

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

# Building Science

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Adventures In Building Science

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# Things Are Different

## Energy Efficiency

## Materials

# There Is No Such Thing As A Free Thermodynamic Lunch

# Condensation on Ductwork

# Condensation on Ductwork

## Ductwork in Vented Attics and Vented Crawlspaces

# Vented and Unvented Attics

## Vented and Unvented Crawlspace

# There Is Nothing Wrong With A Vented Attic

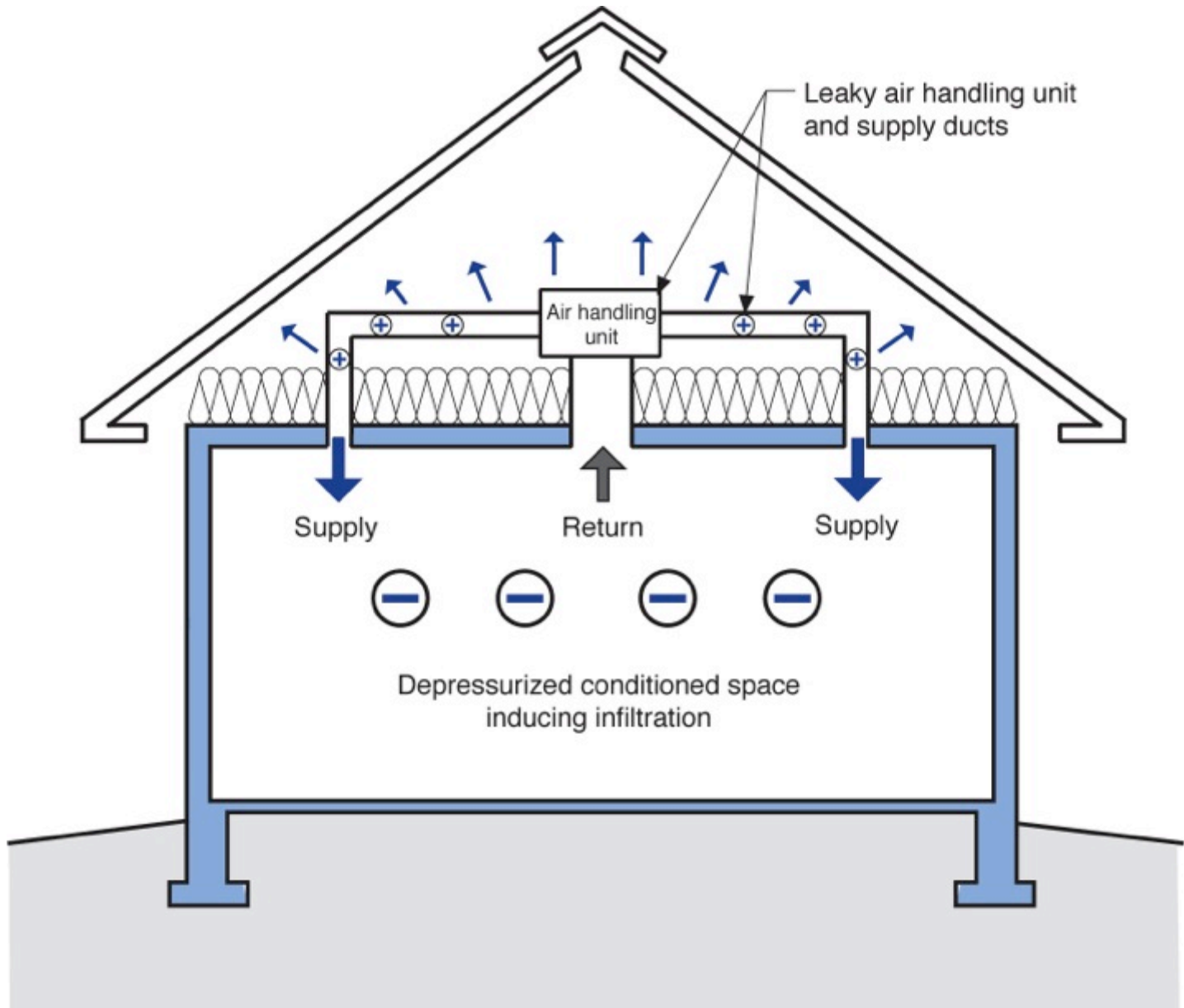
There Is Nothing Wrong With A Vented Attic  
But.....

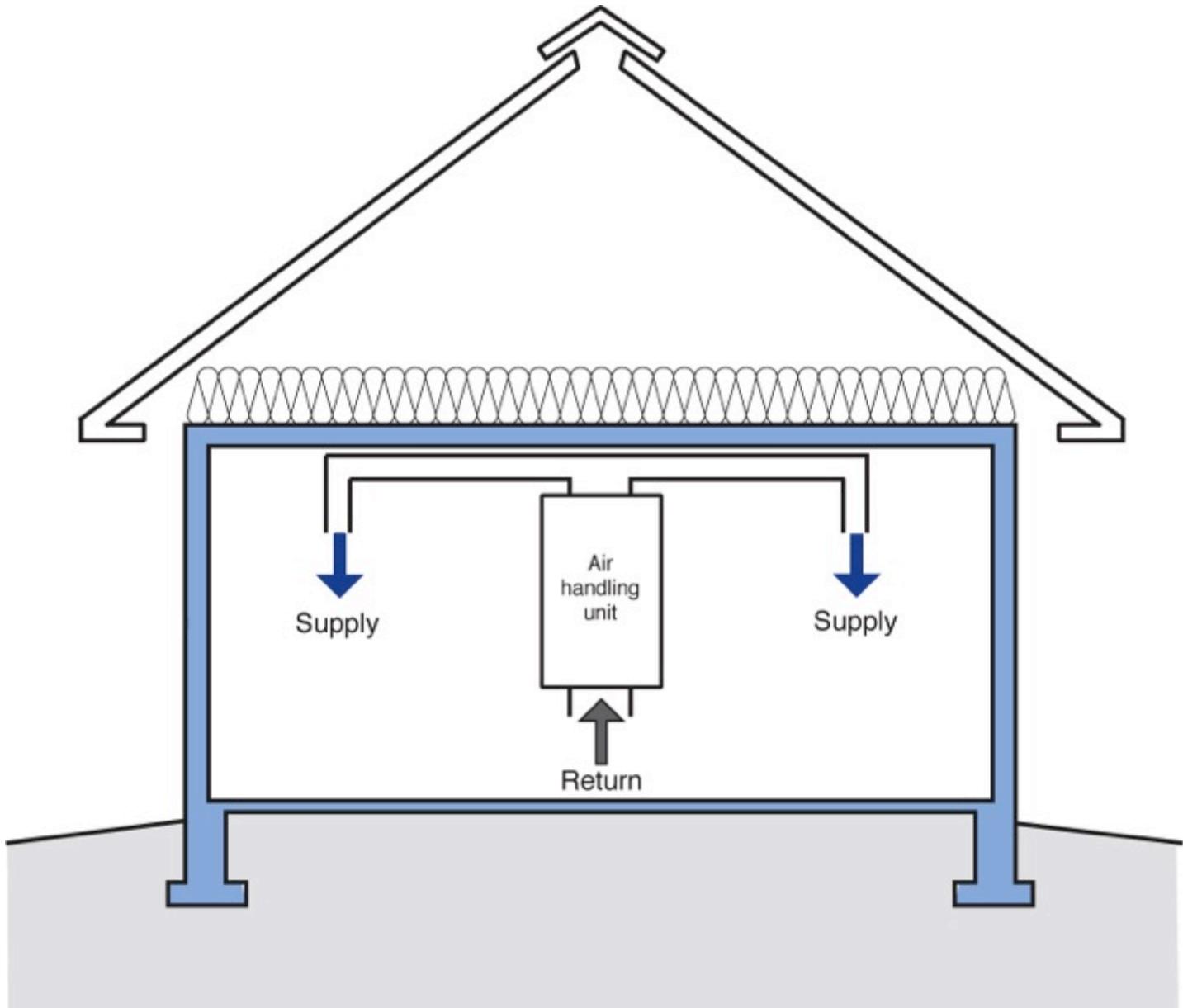


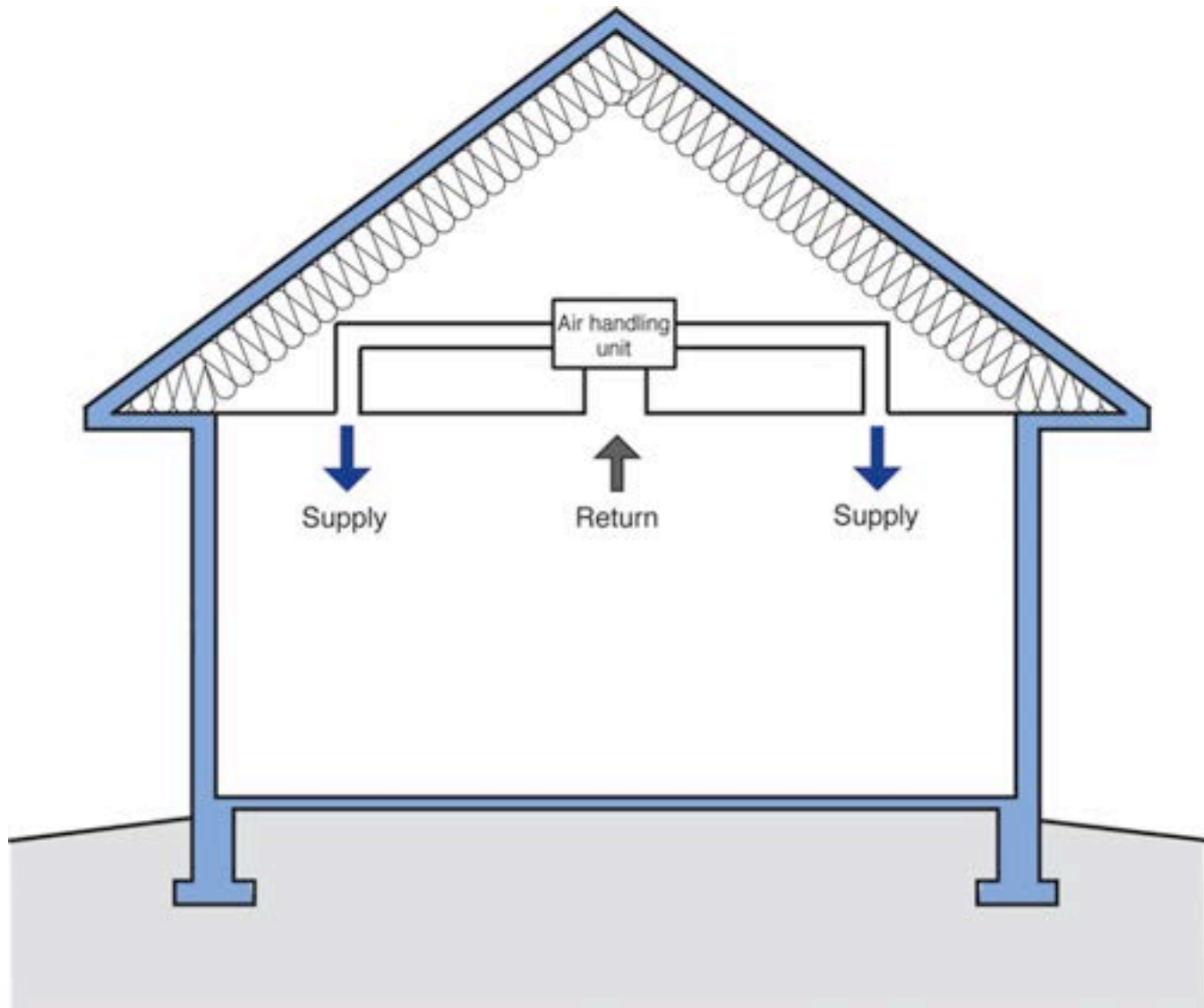
Houses With Vented Attics Suck  
Not all the Time.....but.....

