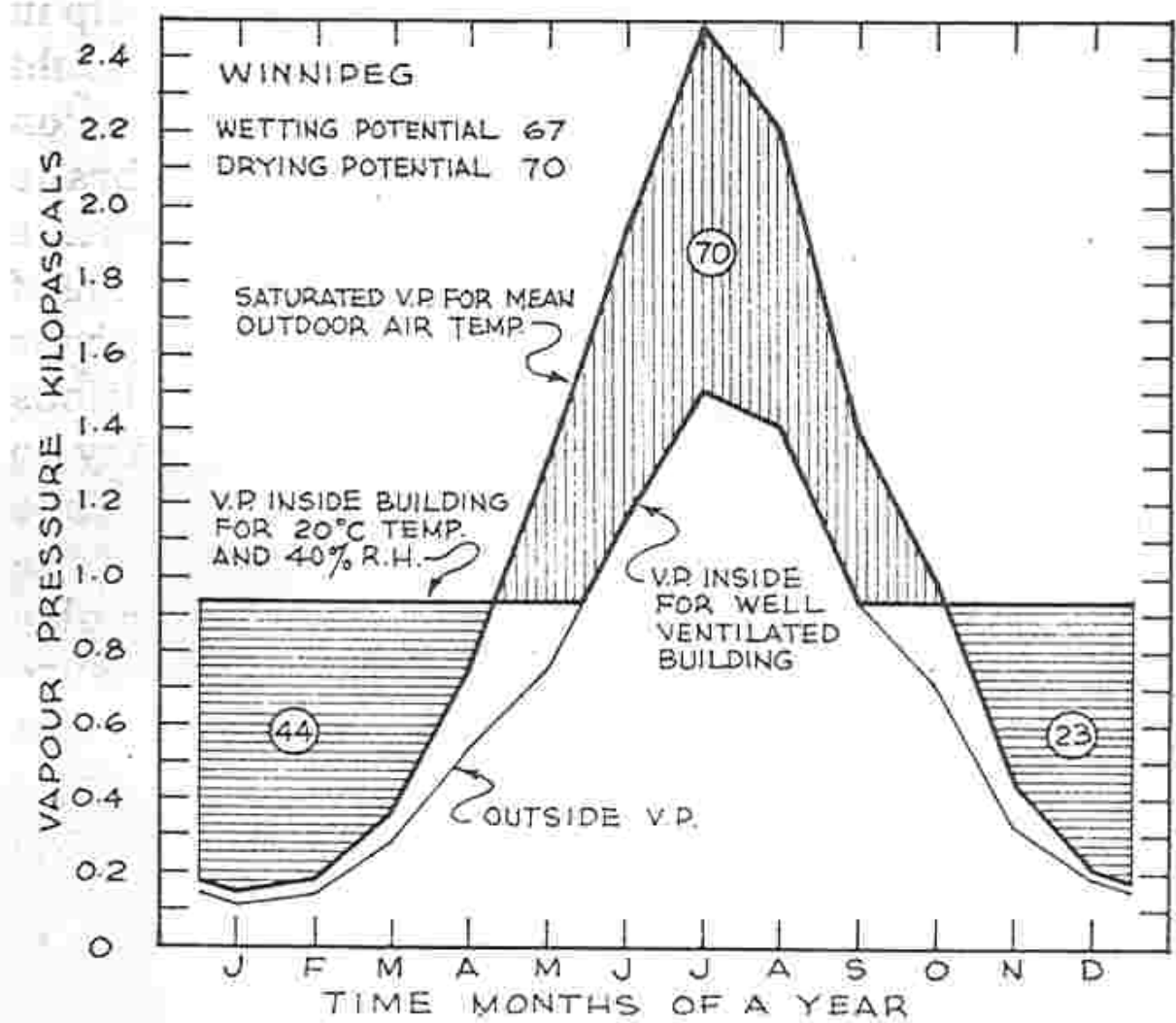
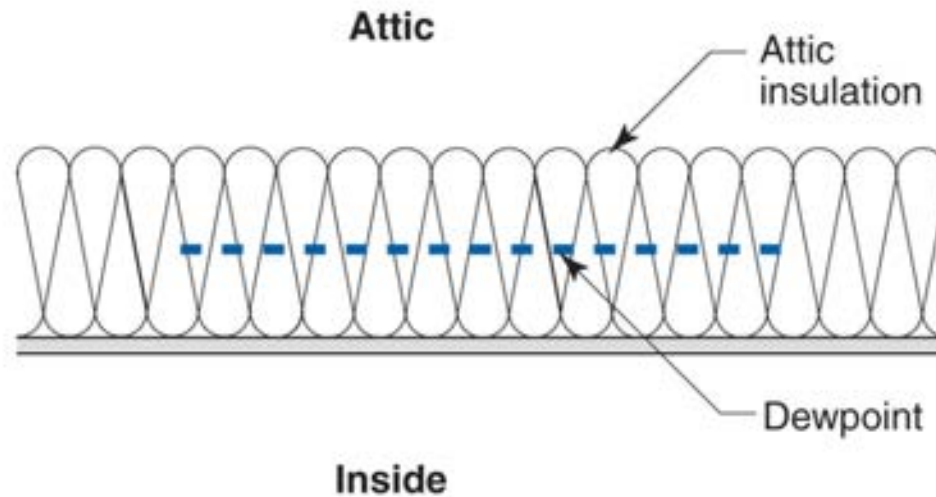
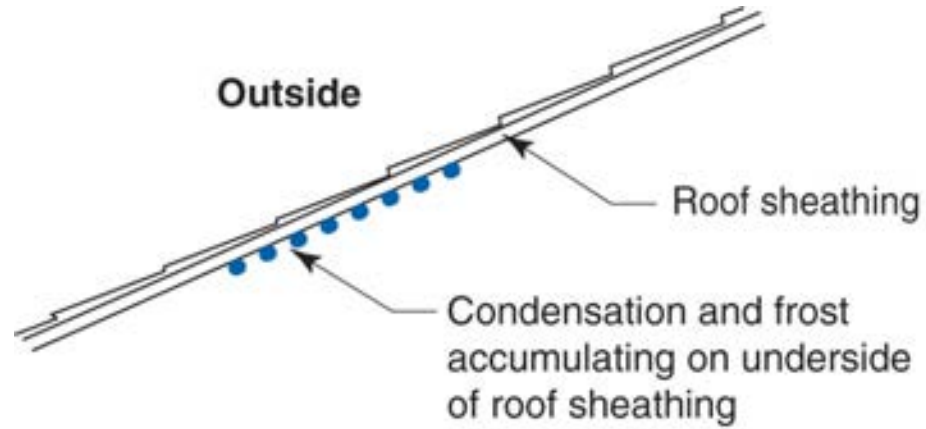
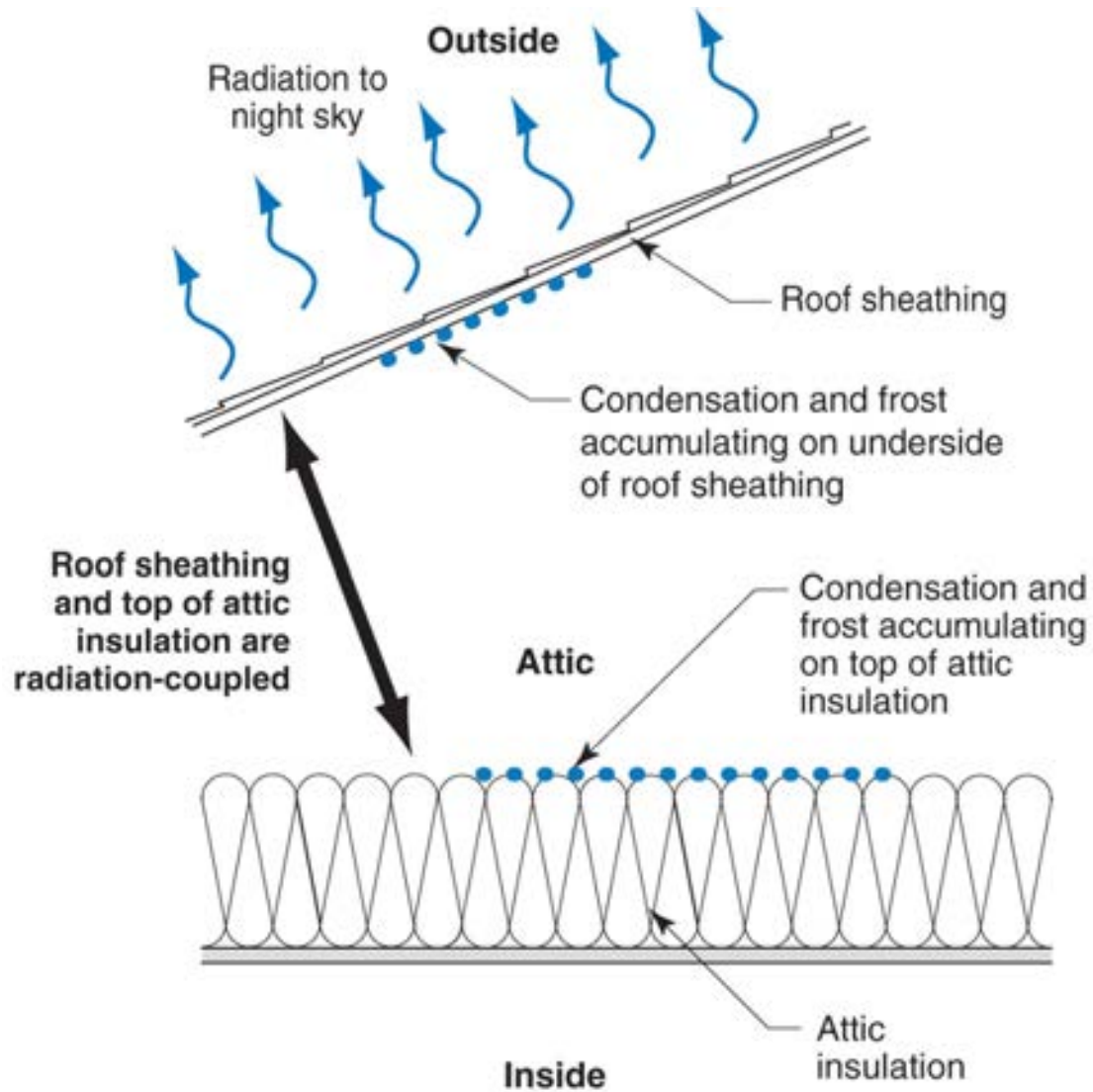
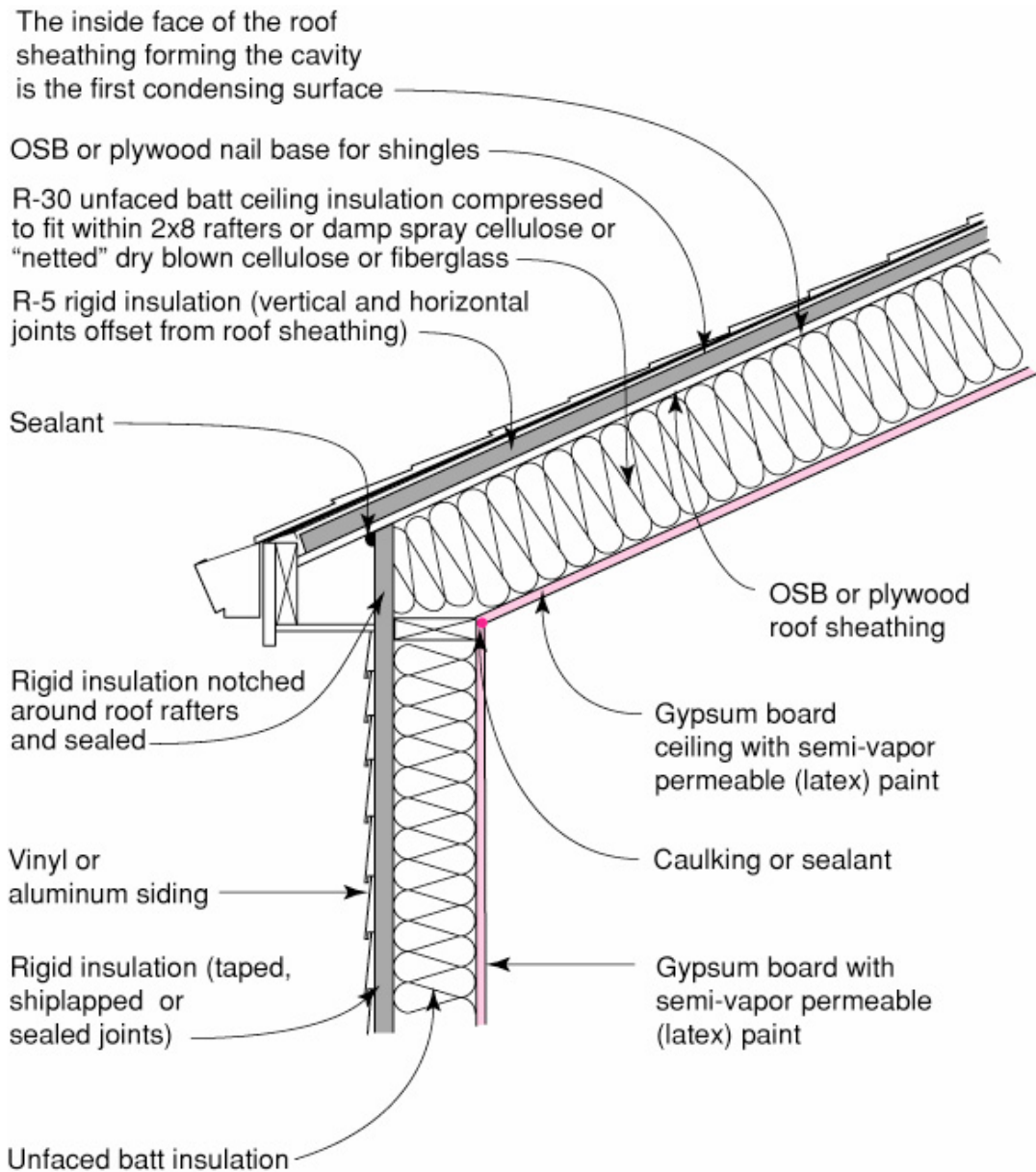


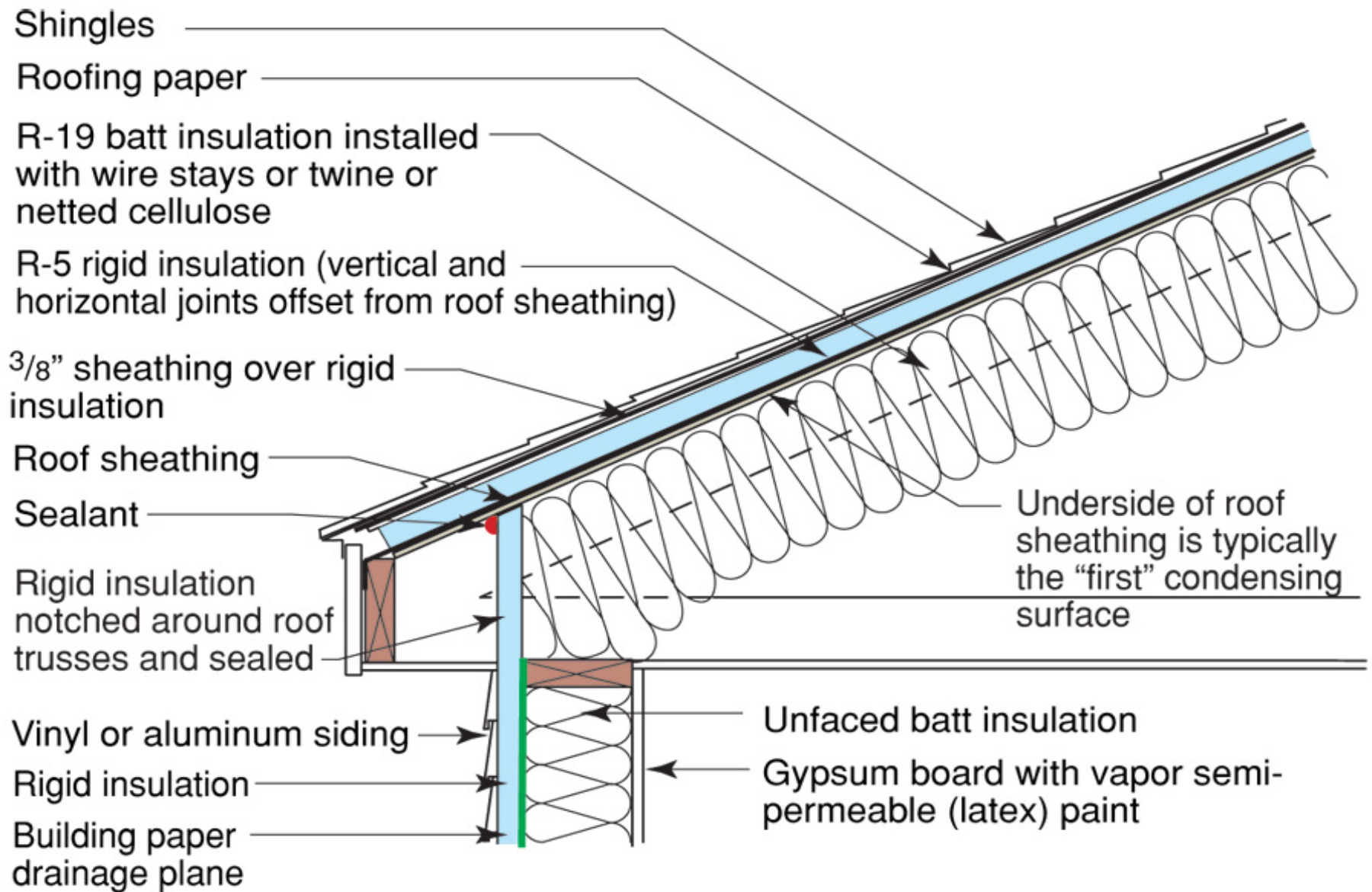
Figure 8-7. Outside vapour pressure, saturated vapour pressure and inside vapour pressure for Winnipeg.

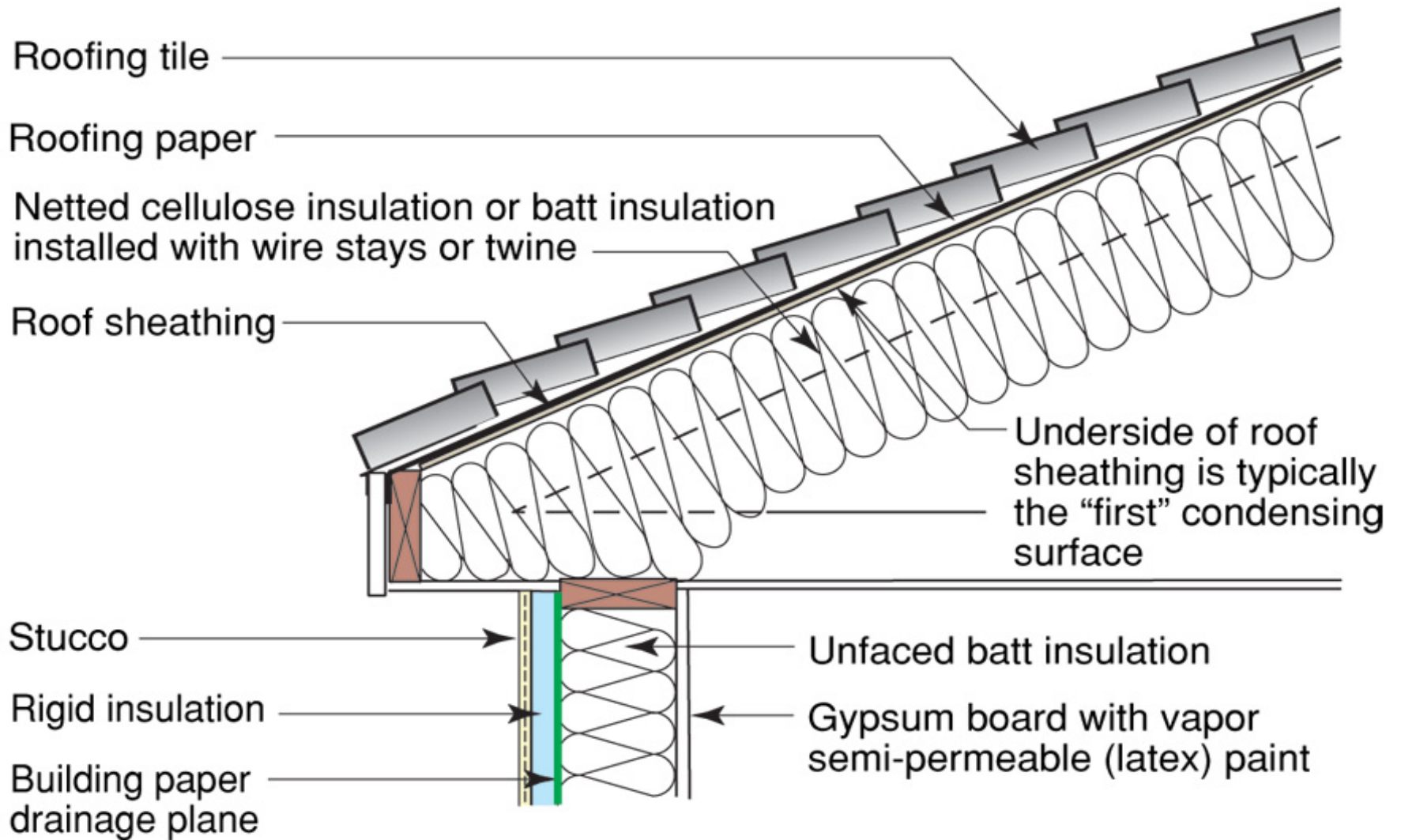








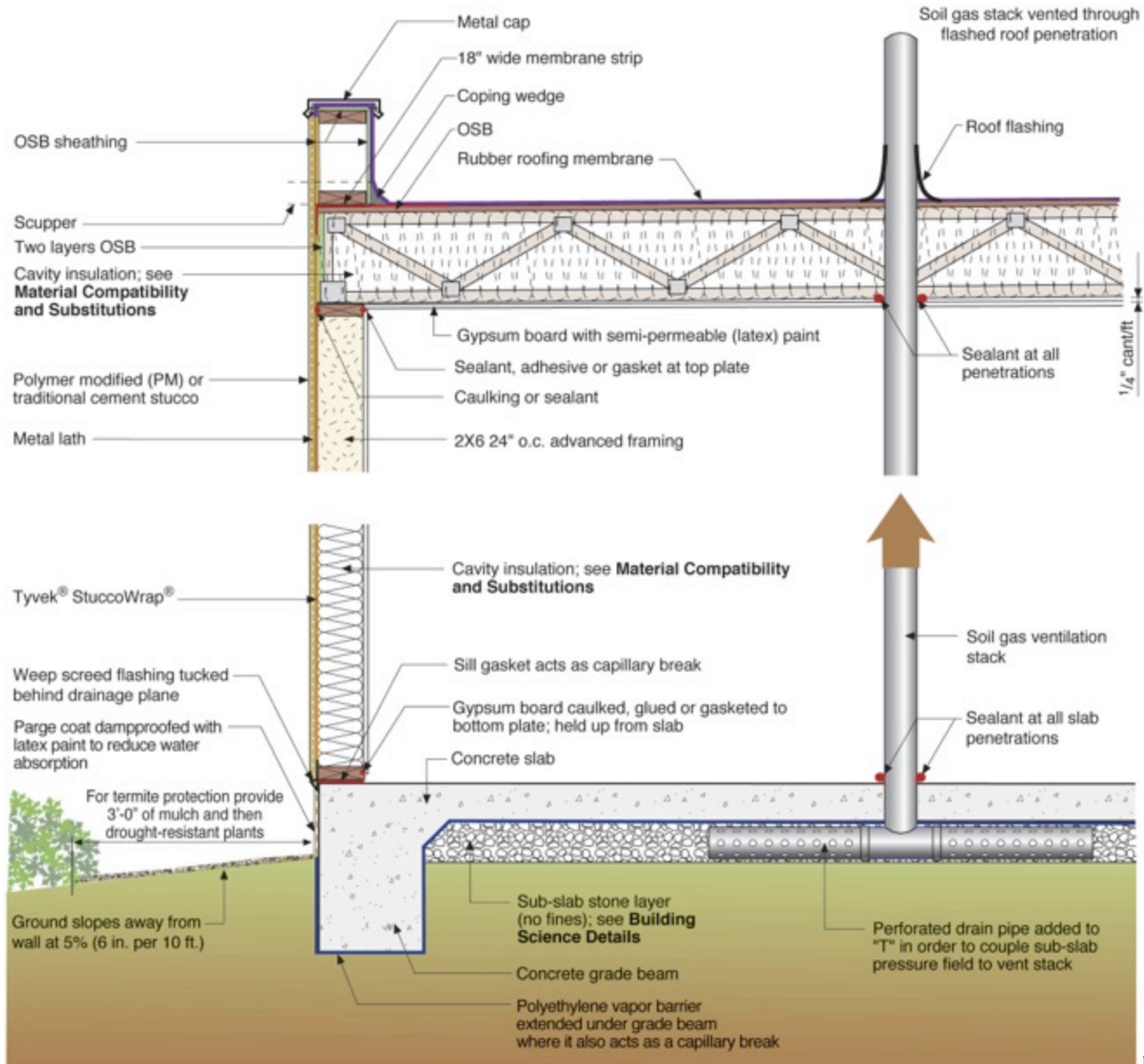










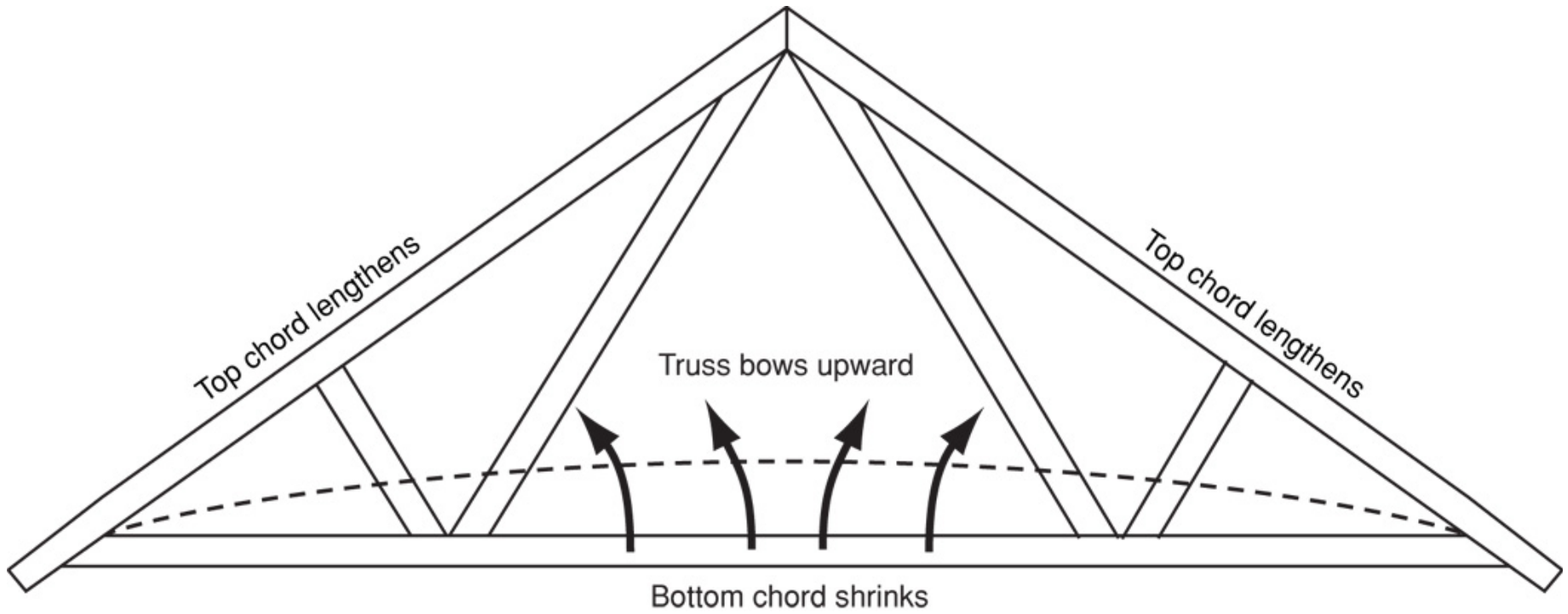


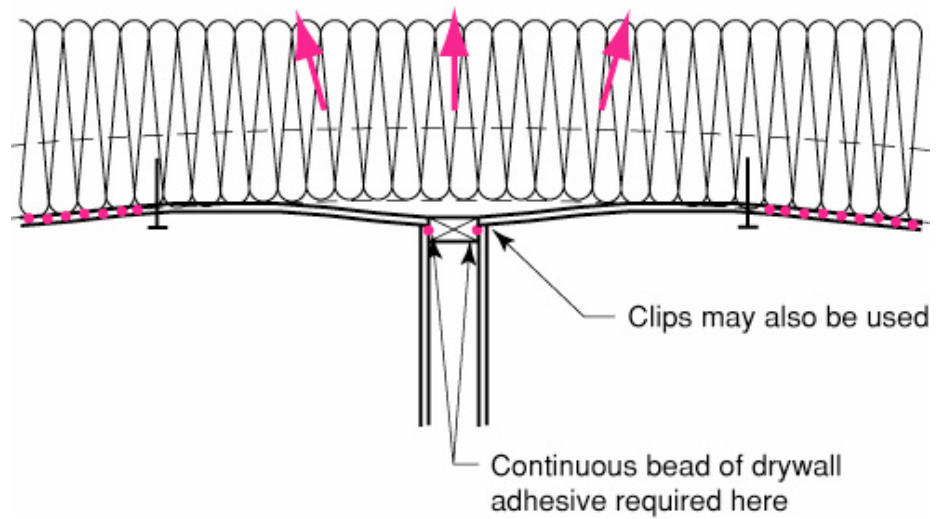
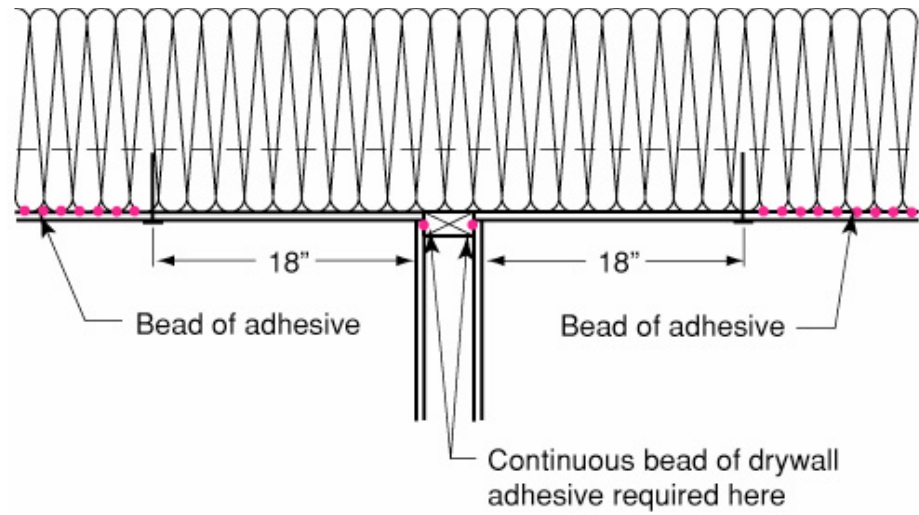
Truss Uplift