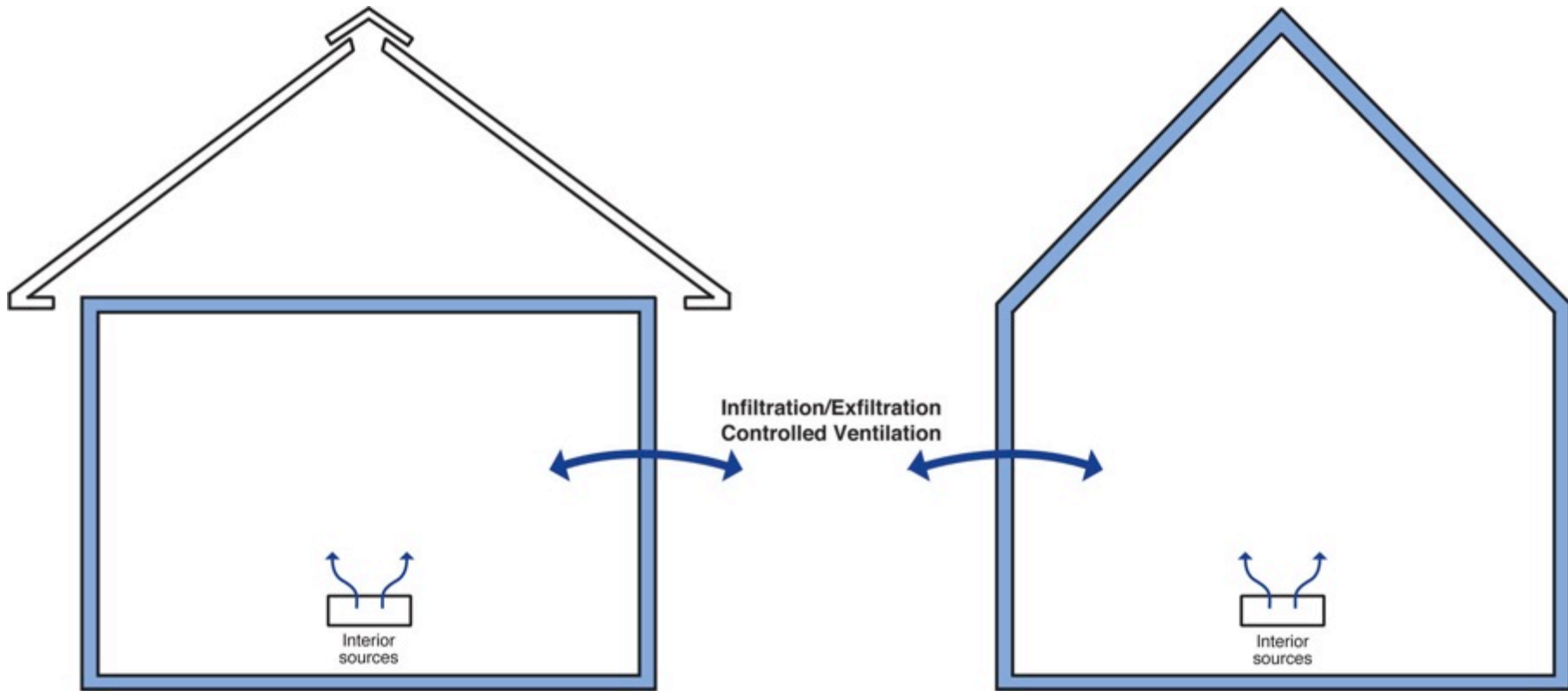






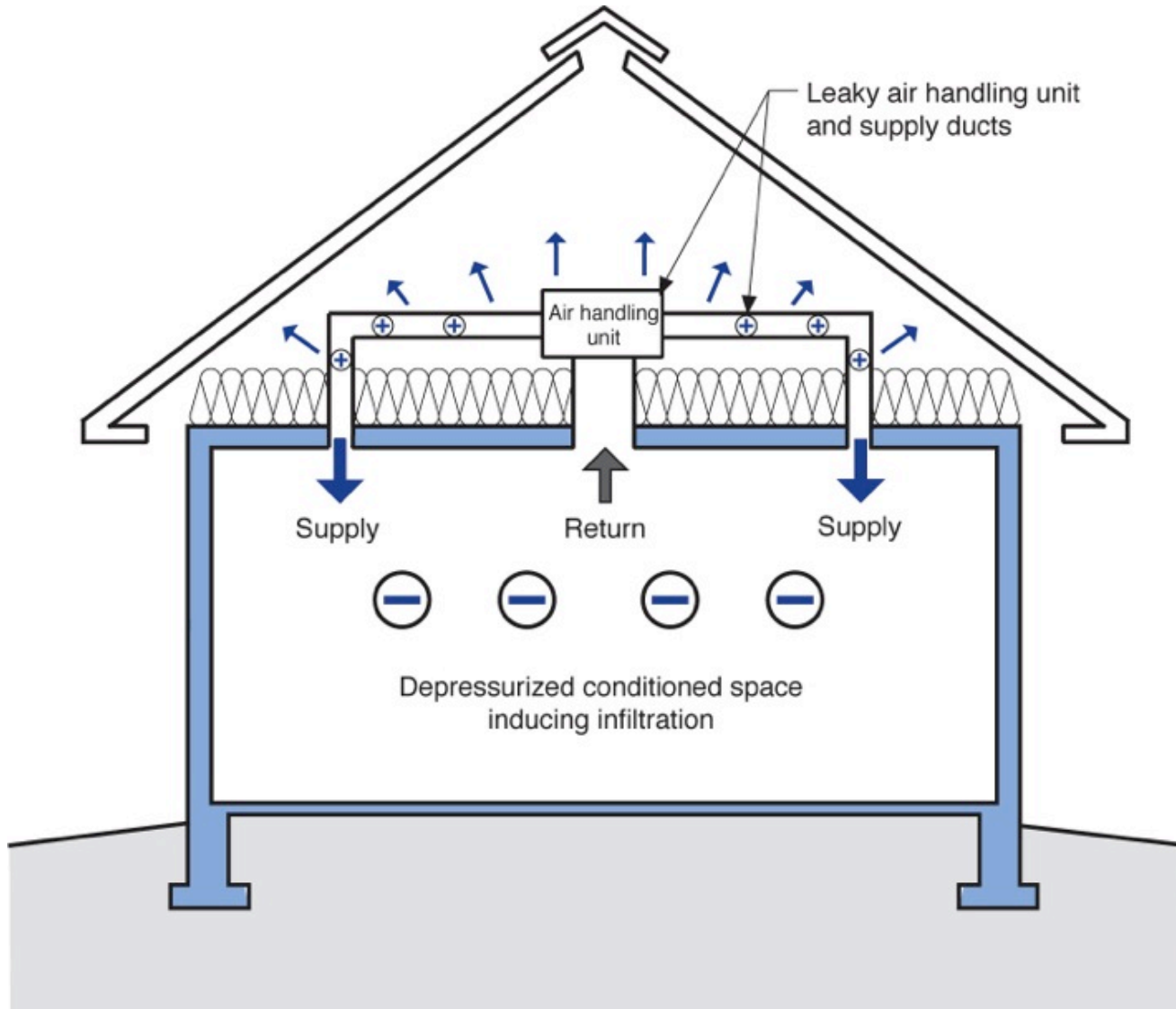


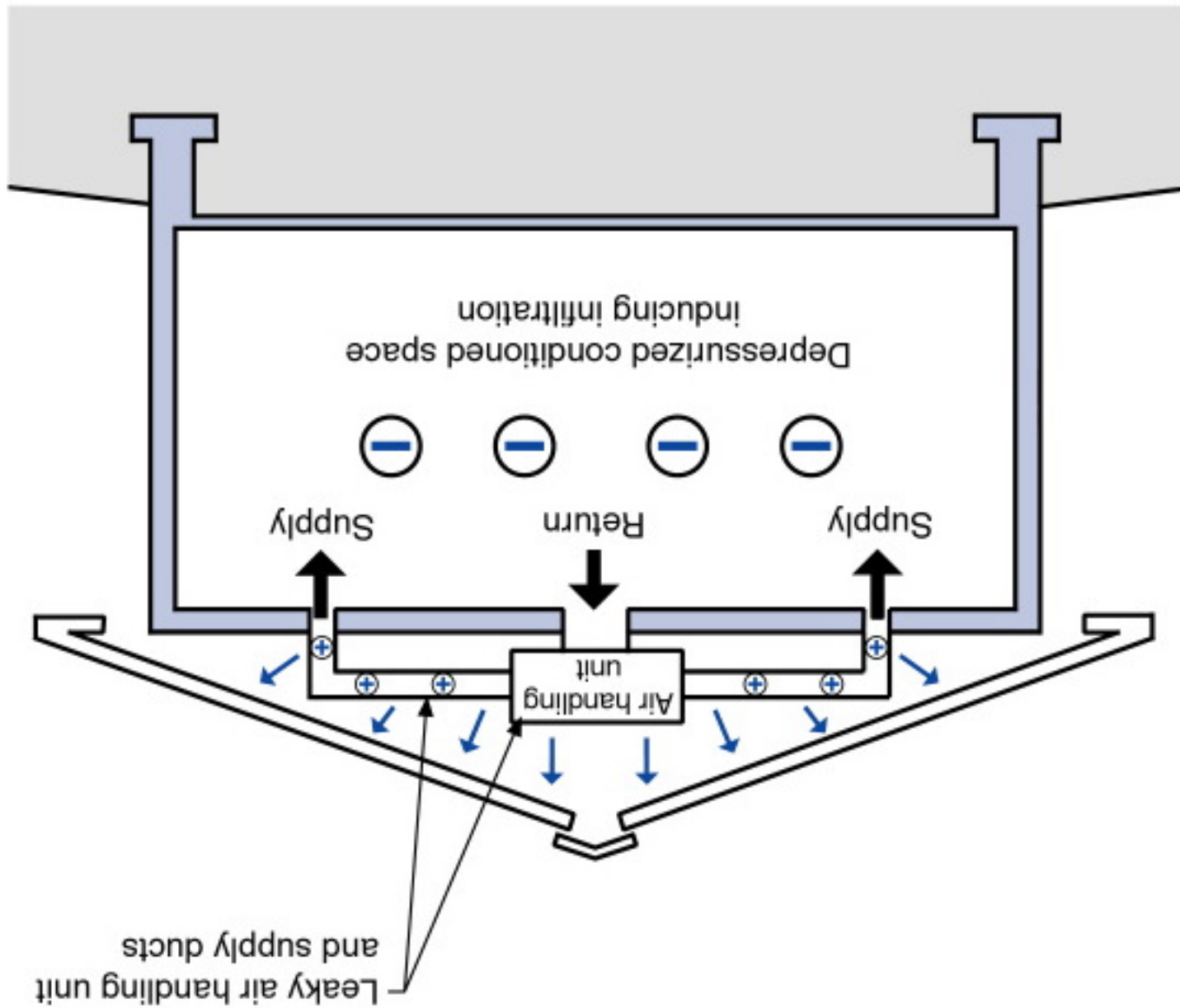