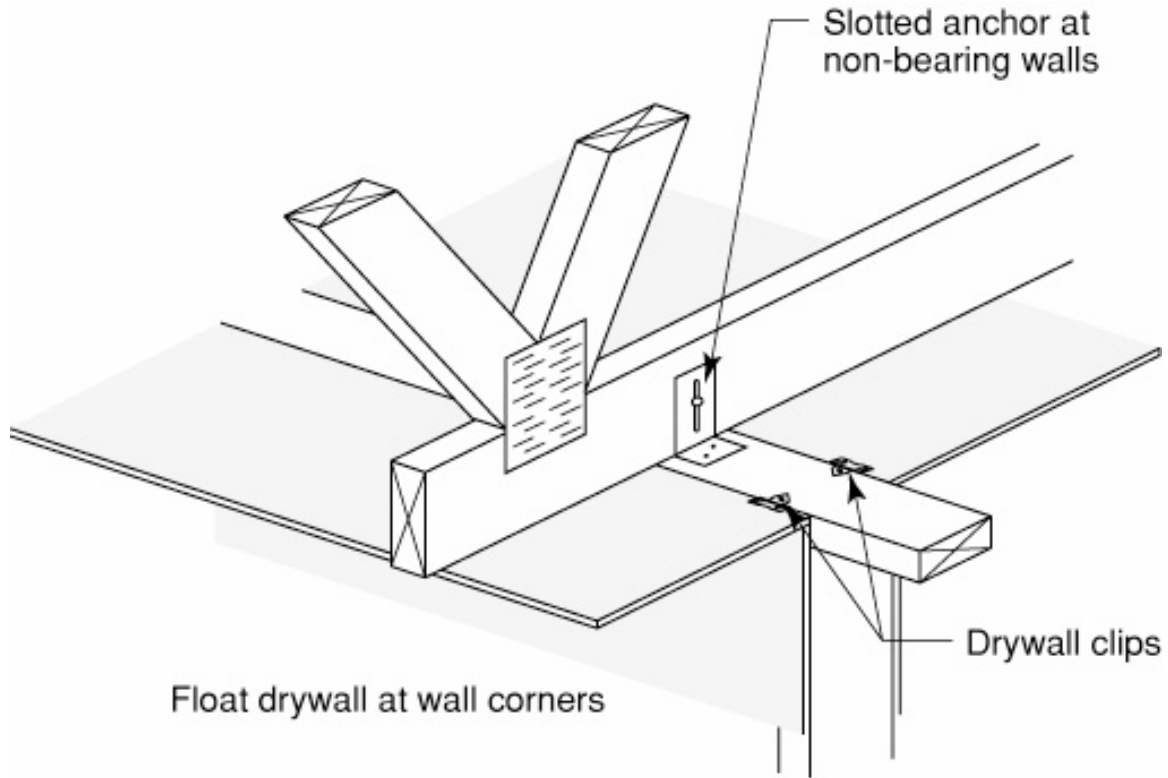






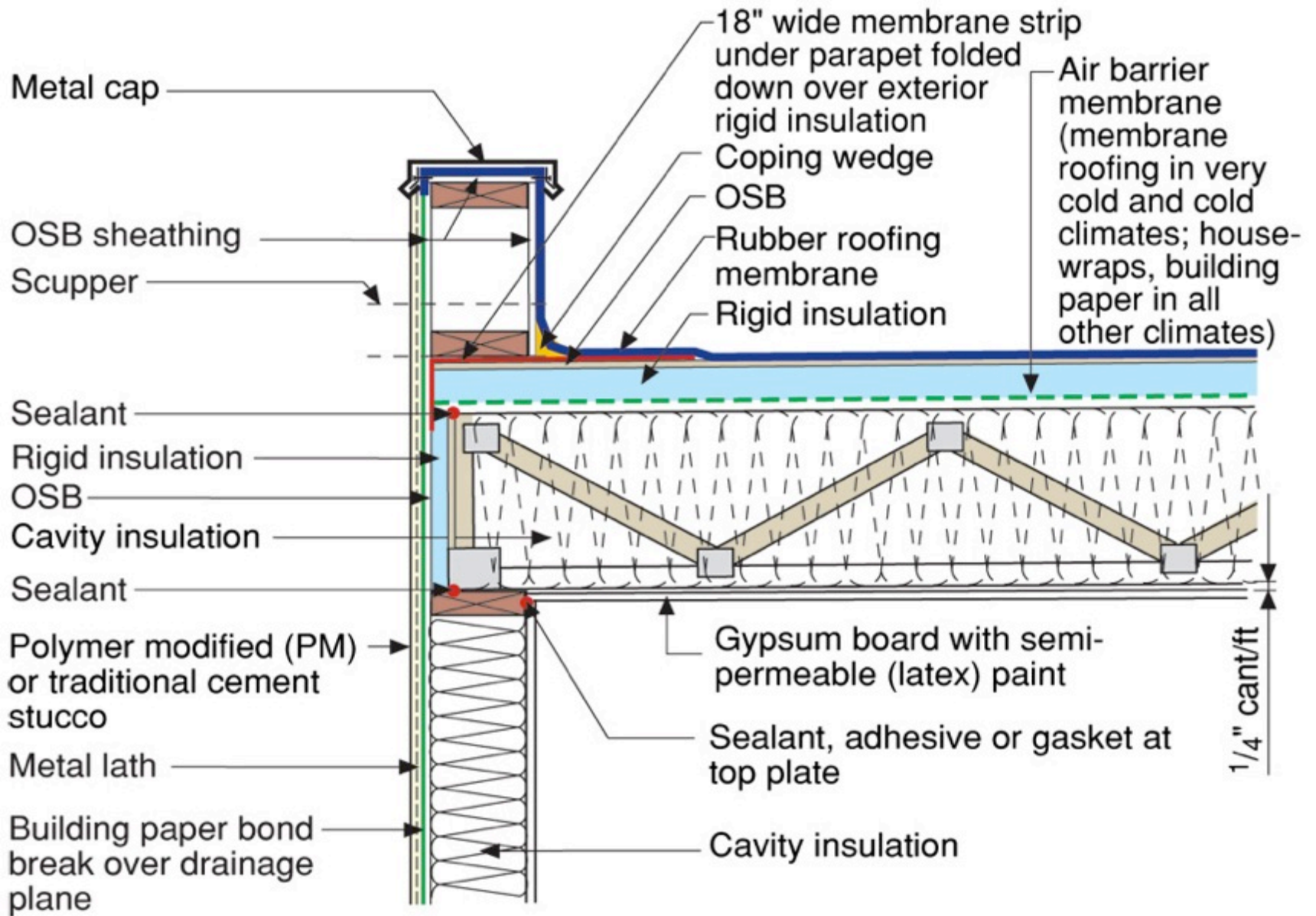


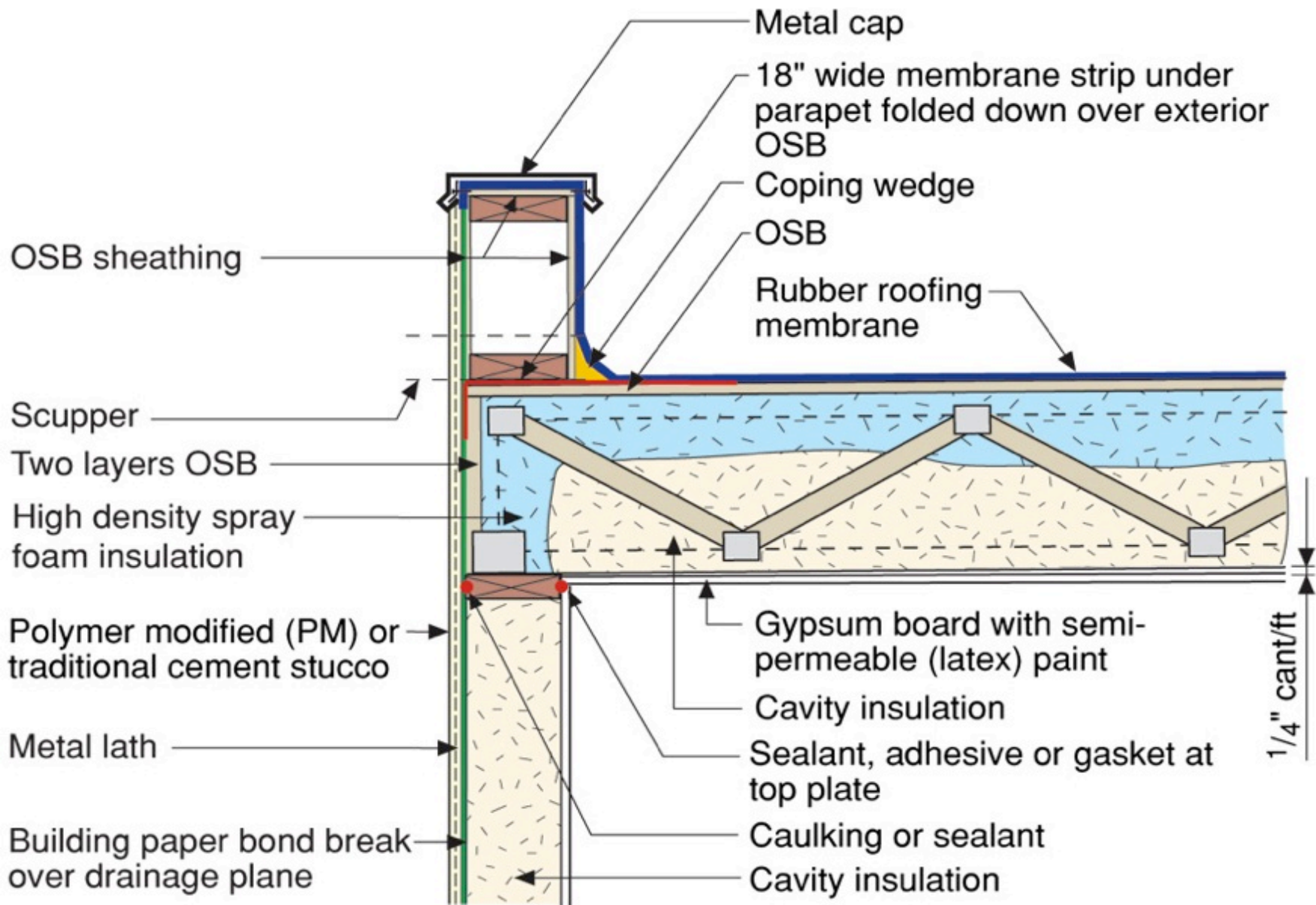


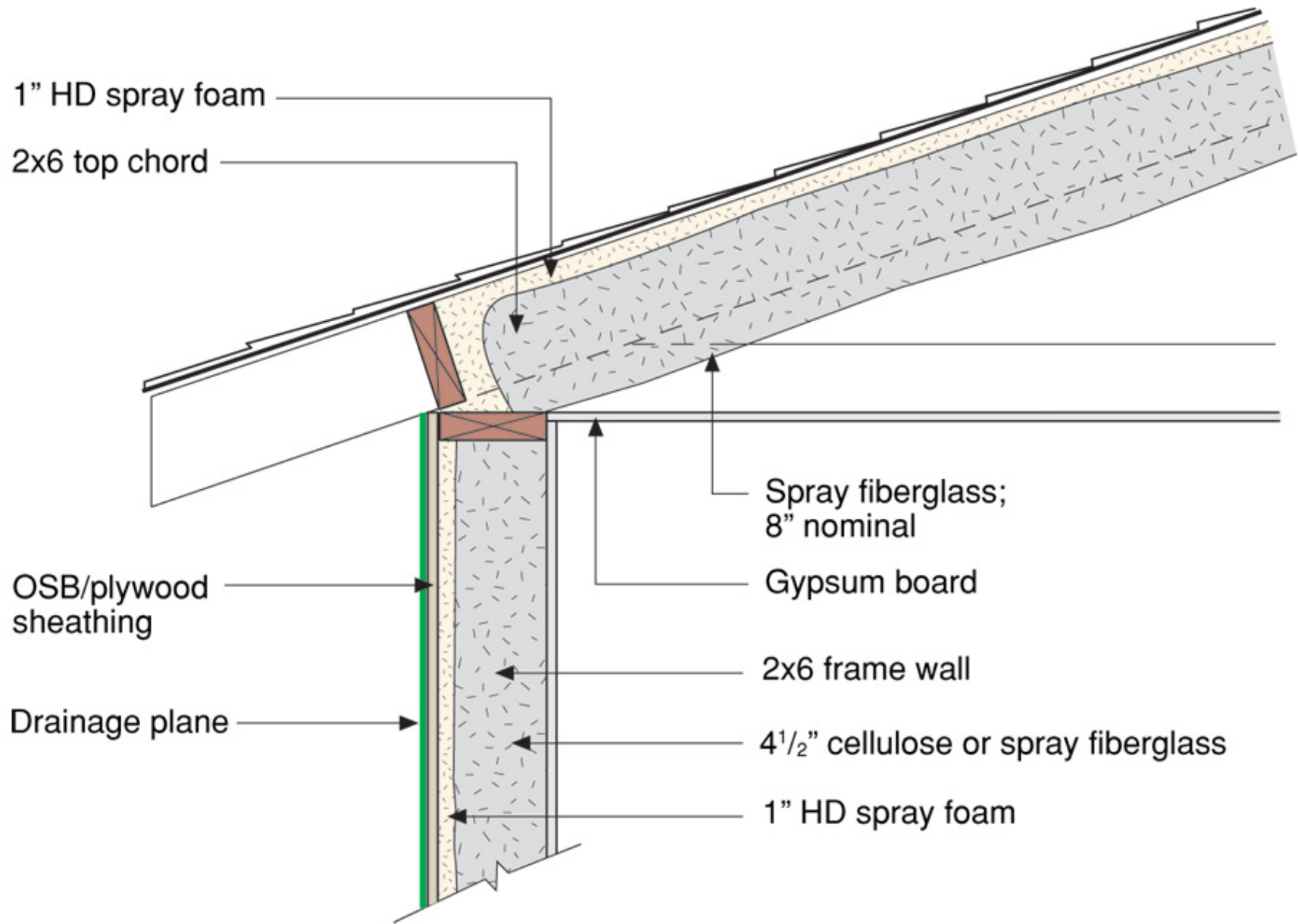


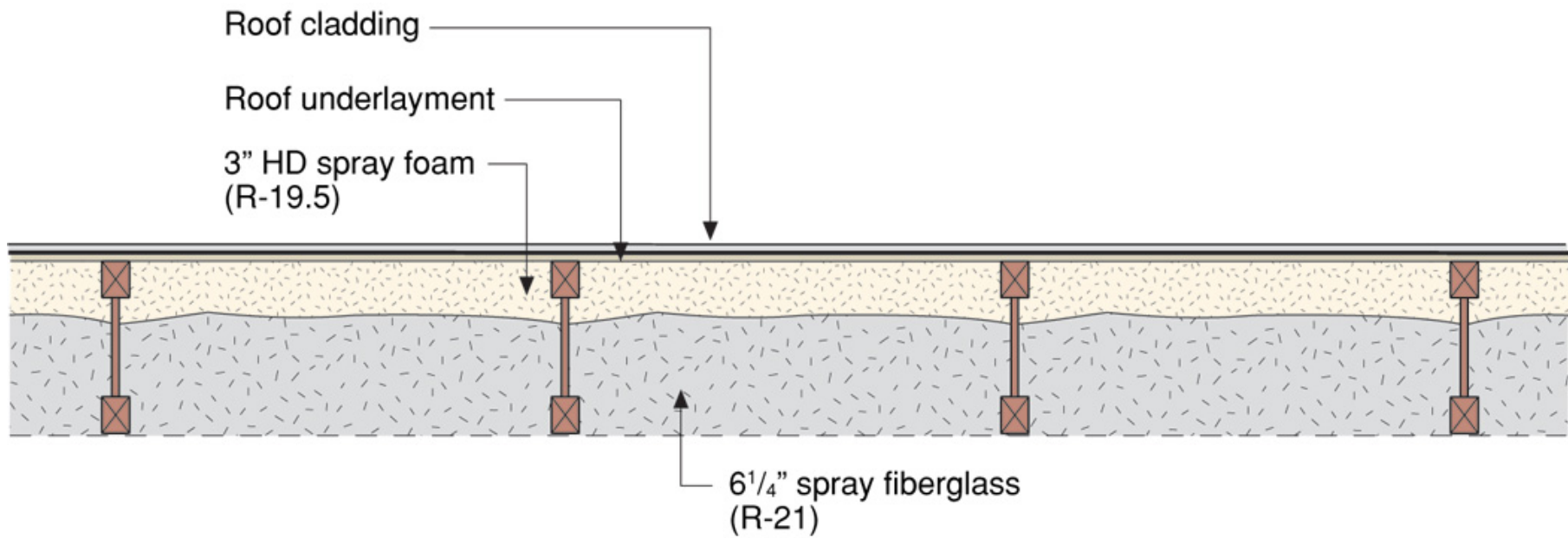


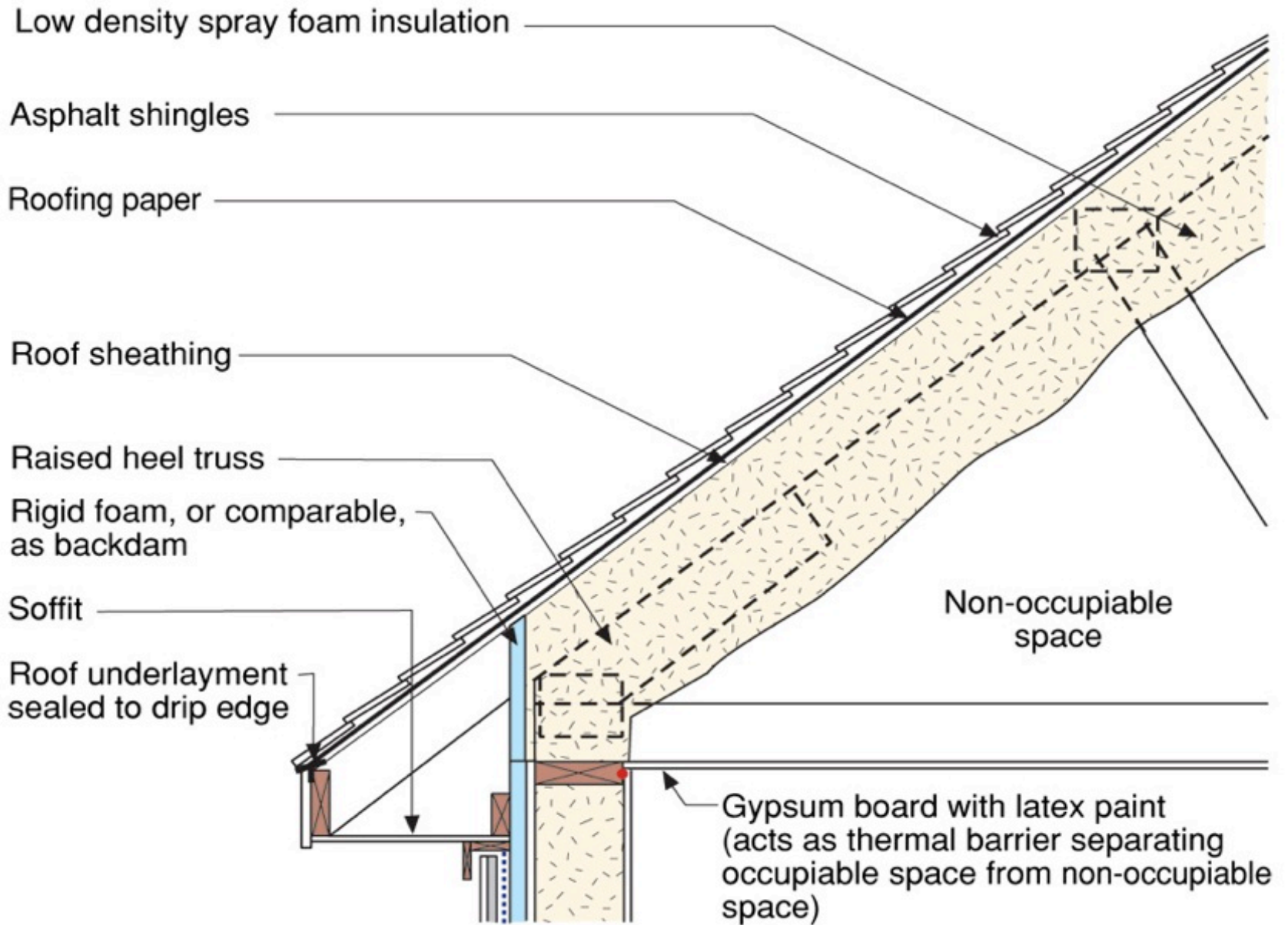












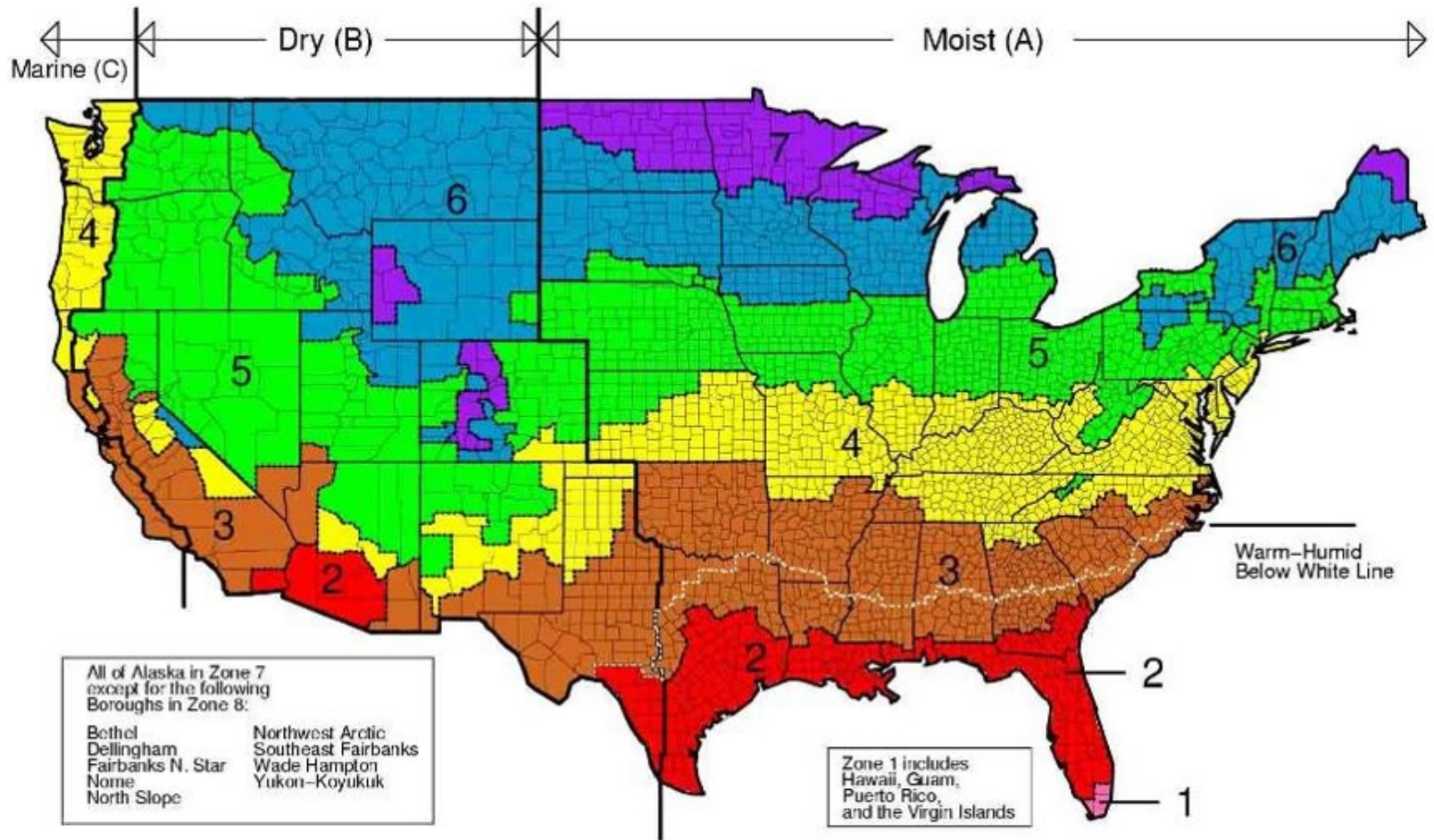










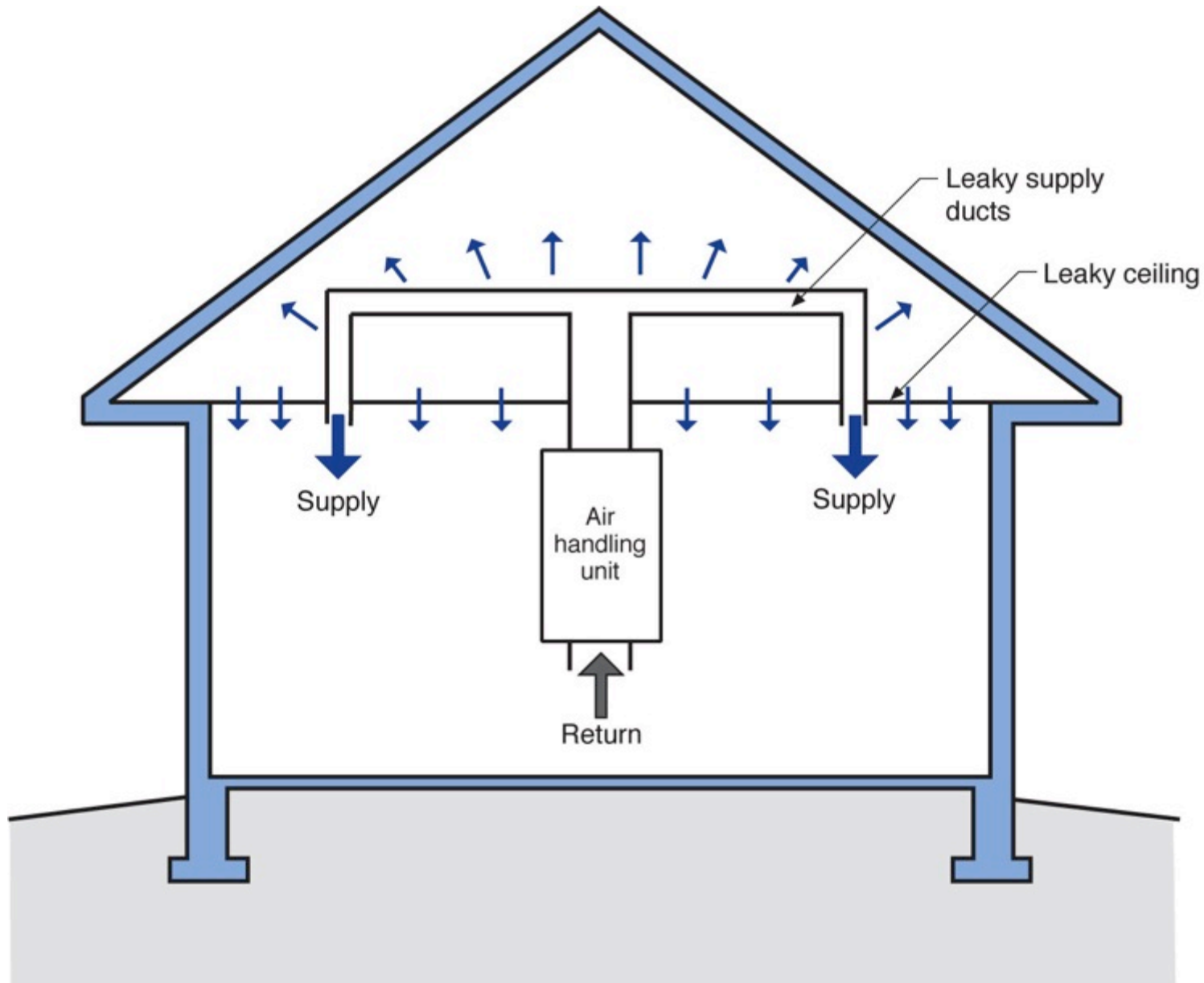








Conditioned Attics Not Unvented Attics





Conditioned Attics Not Unvented Attics Need Supply Air

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

Hygric Buoyancy

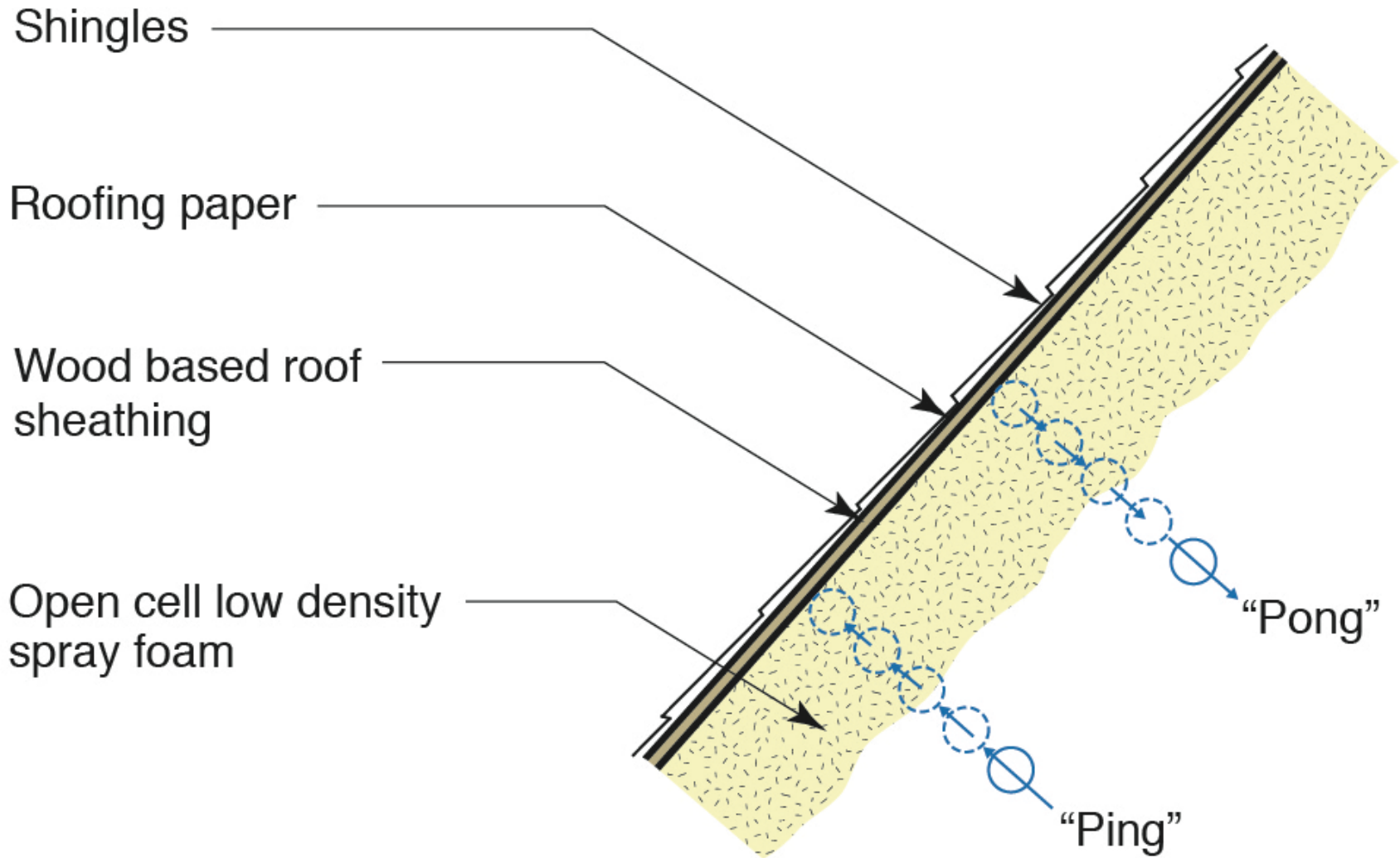
Components in Dry Air	Volume Ratio compared to Dry Air	Molecular Mass - M (kg/kmol)	Molecular Mass in Air
Oxygen	0.2095	32.00	6.704
Nitrogen	0.7809	28.02	21.88
Carbon Dioxide	0.0003	44.01	0.013
Hydrogen	0.0000005	2.02	0
Argon	0.00933	39.94	0.373
Neon	0.000018	20.18	0
Helium	0.000005	4.00	0
Krypton	0.000001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

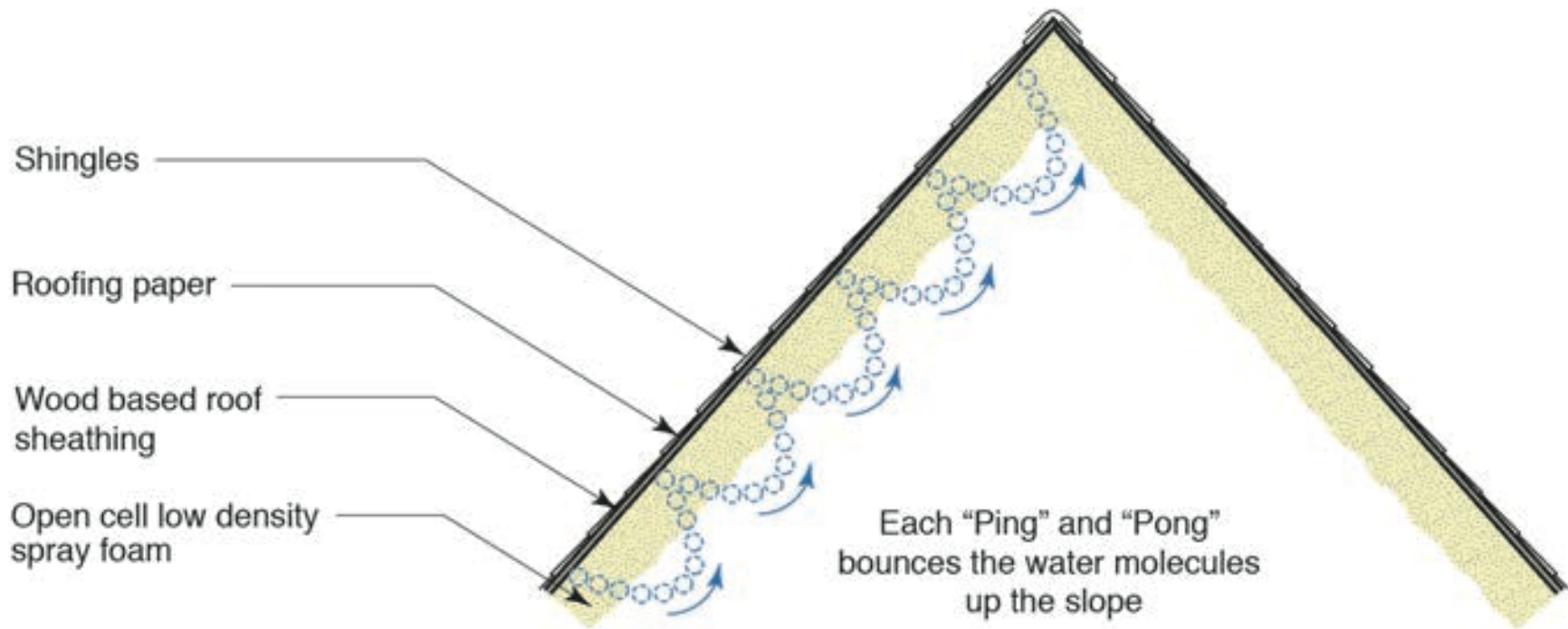
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Total Molecular Mass of Air			28.97