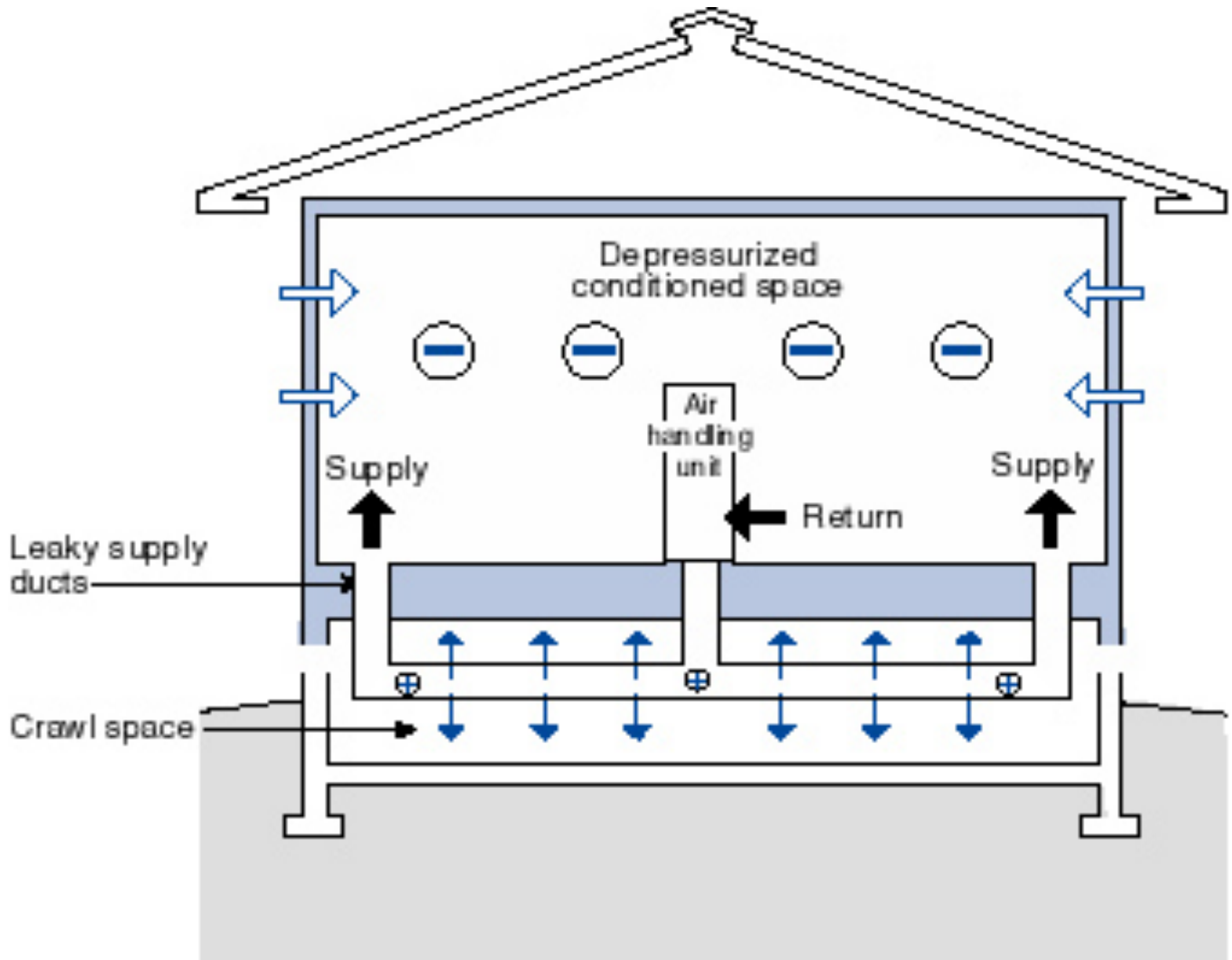


# Crawl Spaces











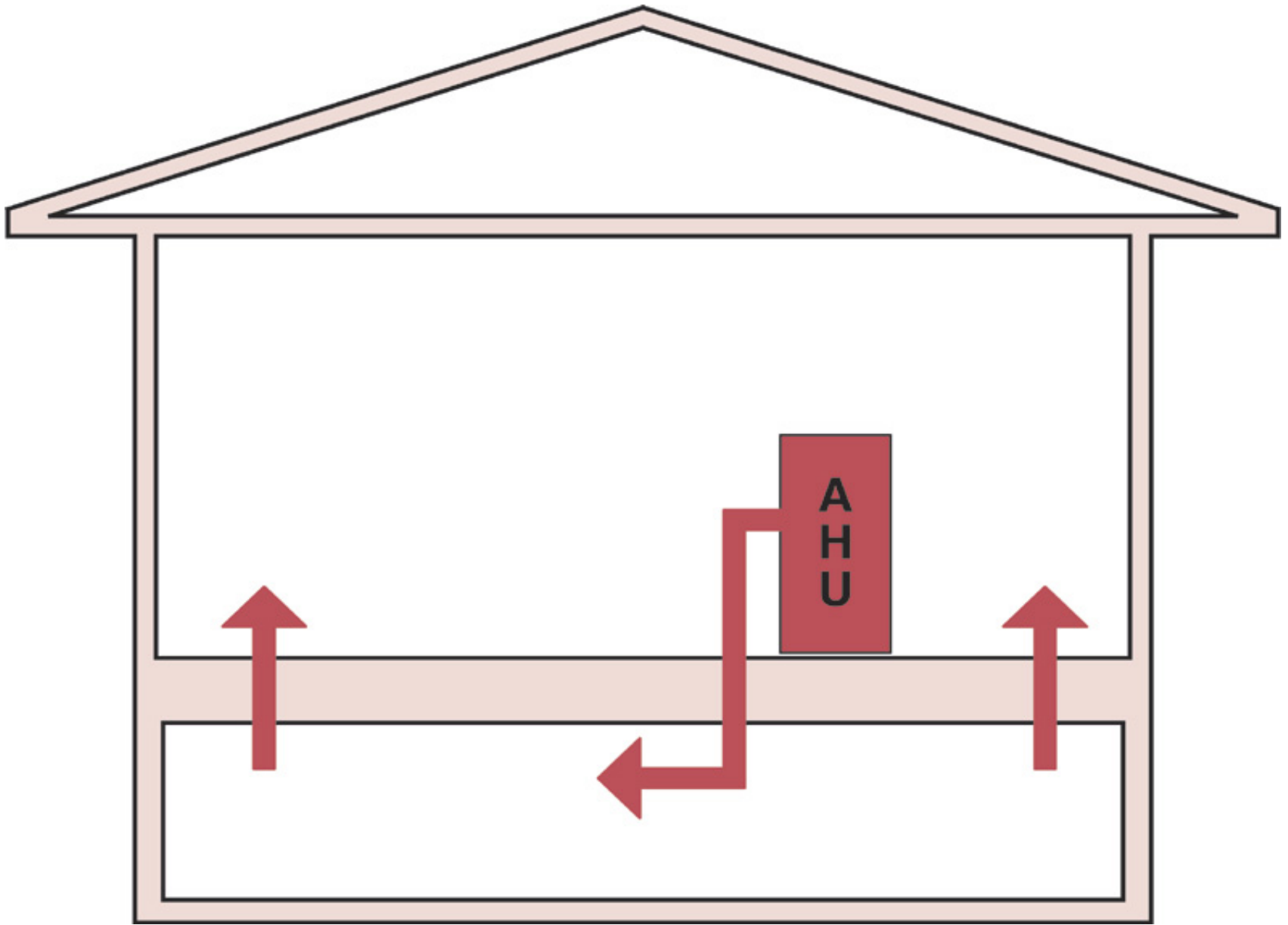
Conditioned Crawlspace Not Unvented  
Crawlspace

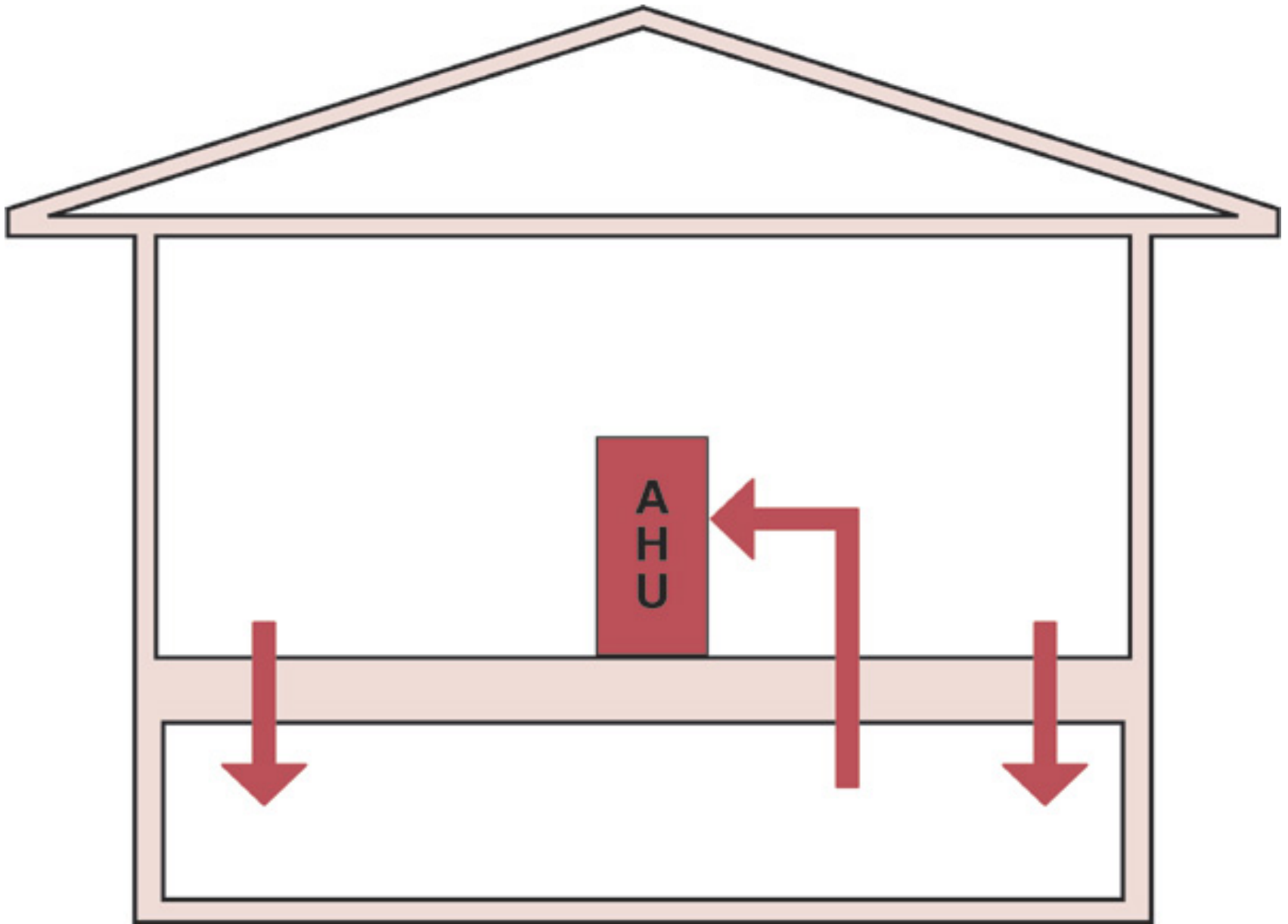
Need Supply Air

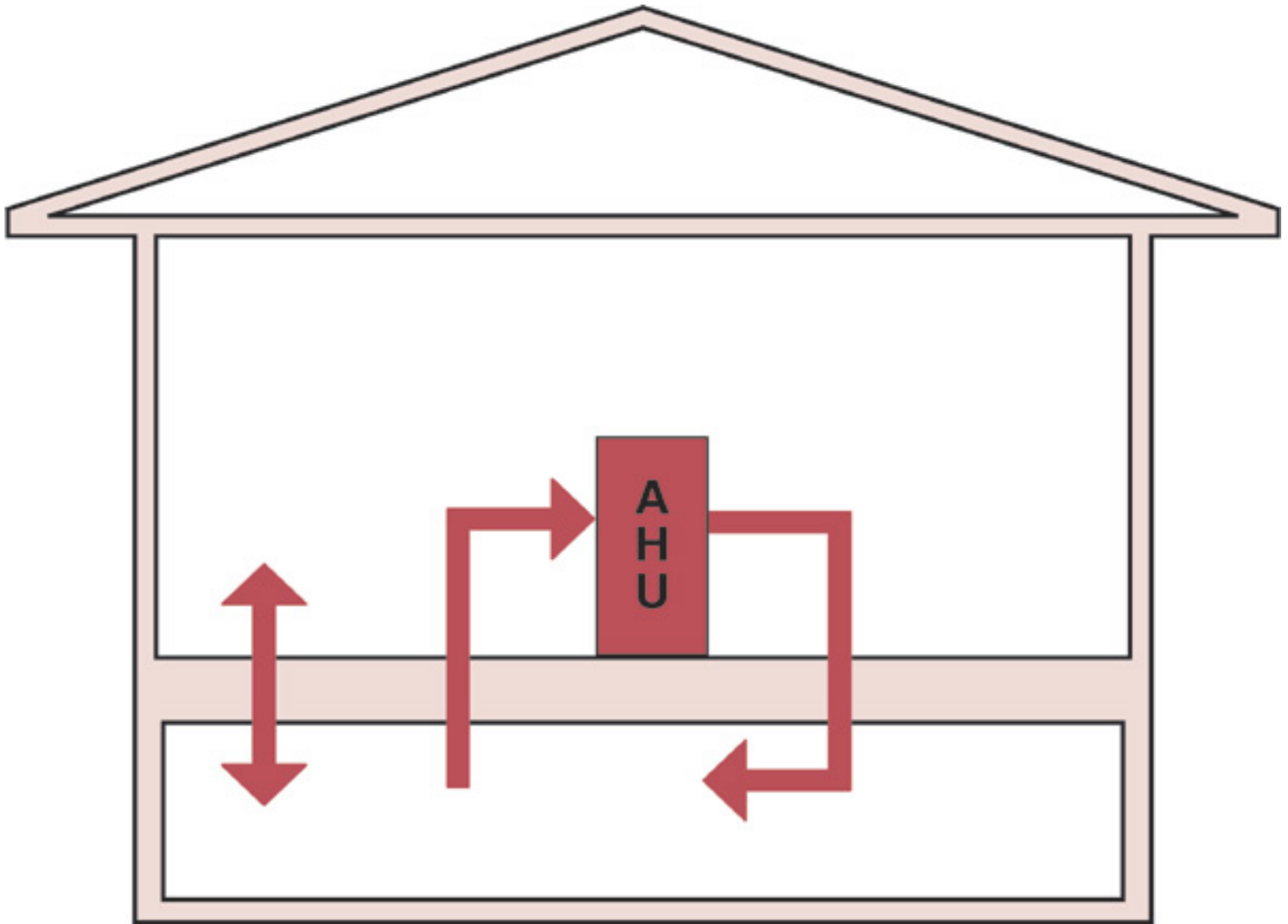
50 cfm/1000 ft<sup>2</sup> of Crawlspace Area