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

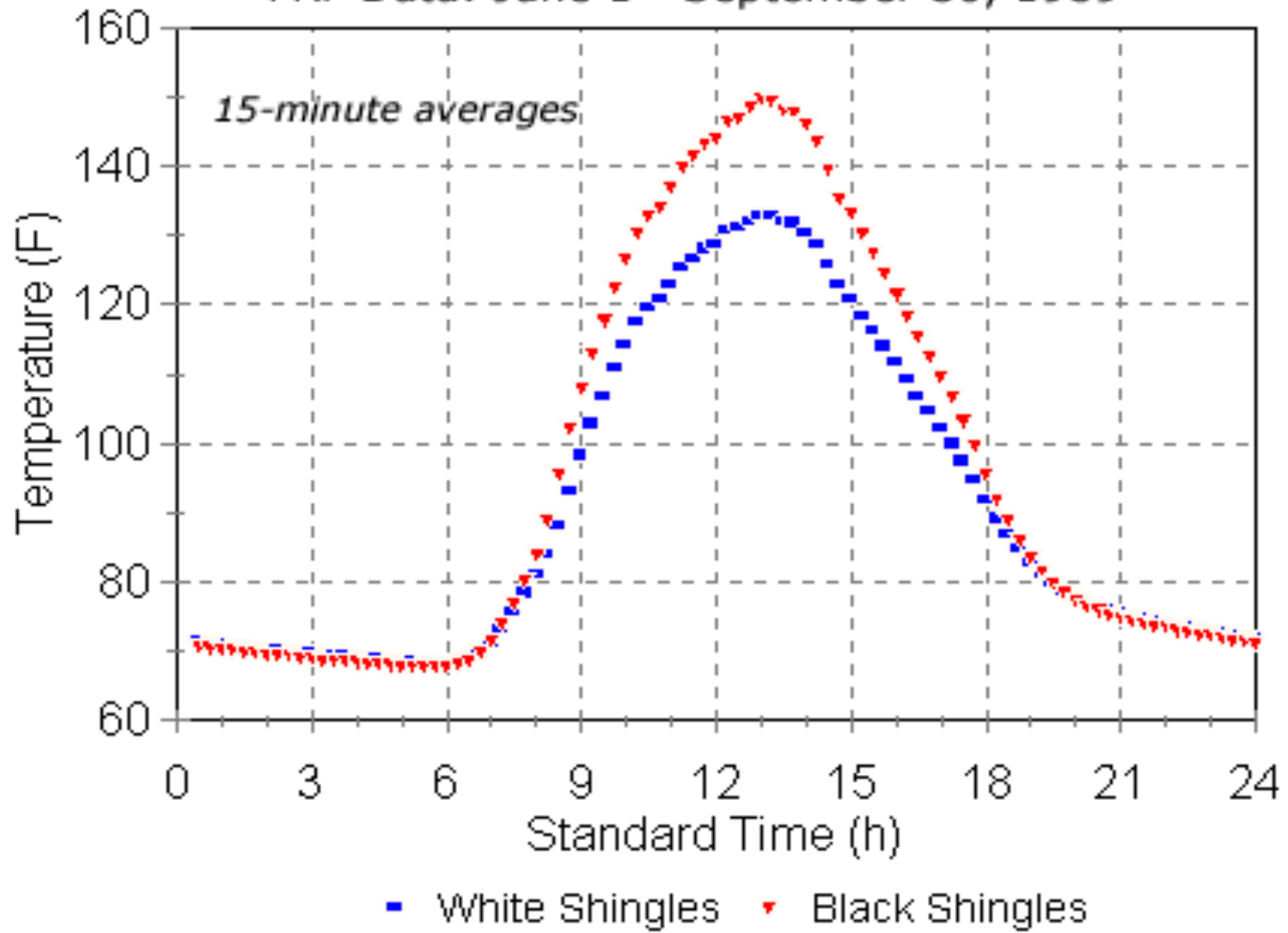




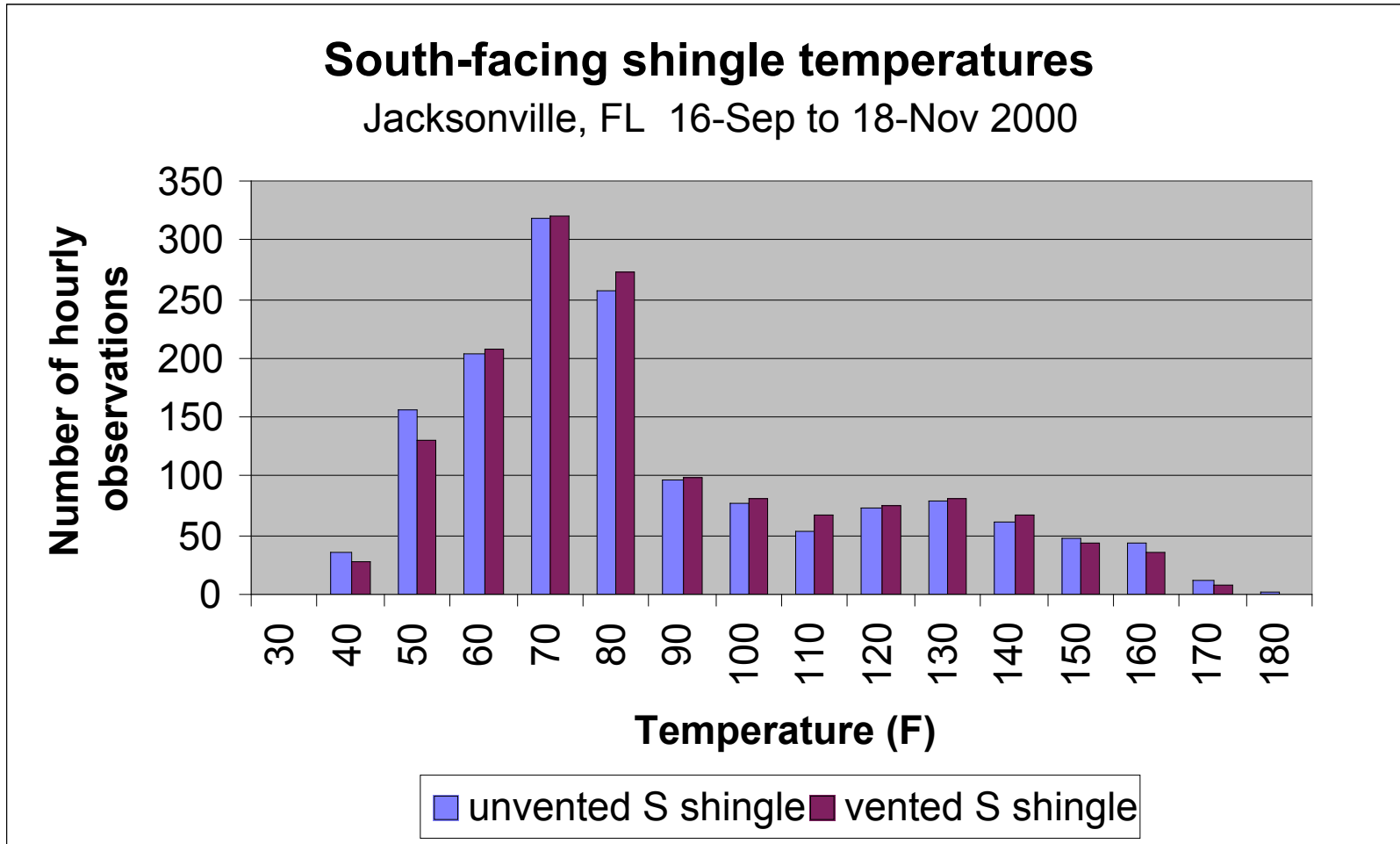




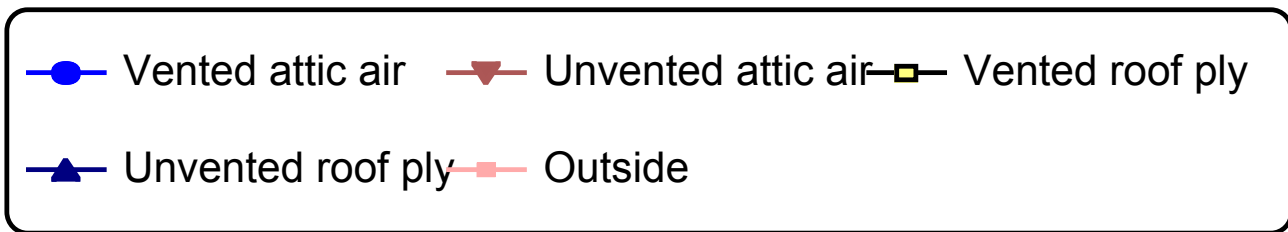
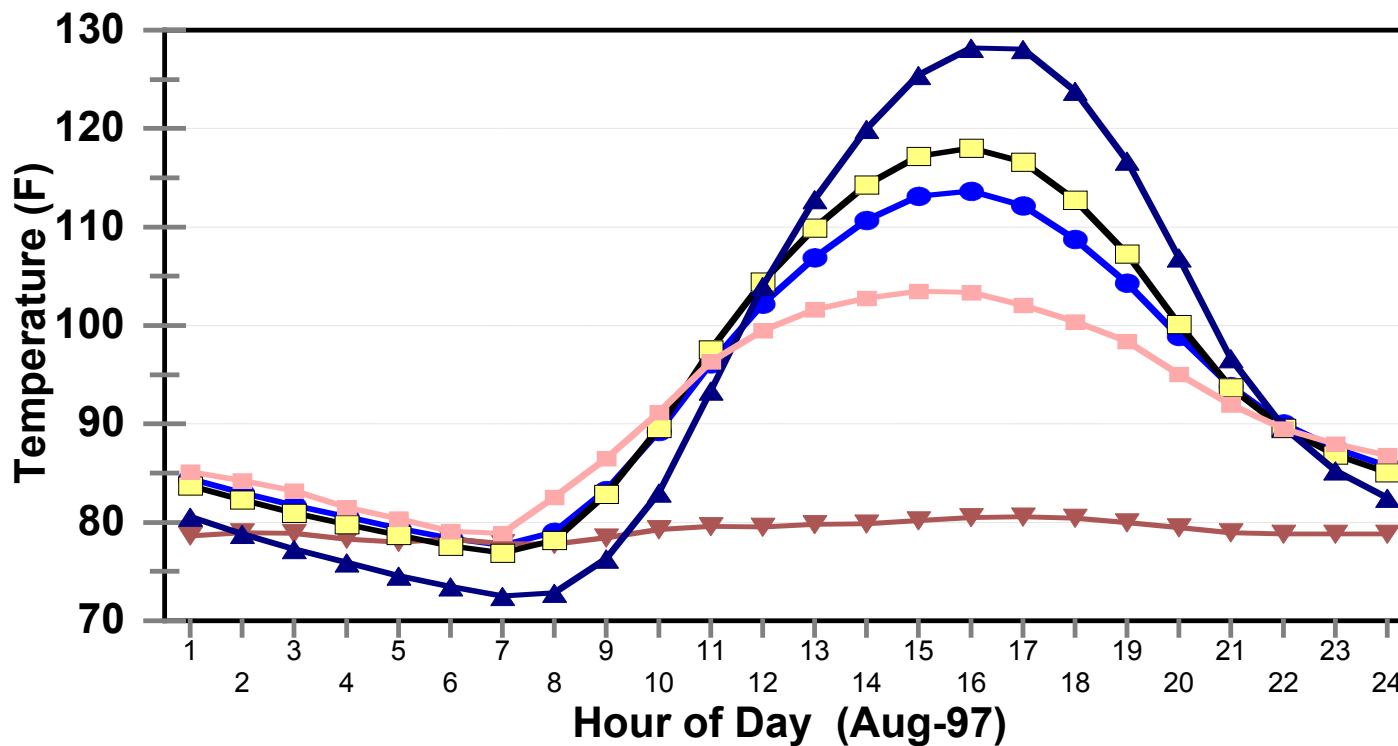
FRF Data: June 1 - September 30, 1989



Vented vs. unvented shingle temperatures

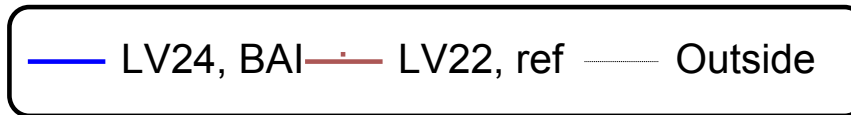
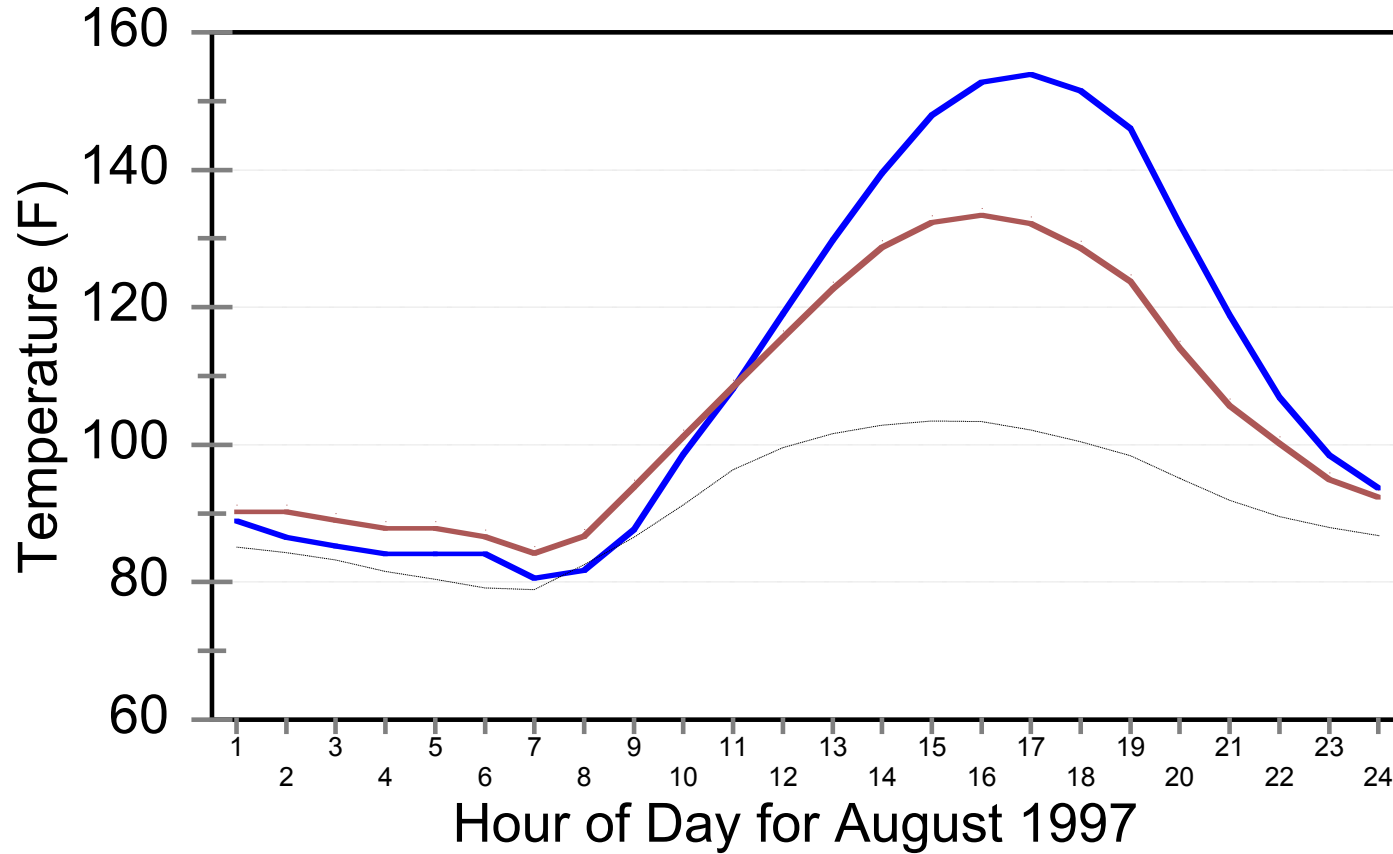


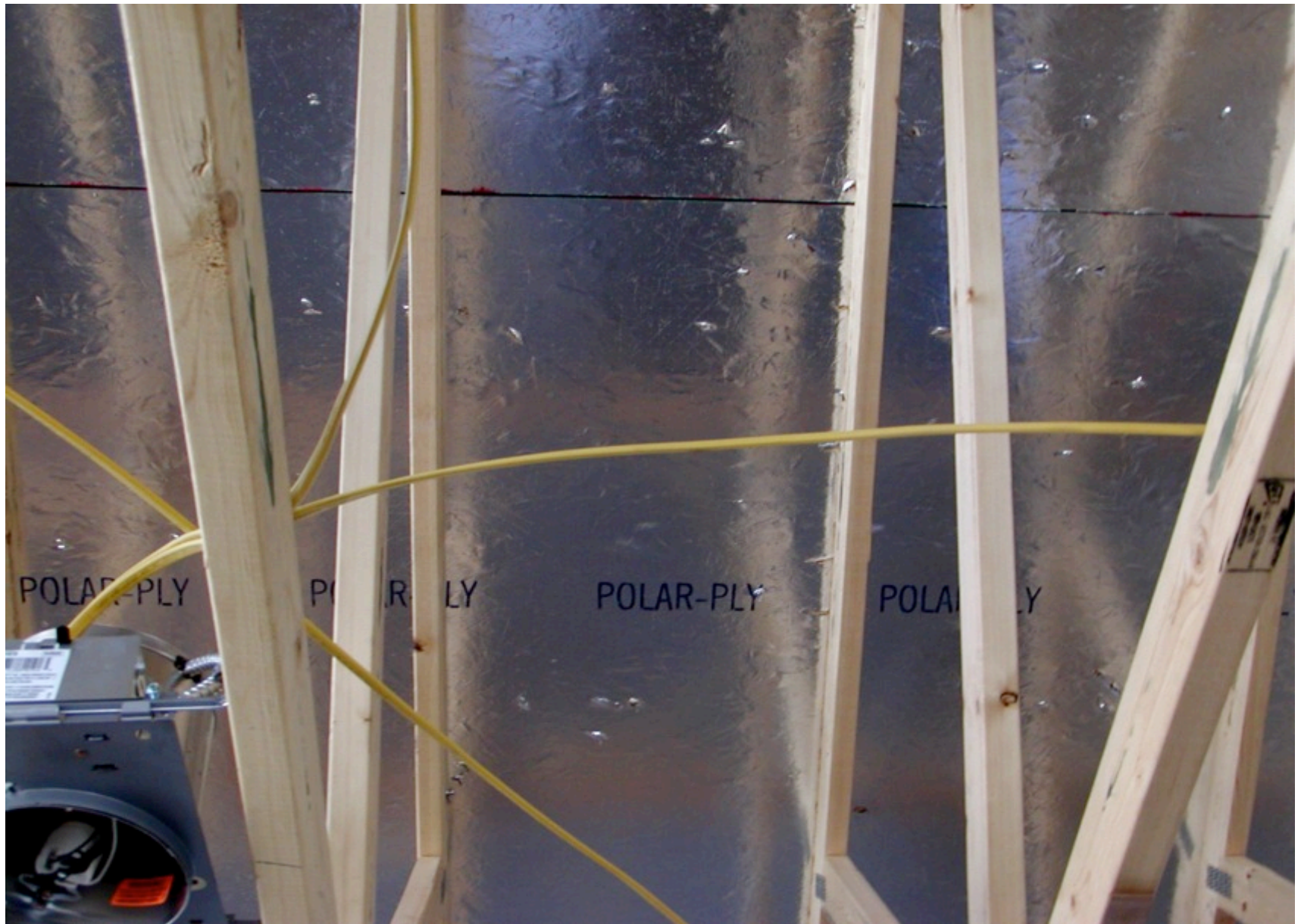
Average Temperatures Vented and Unvented Attics, Aug-97



Hourly Maximim Roof Deck Temperature

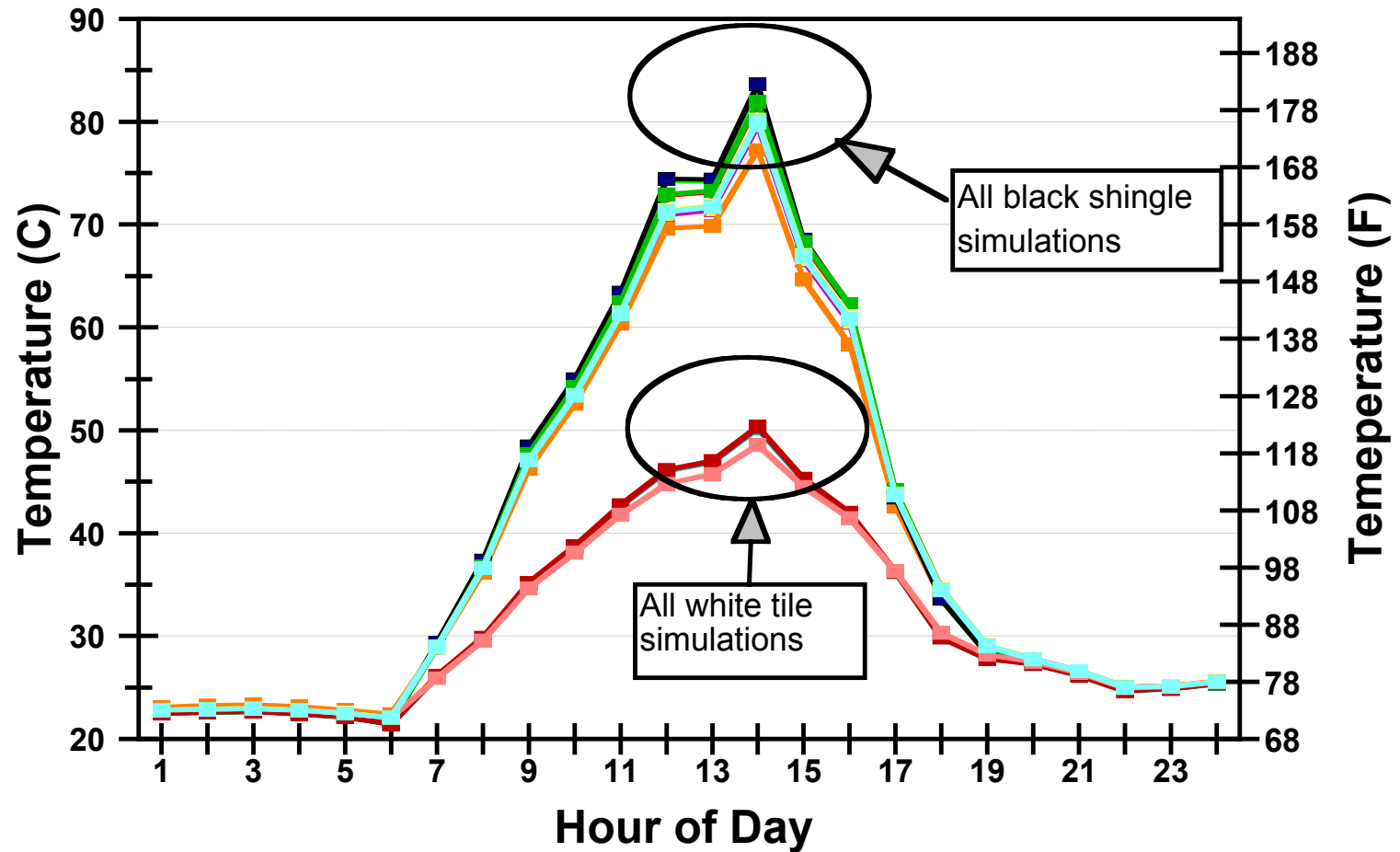
LV24 and LV22





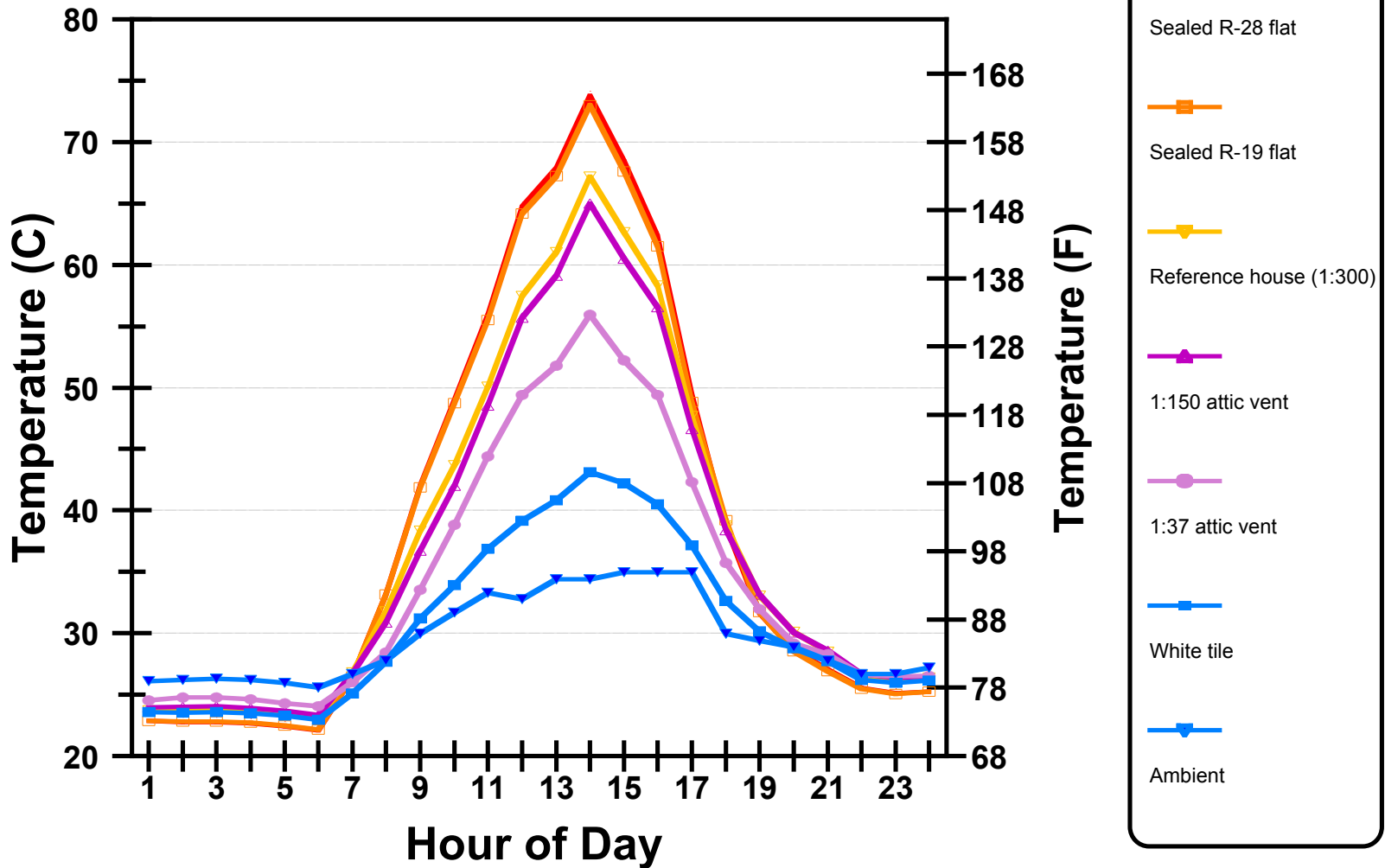
Roof Shingle Temperature

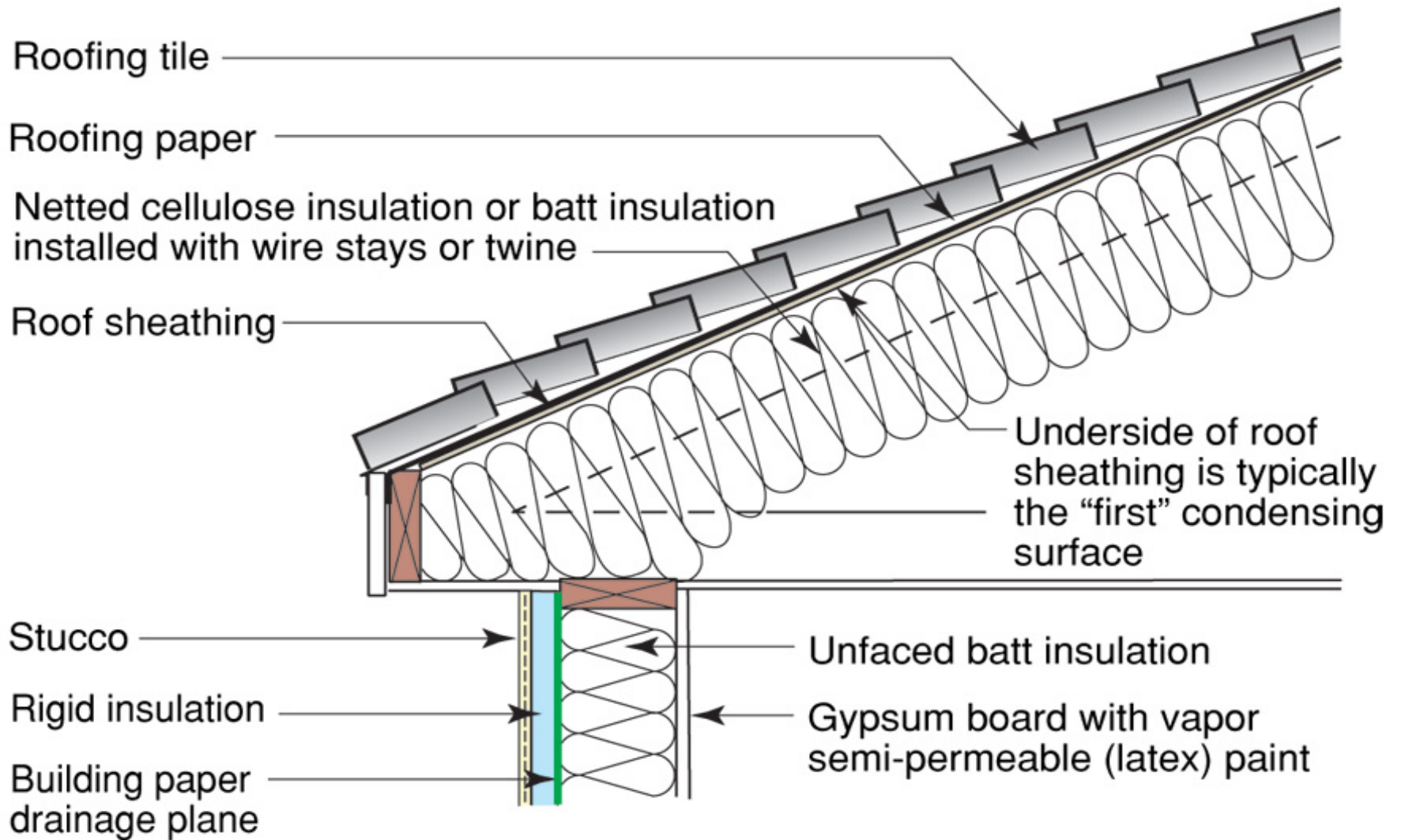
FSEC 3.0: Orlando, 1-Aug

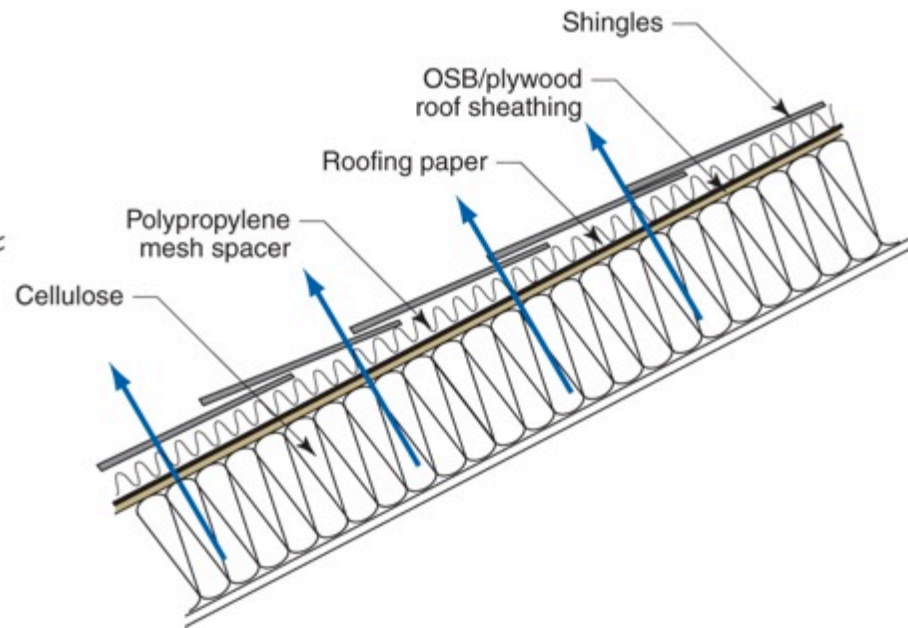
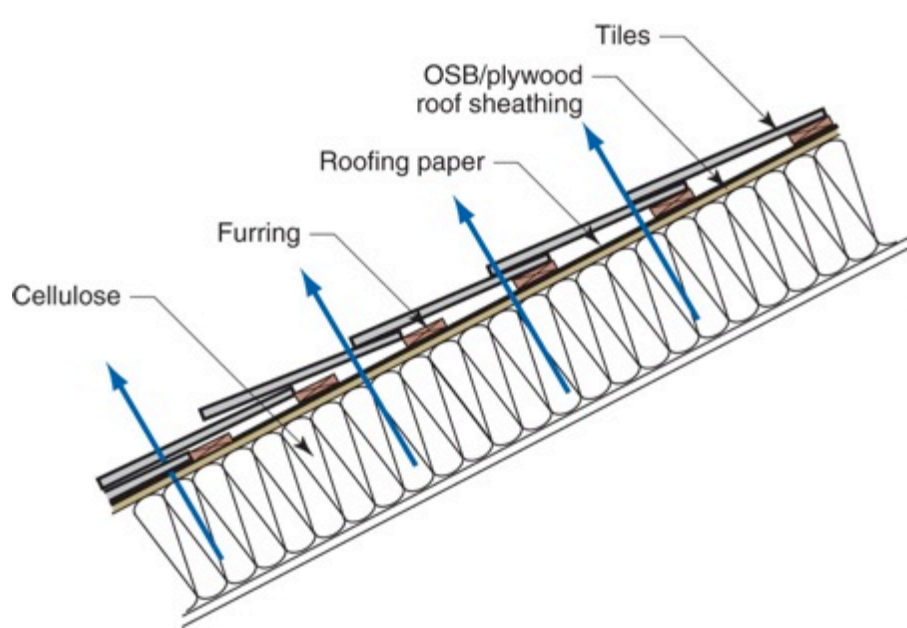