Or

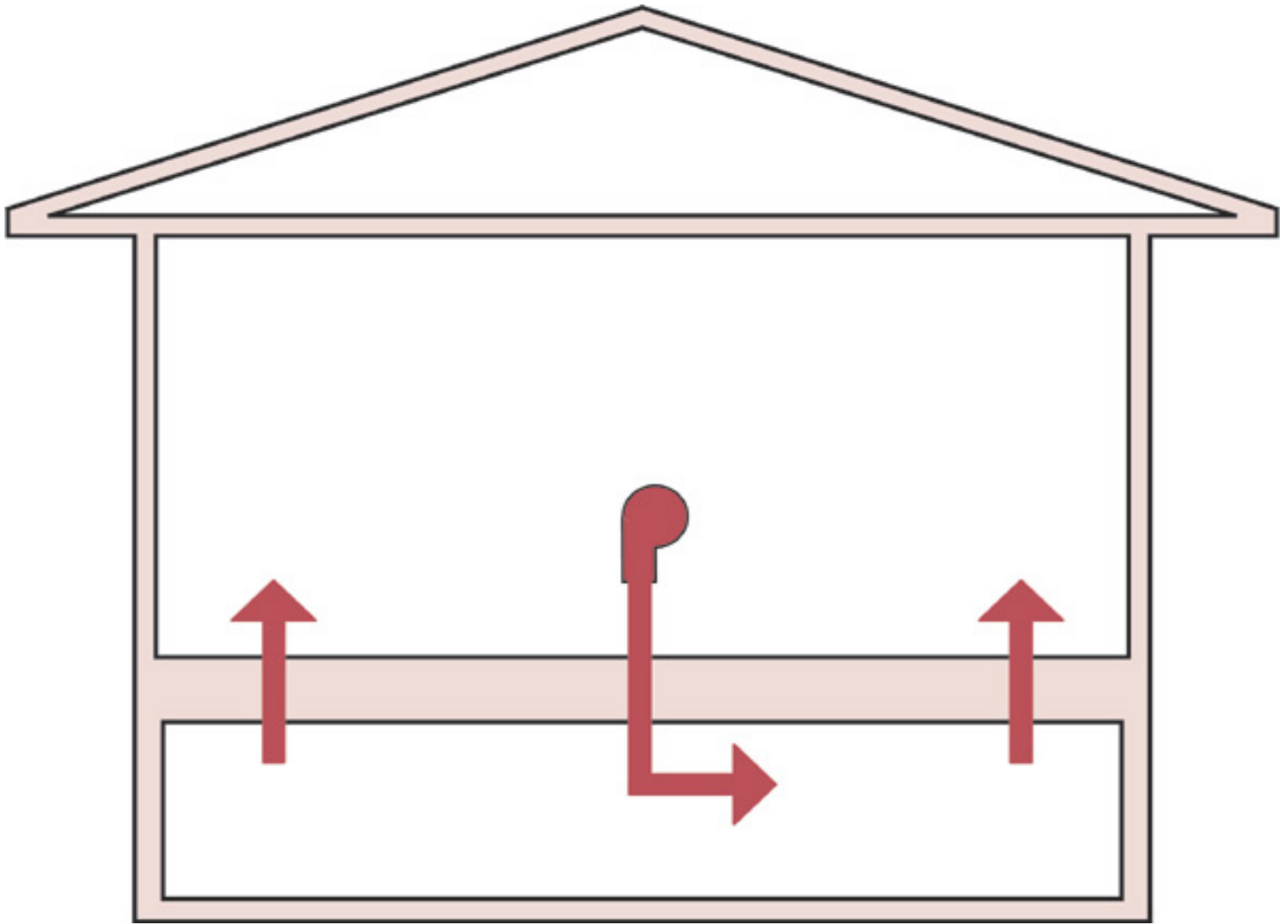
Dehumidification

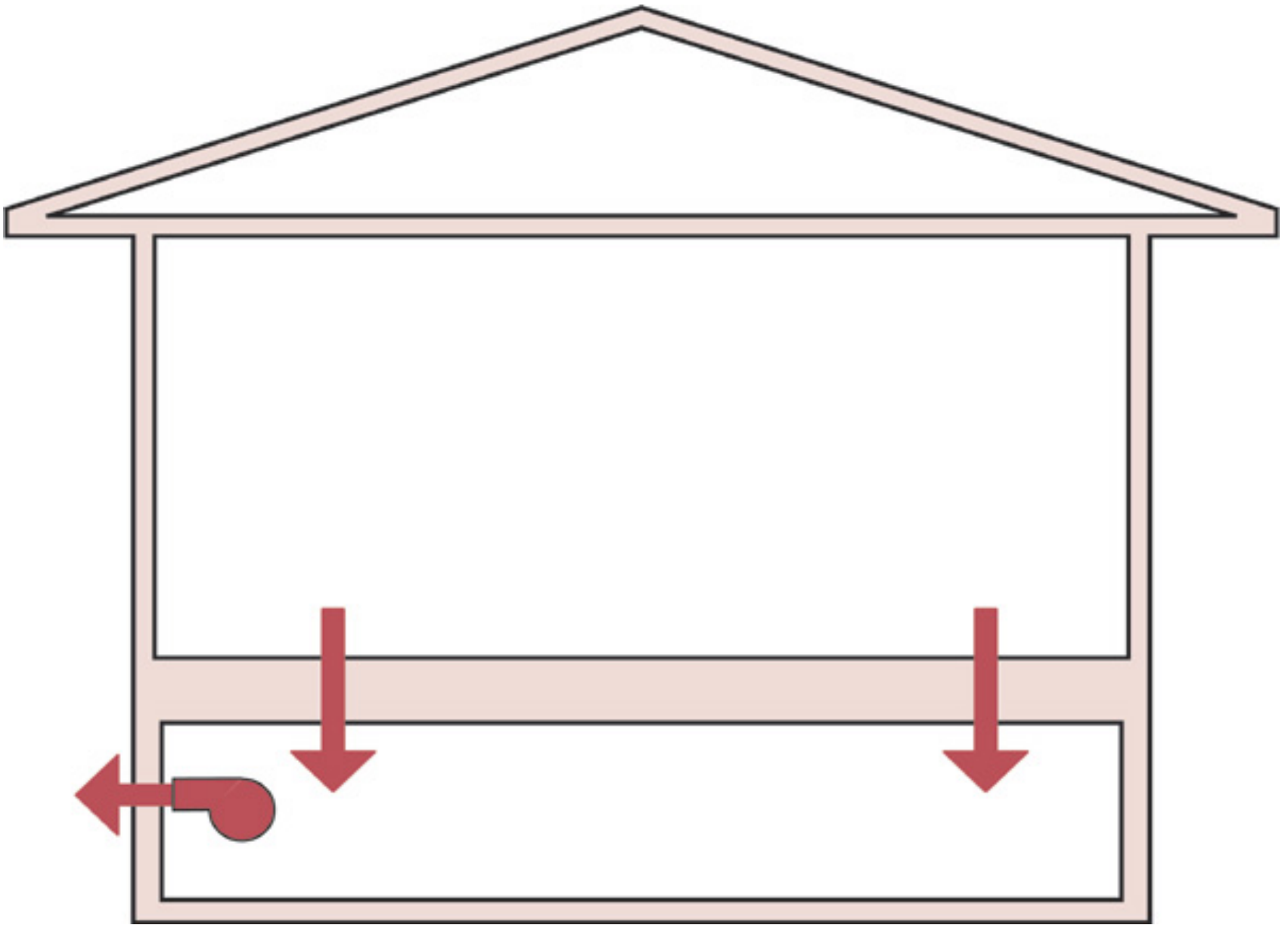


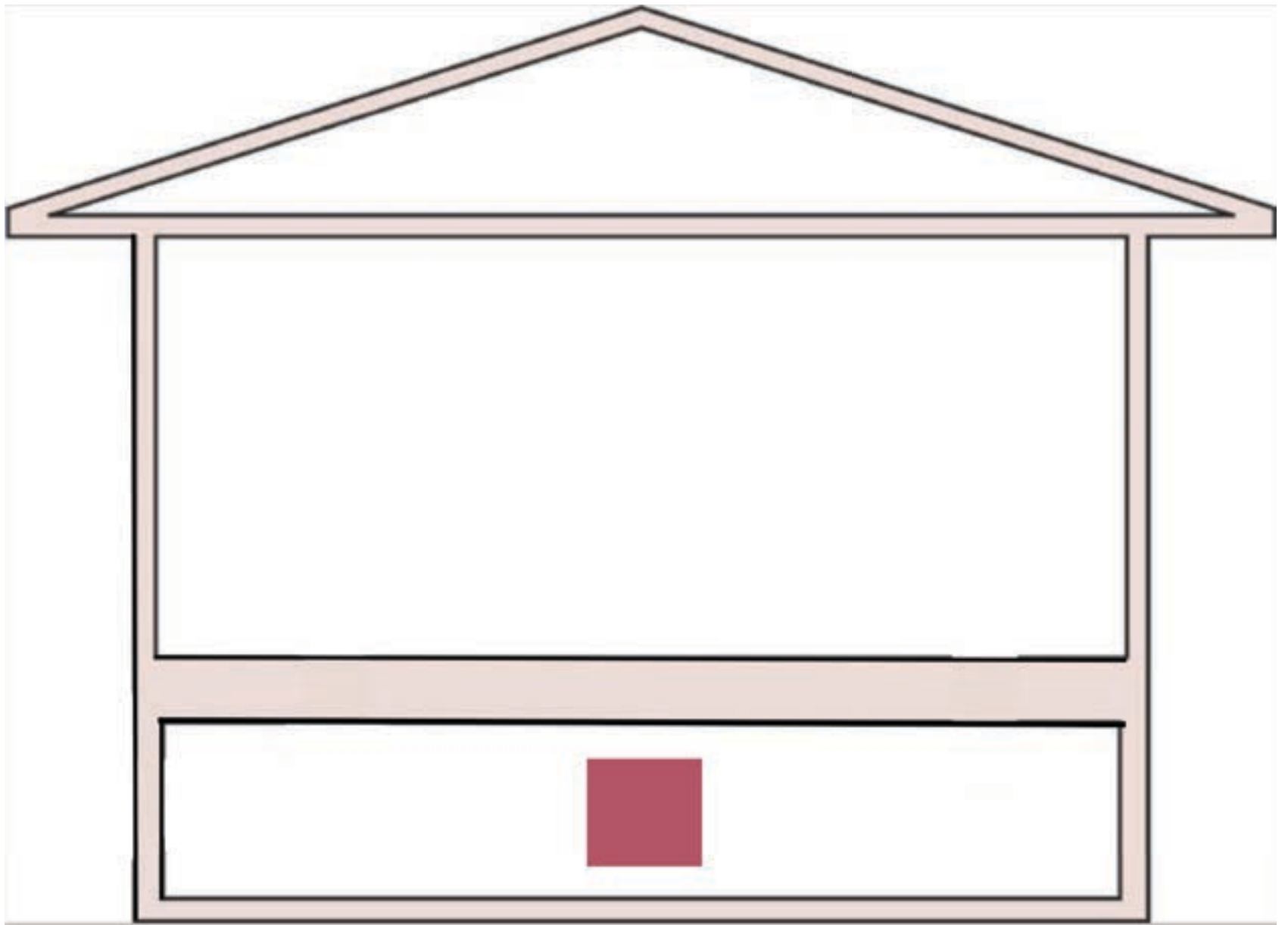


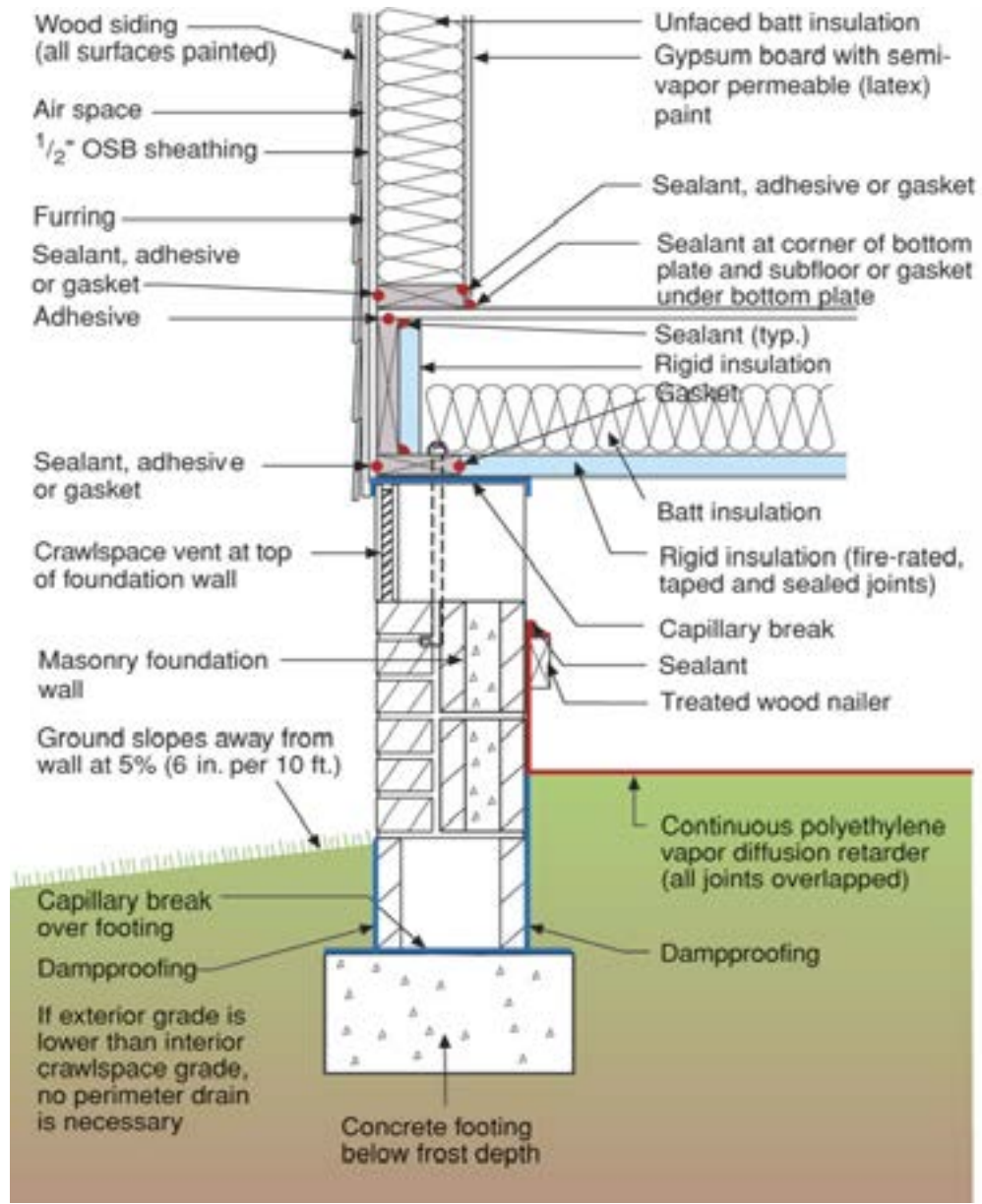


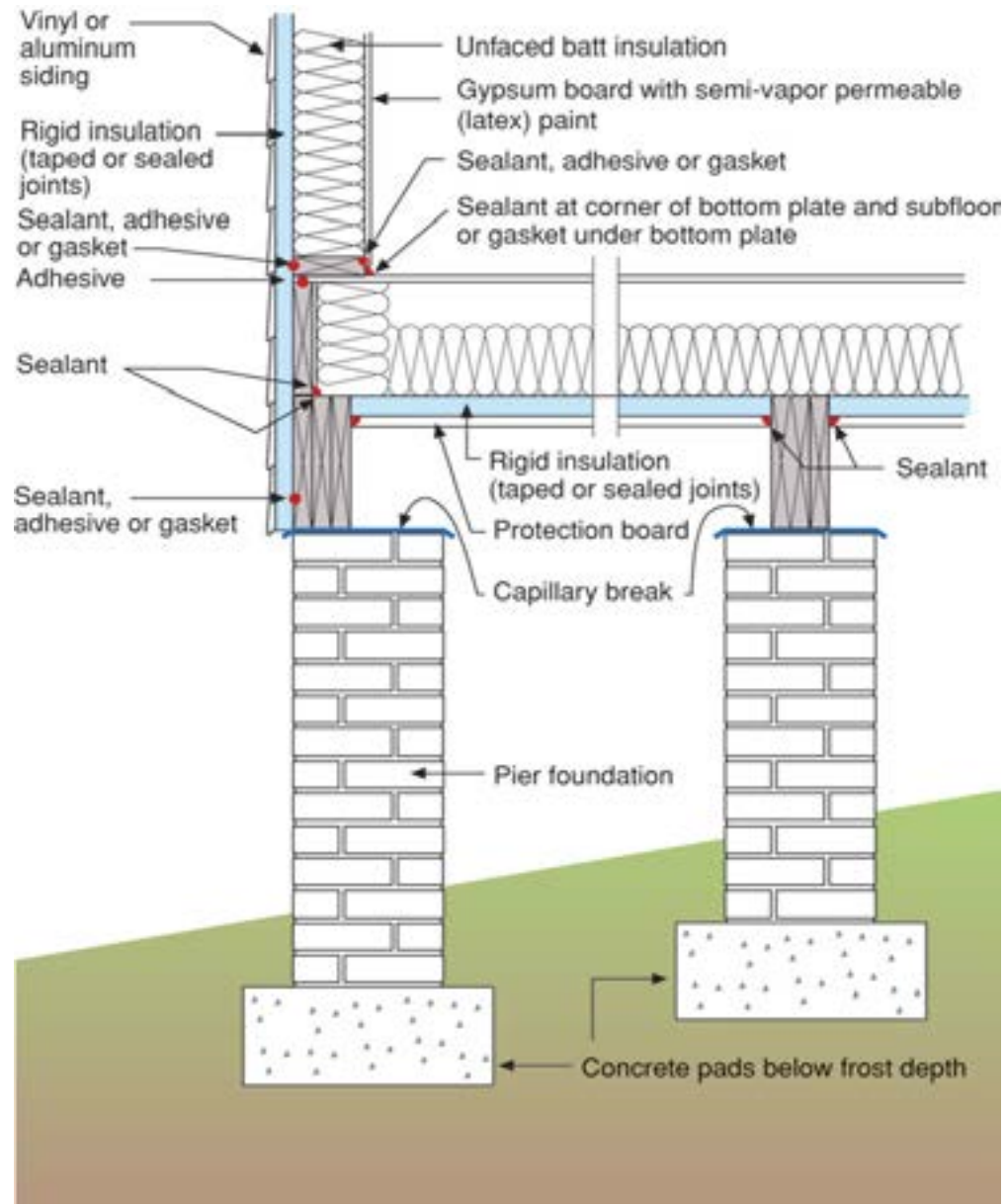


















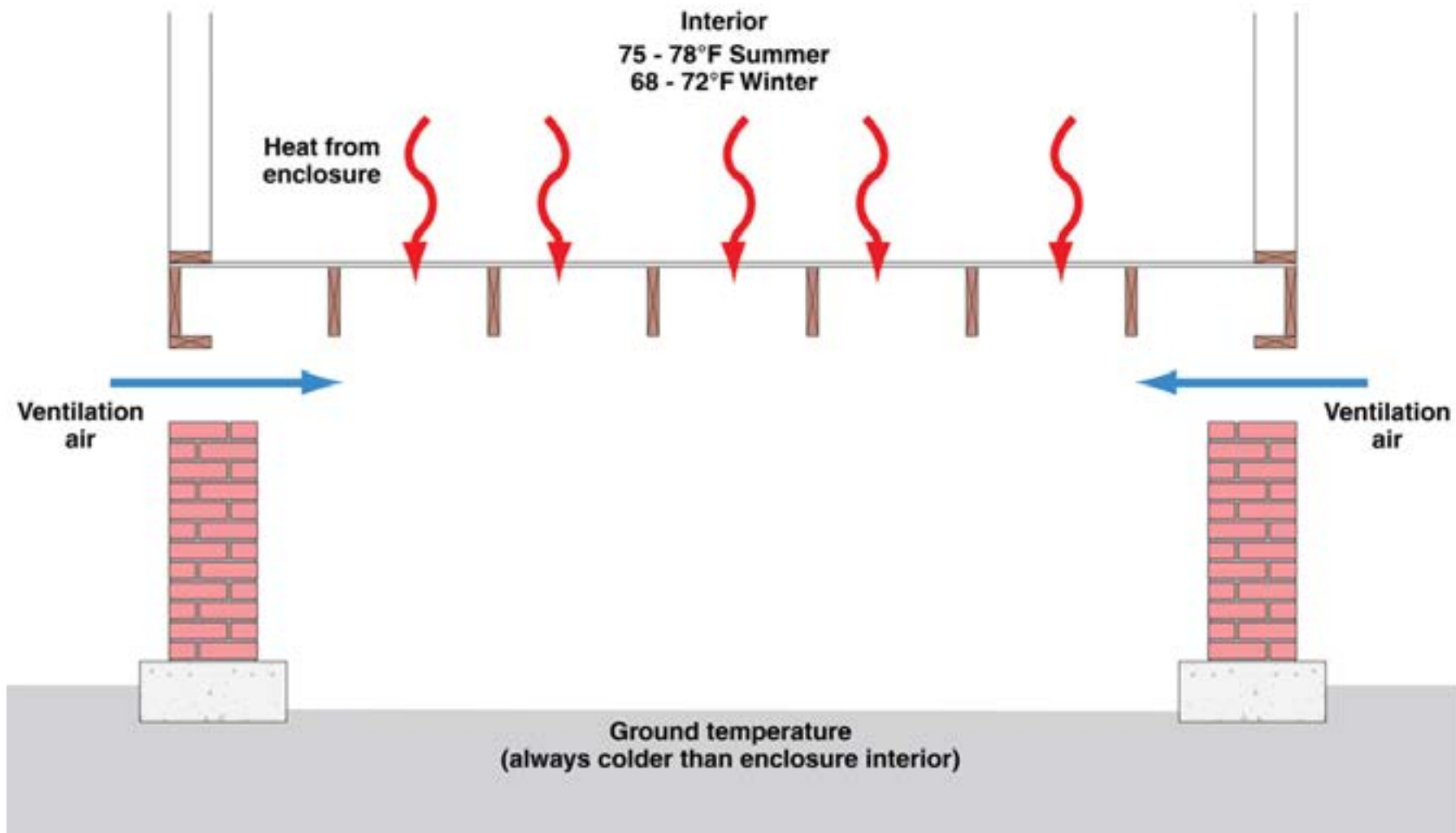