Bottom of Roof Plywood Temperature

FSEC 3.0: Orlando, 1-Aug







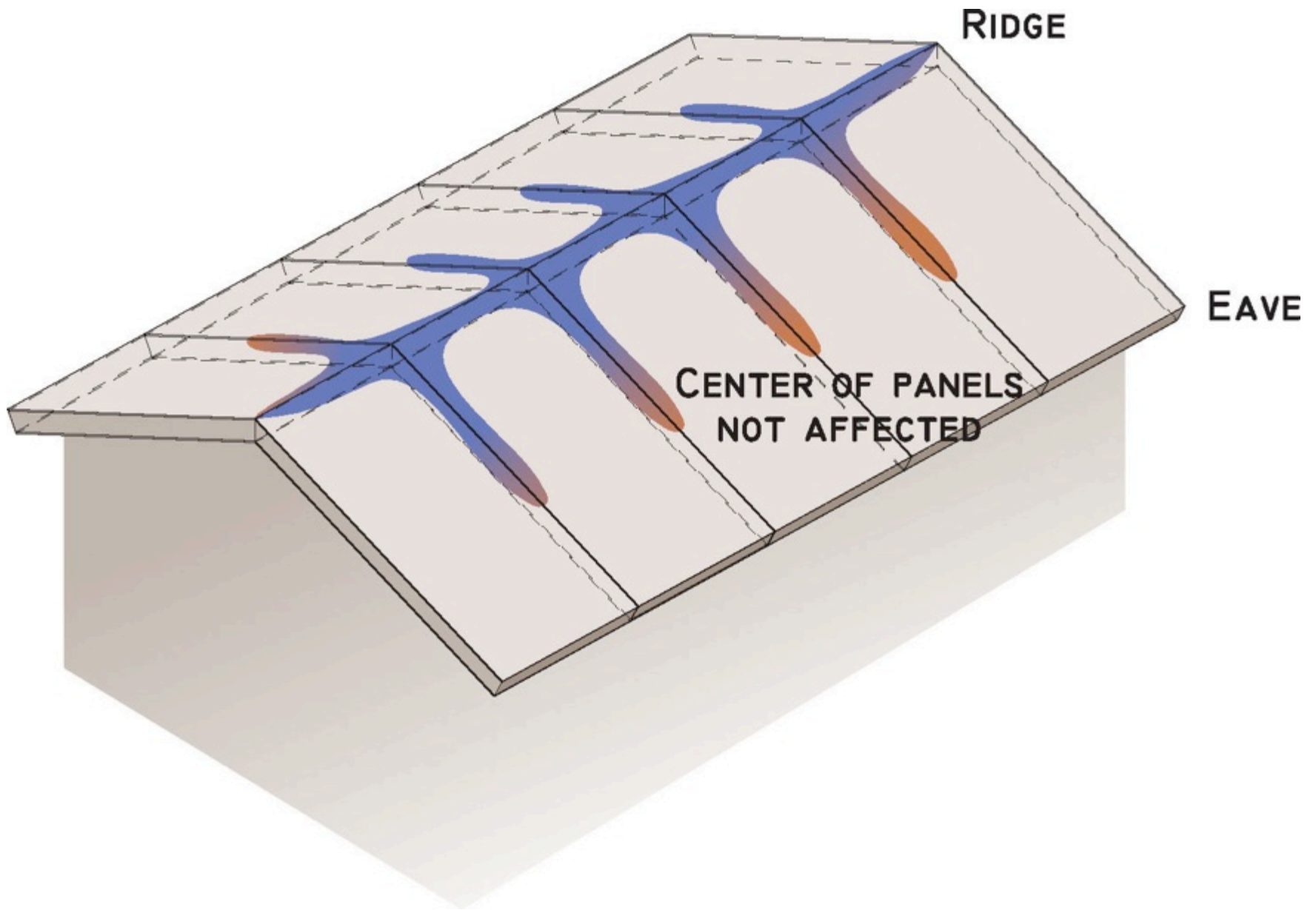














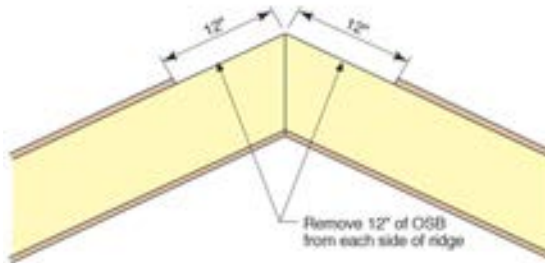






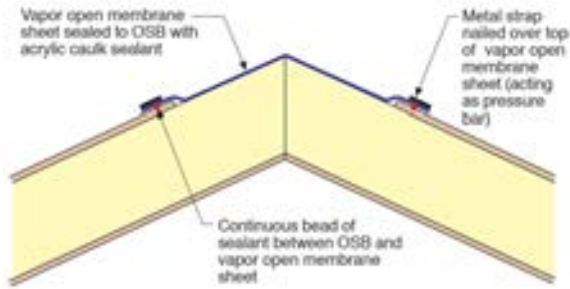
Step 1

- Remove strip of OSB from each side of ridge



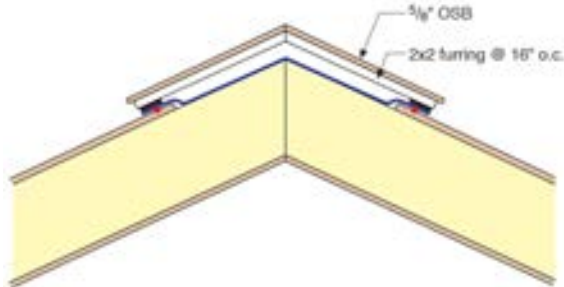
Step 2

- 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









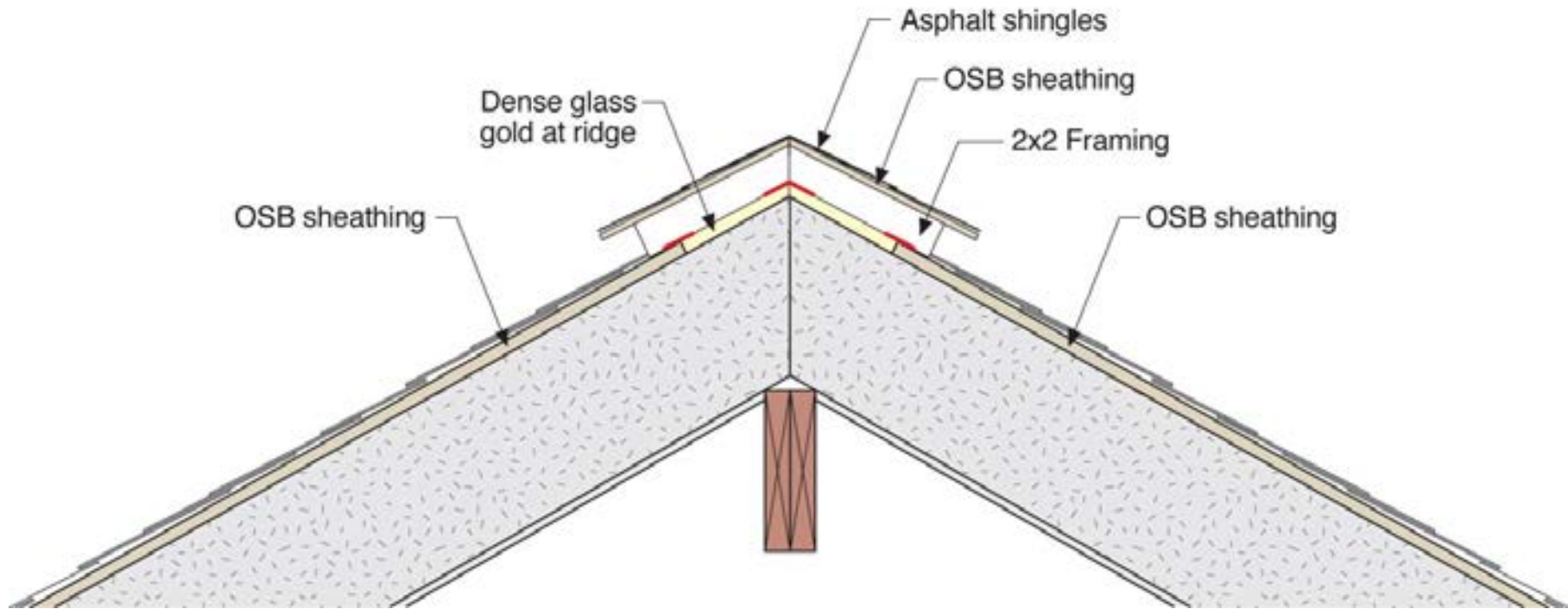


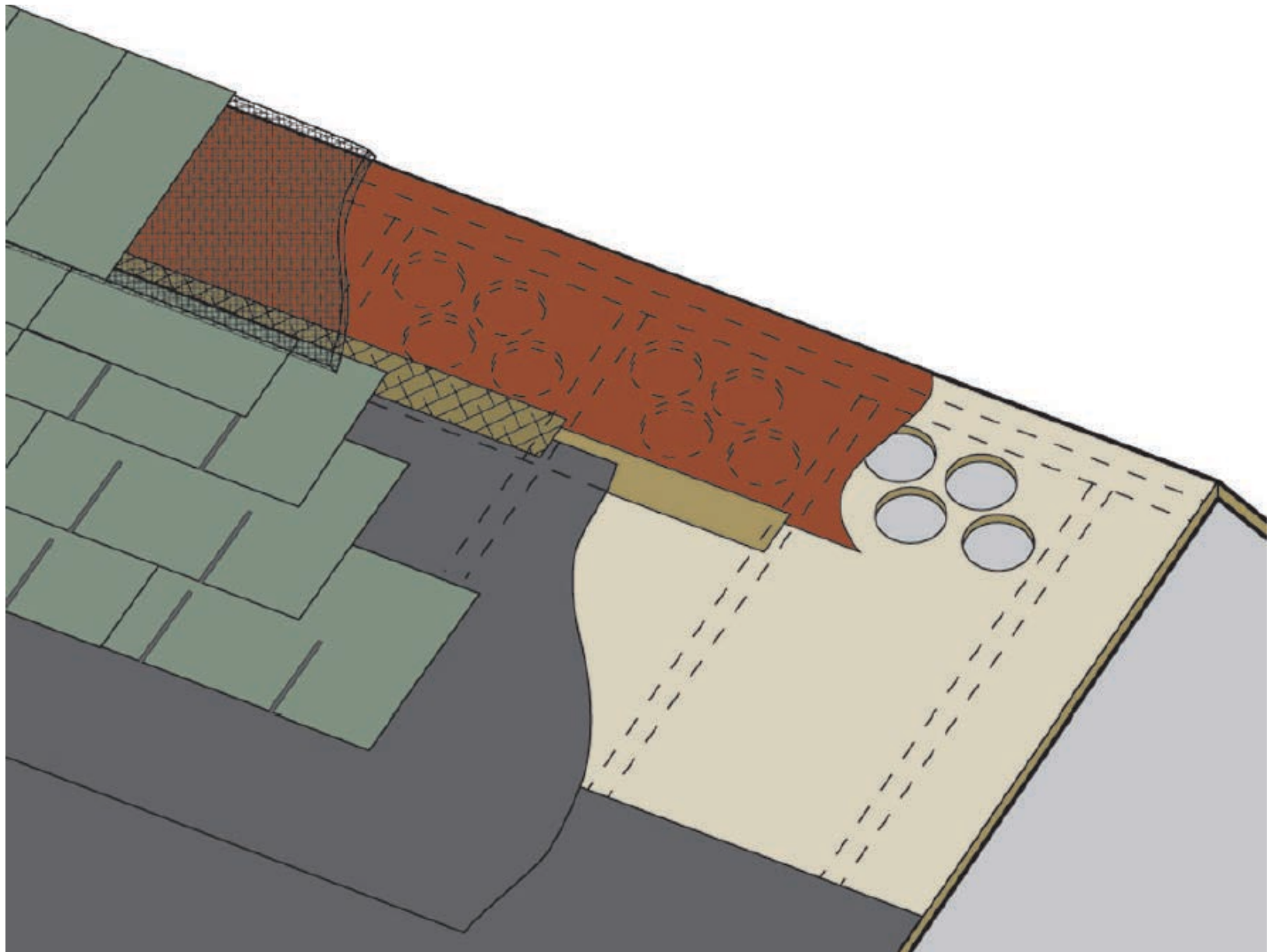


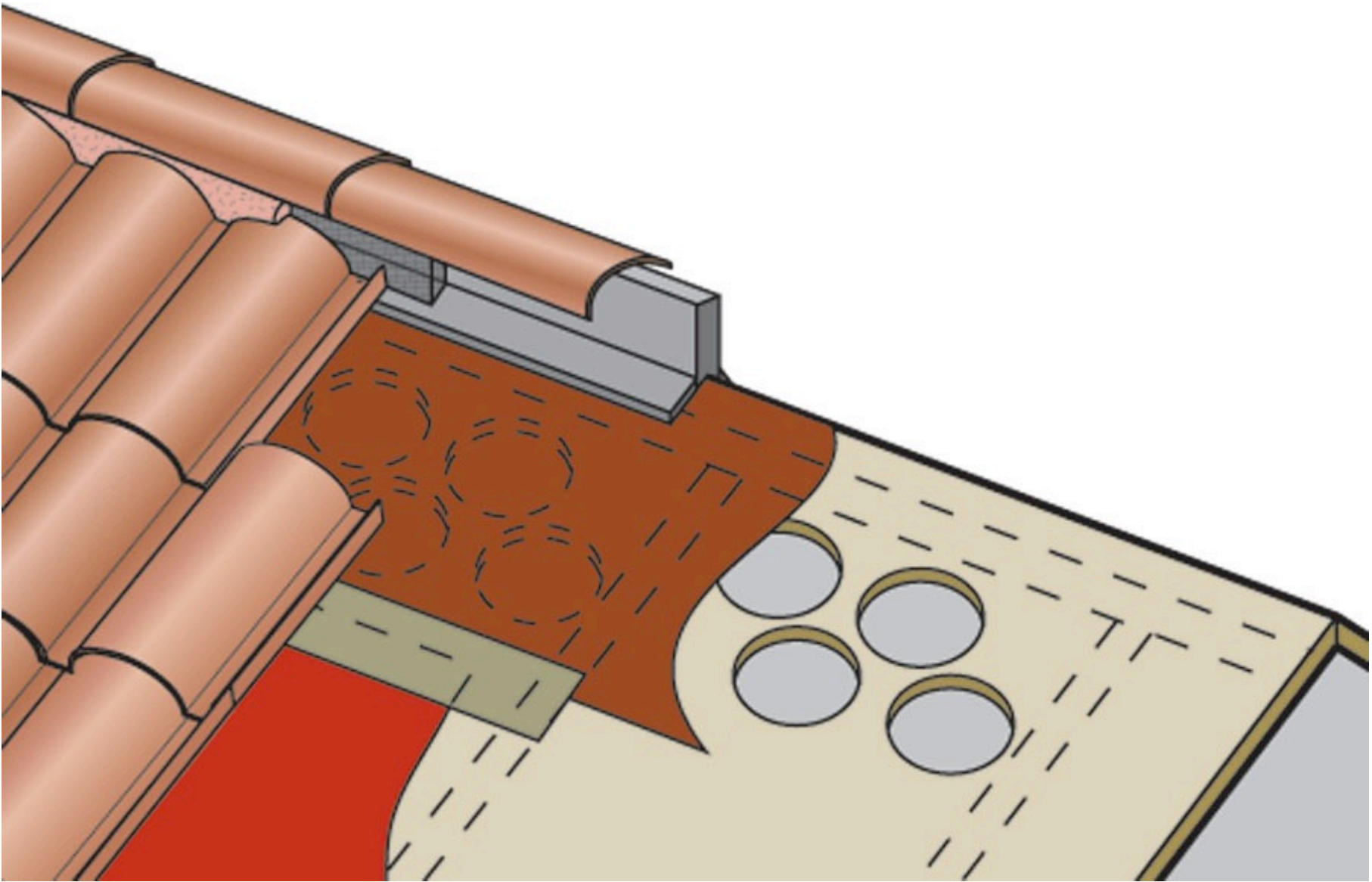