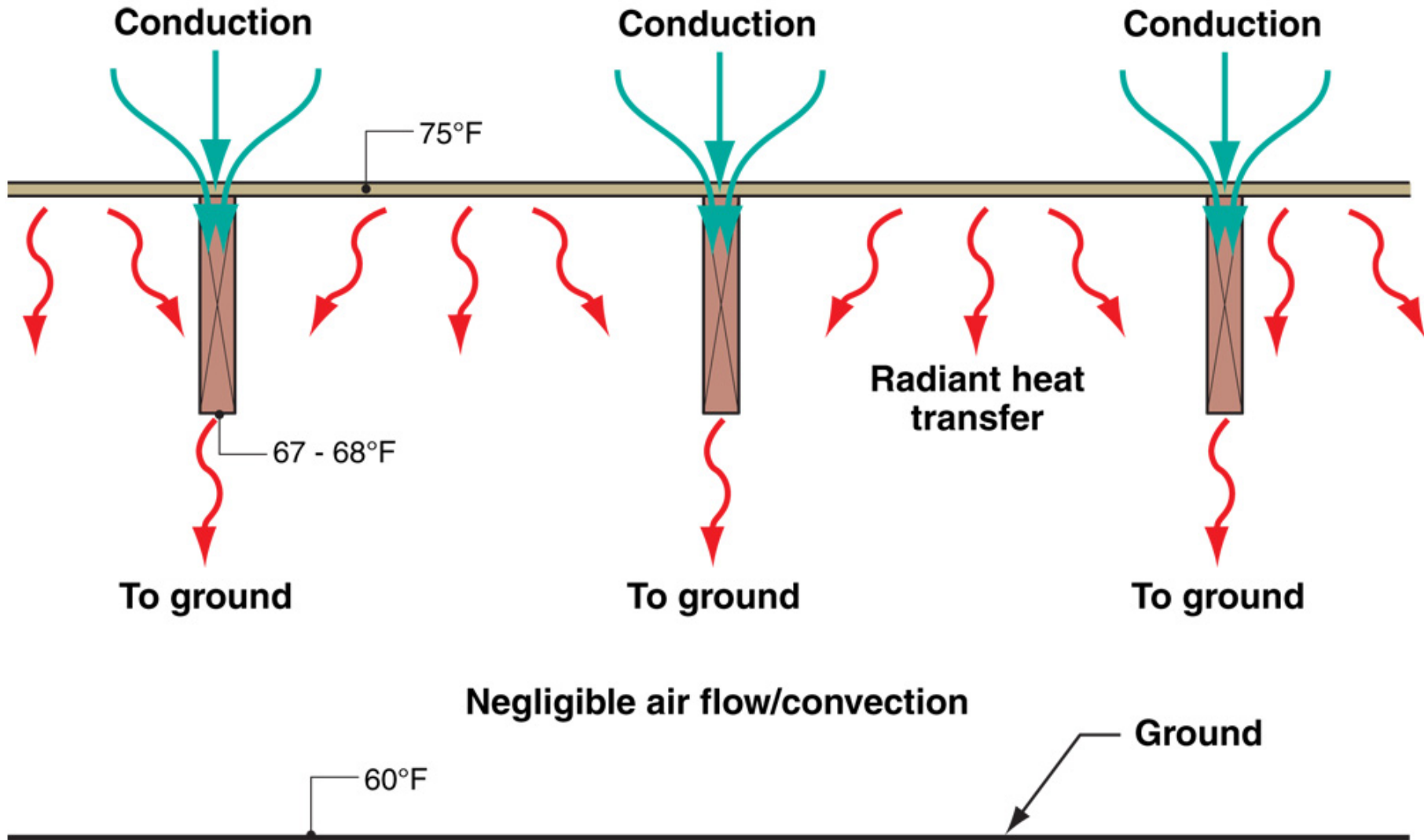


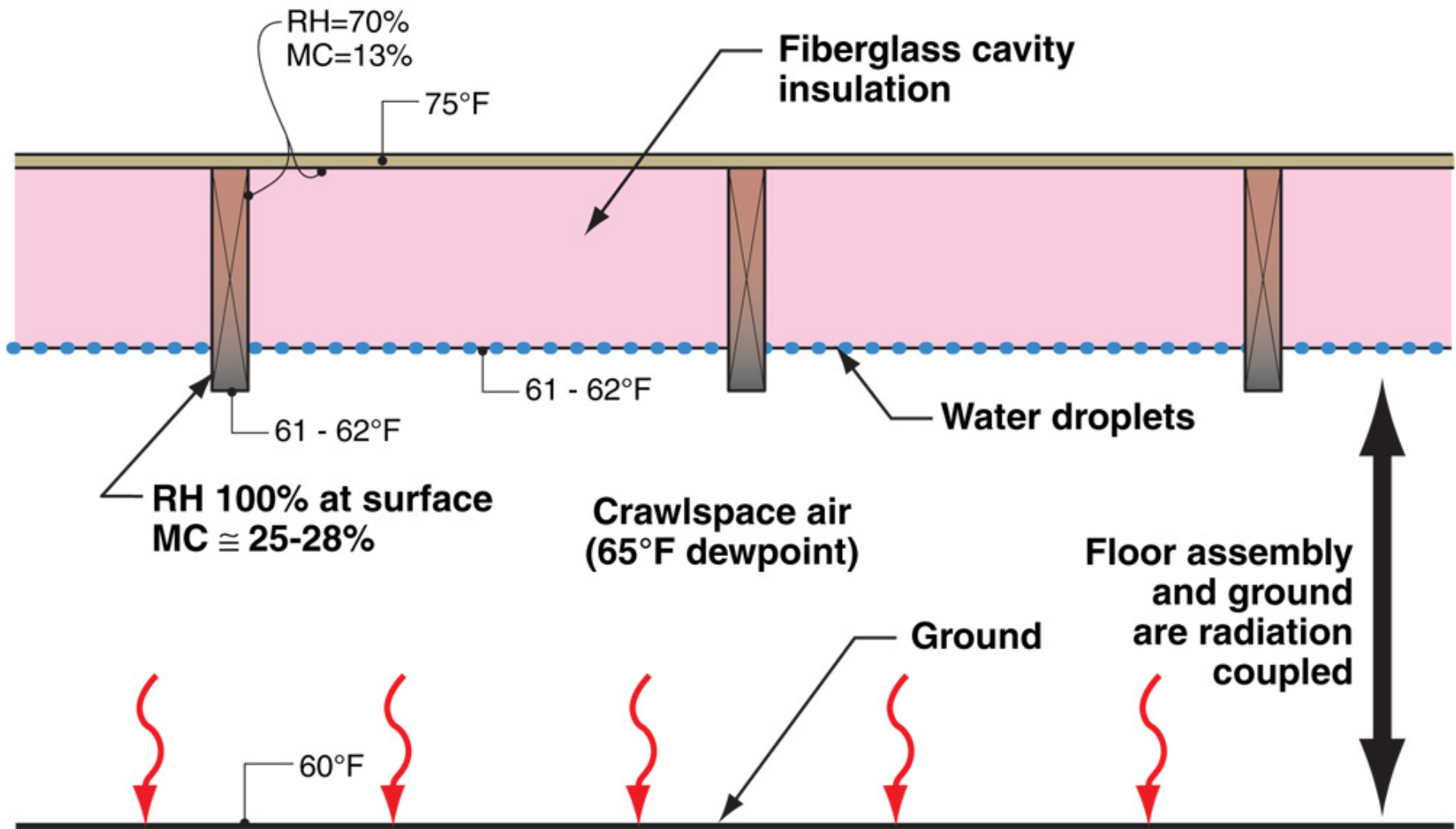


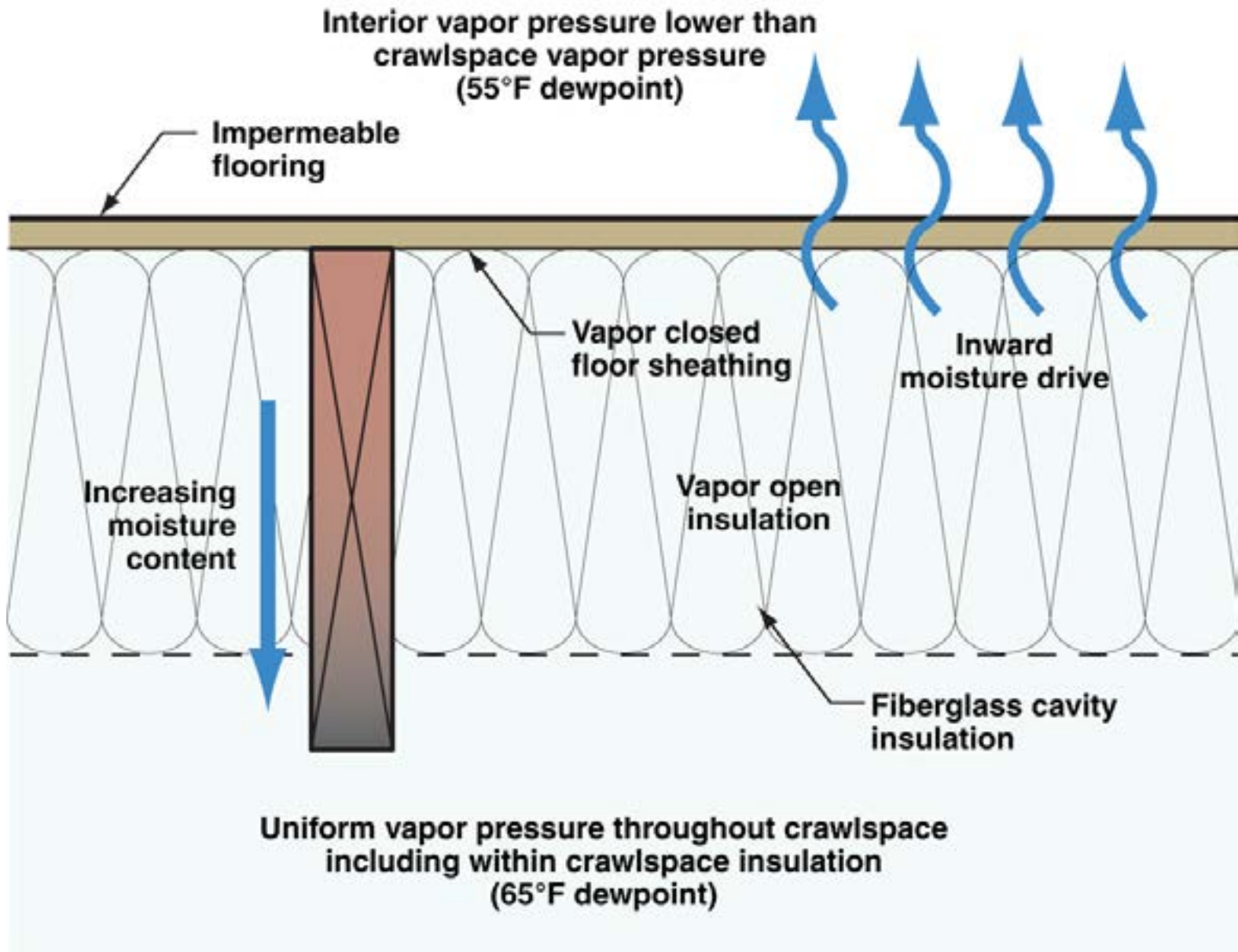


