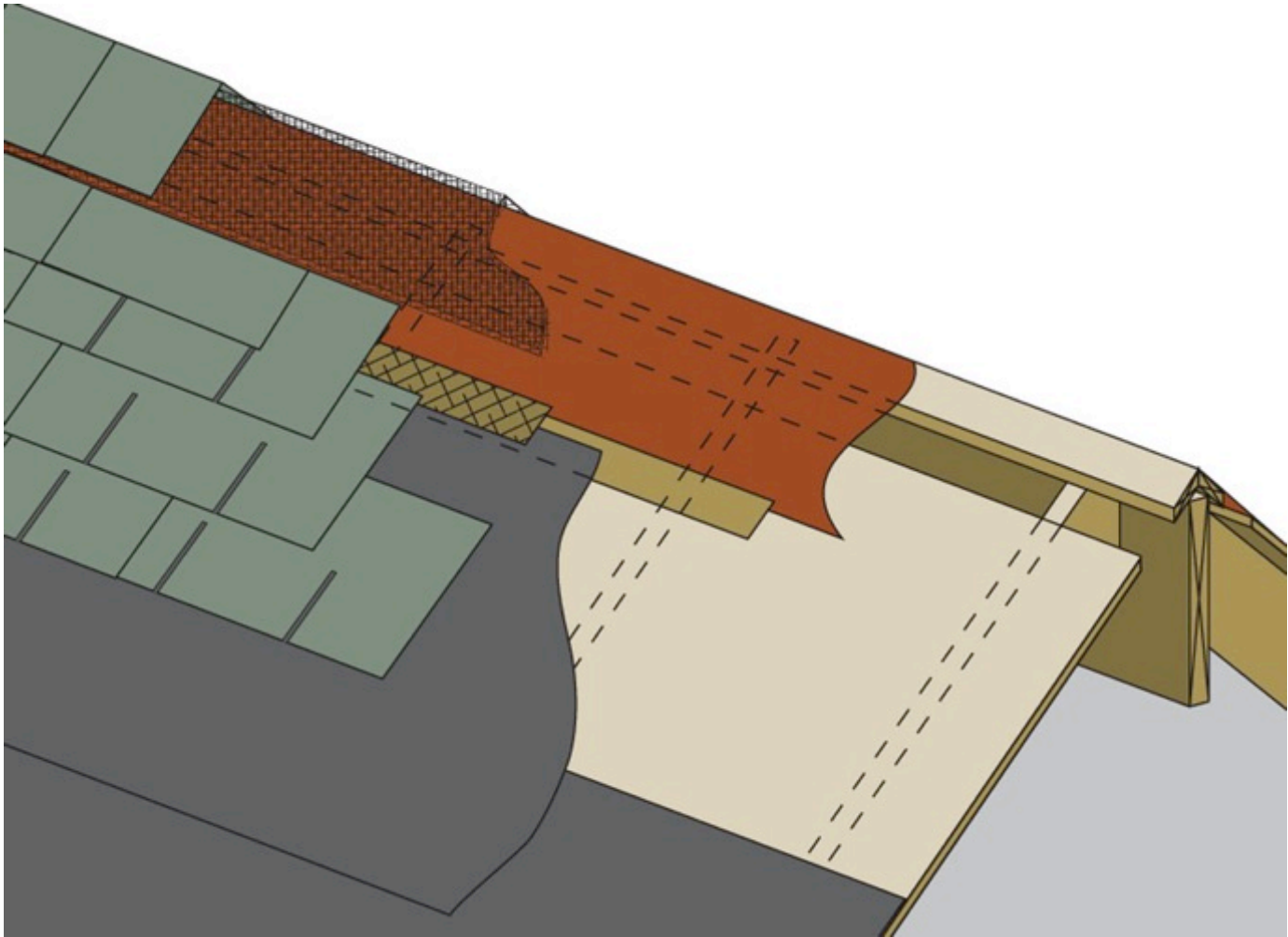


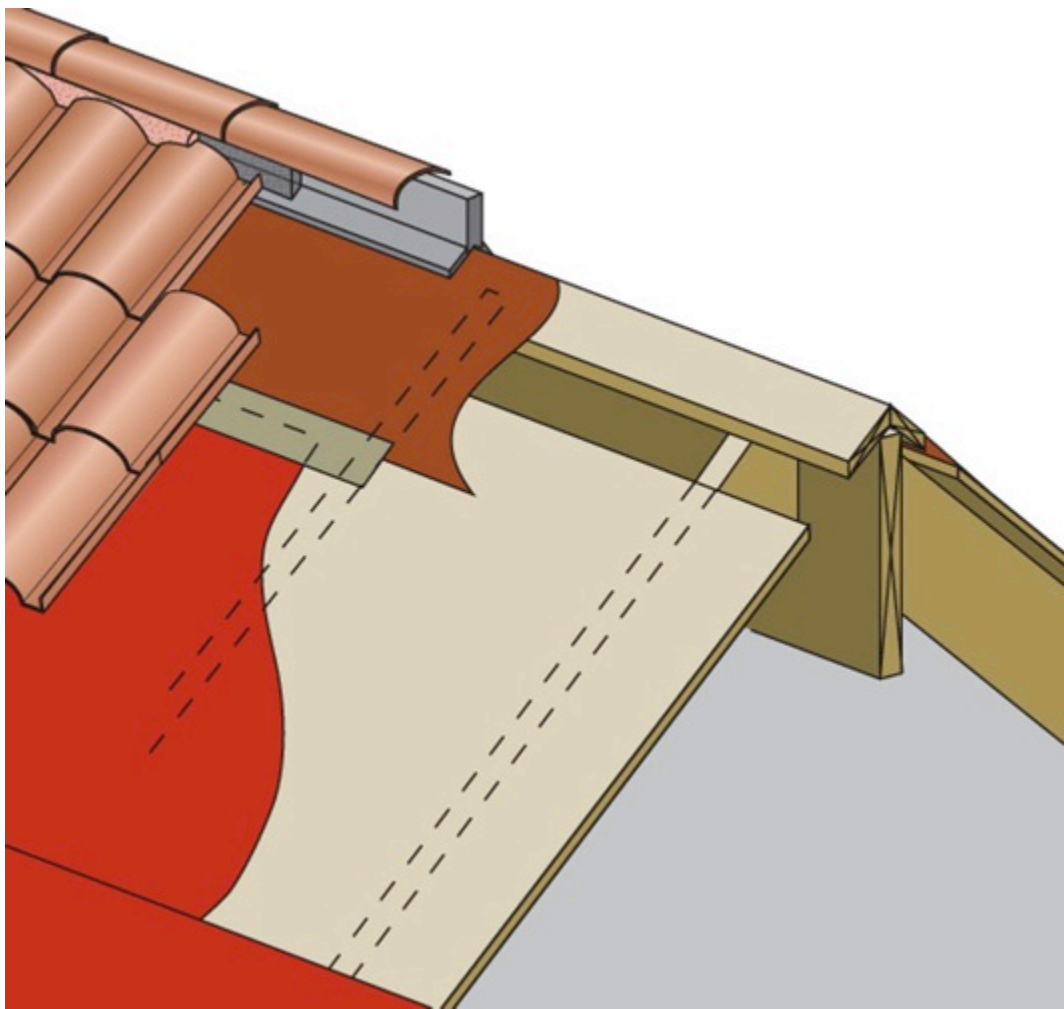


































Sweating Ducts

Sweating Ducts

Light Colored Roofs

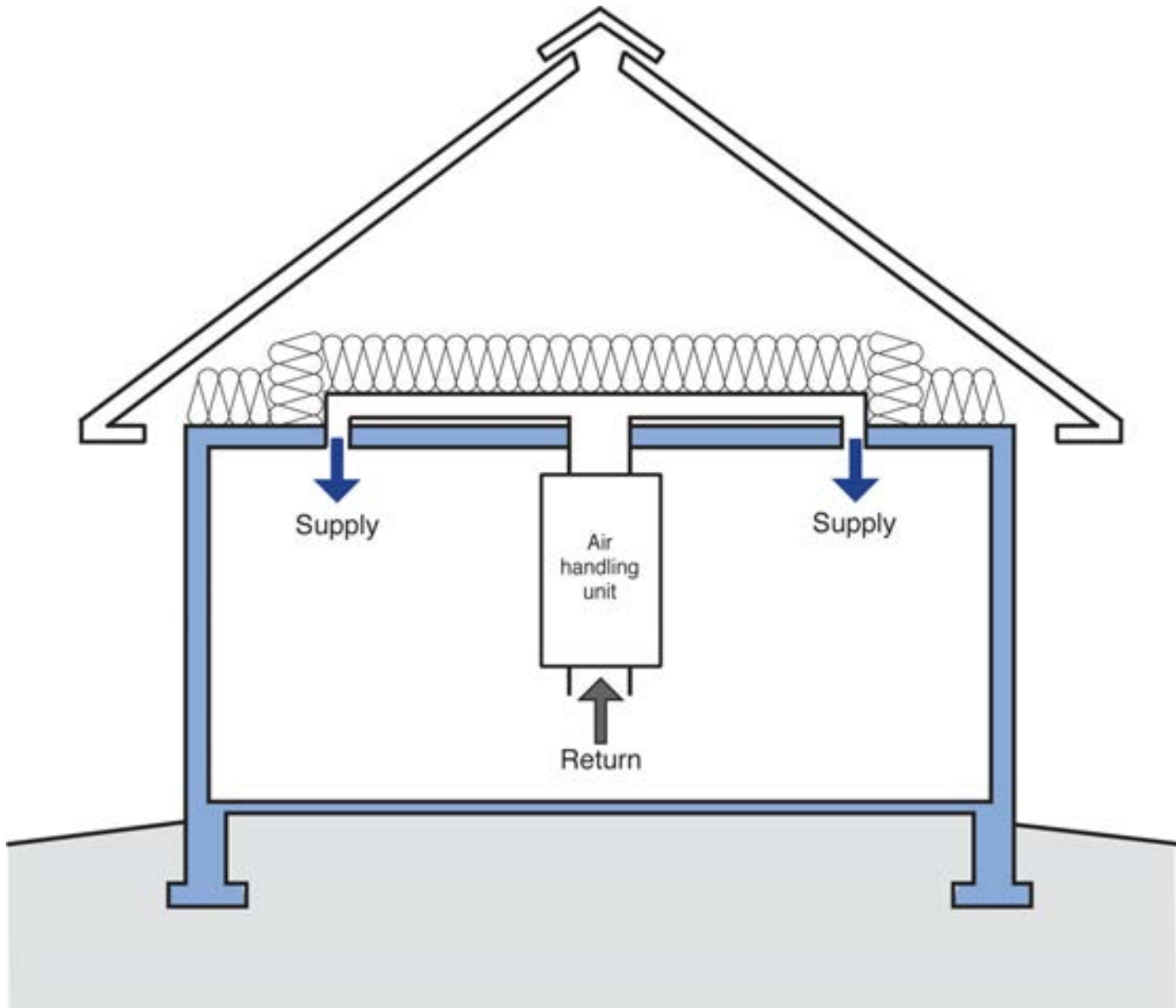
Cool Roofs

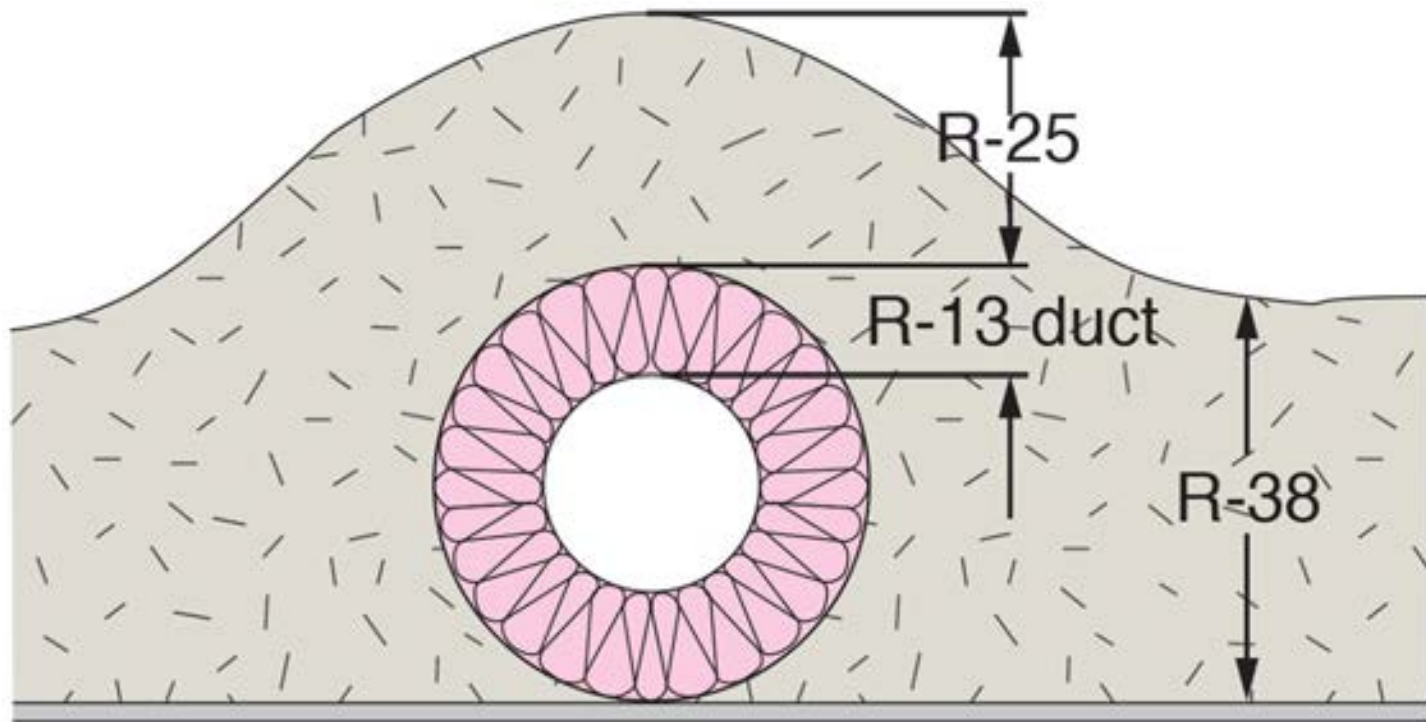
Radiant Barriers

ACCA Manual J, S and D

Ductwork Attic Dehumidification System

Burying Ducts

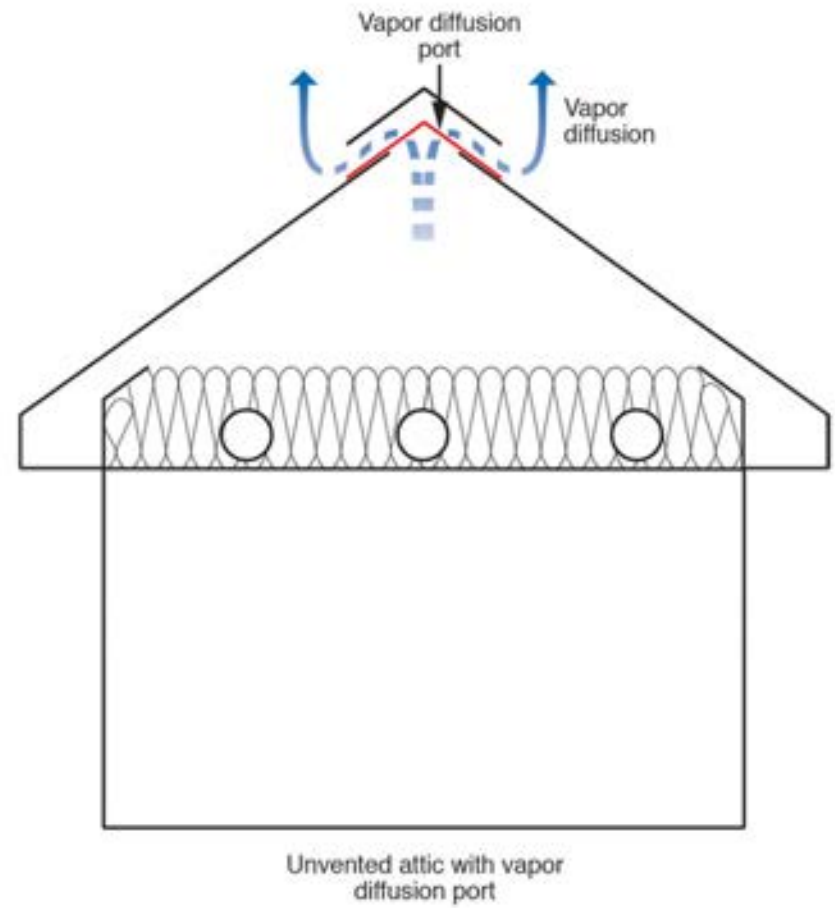
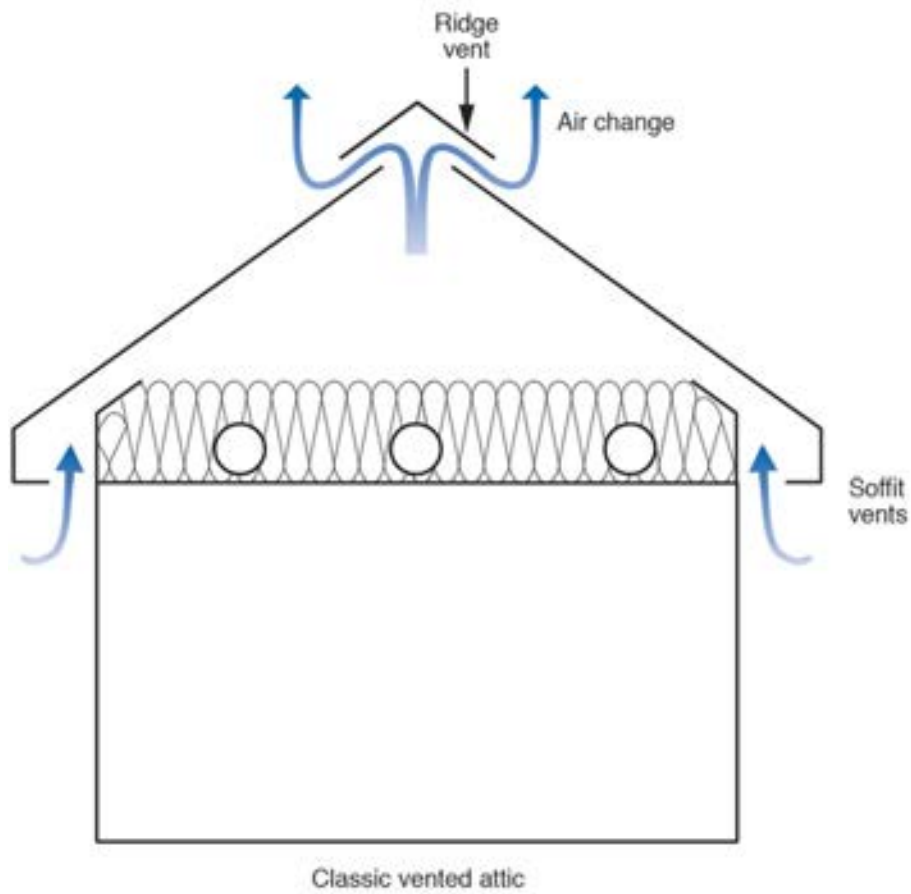












Cold Climates