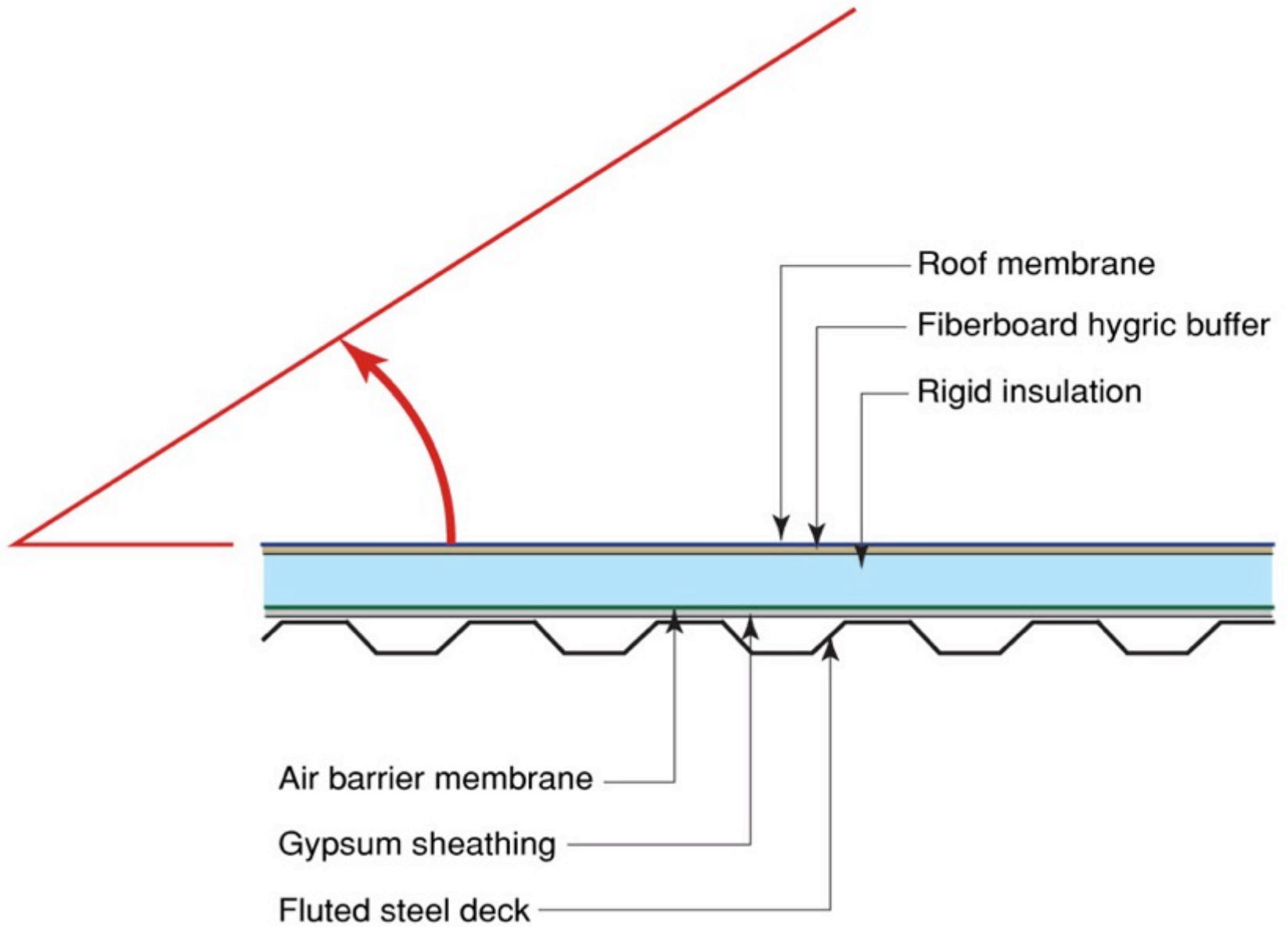
Back to Ducts....



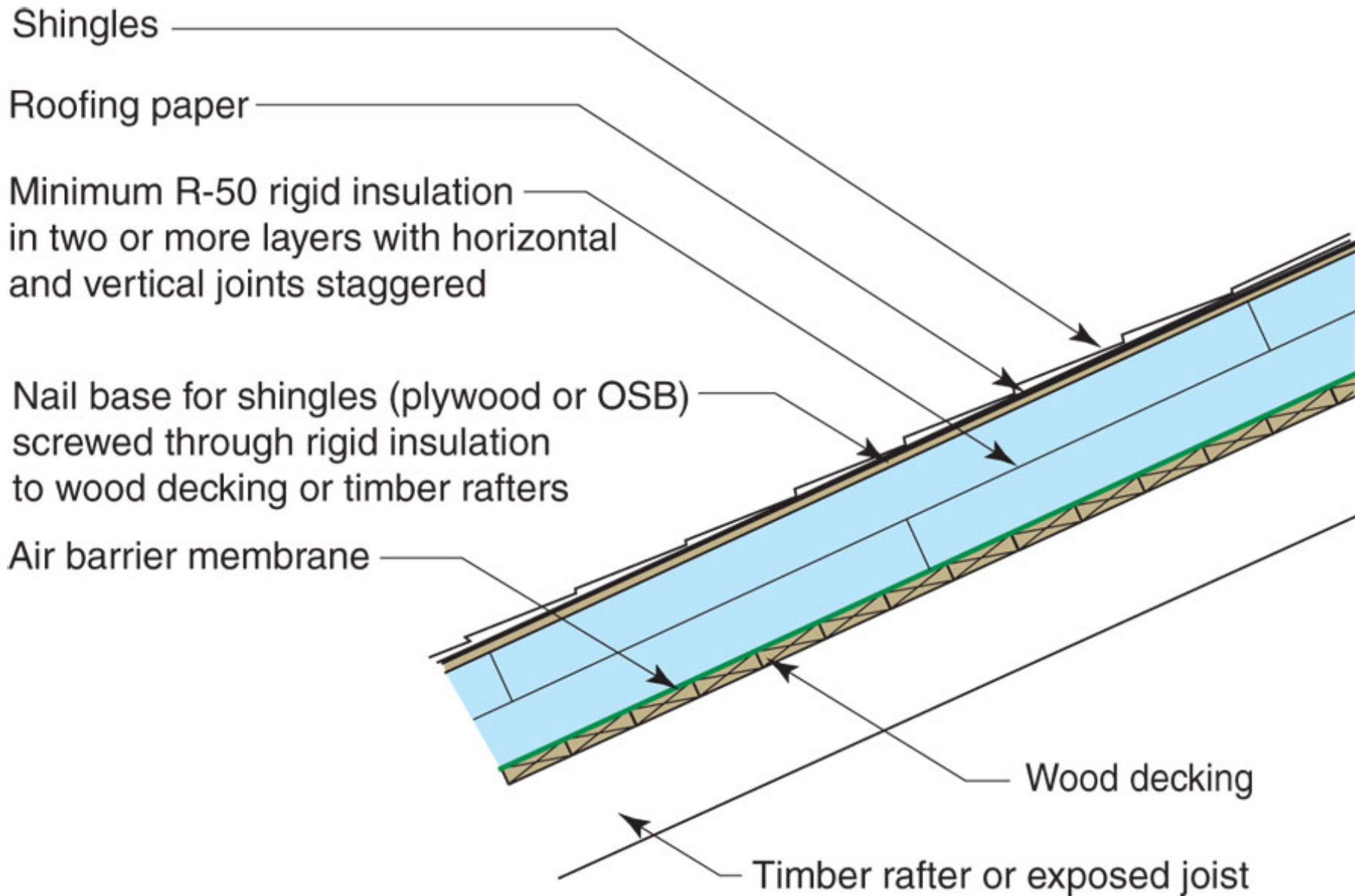


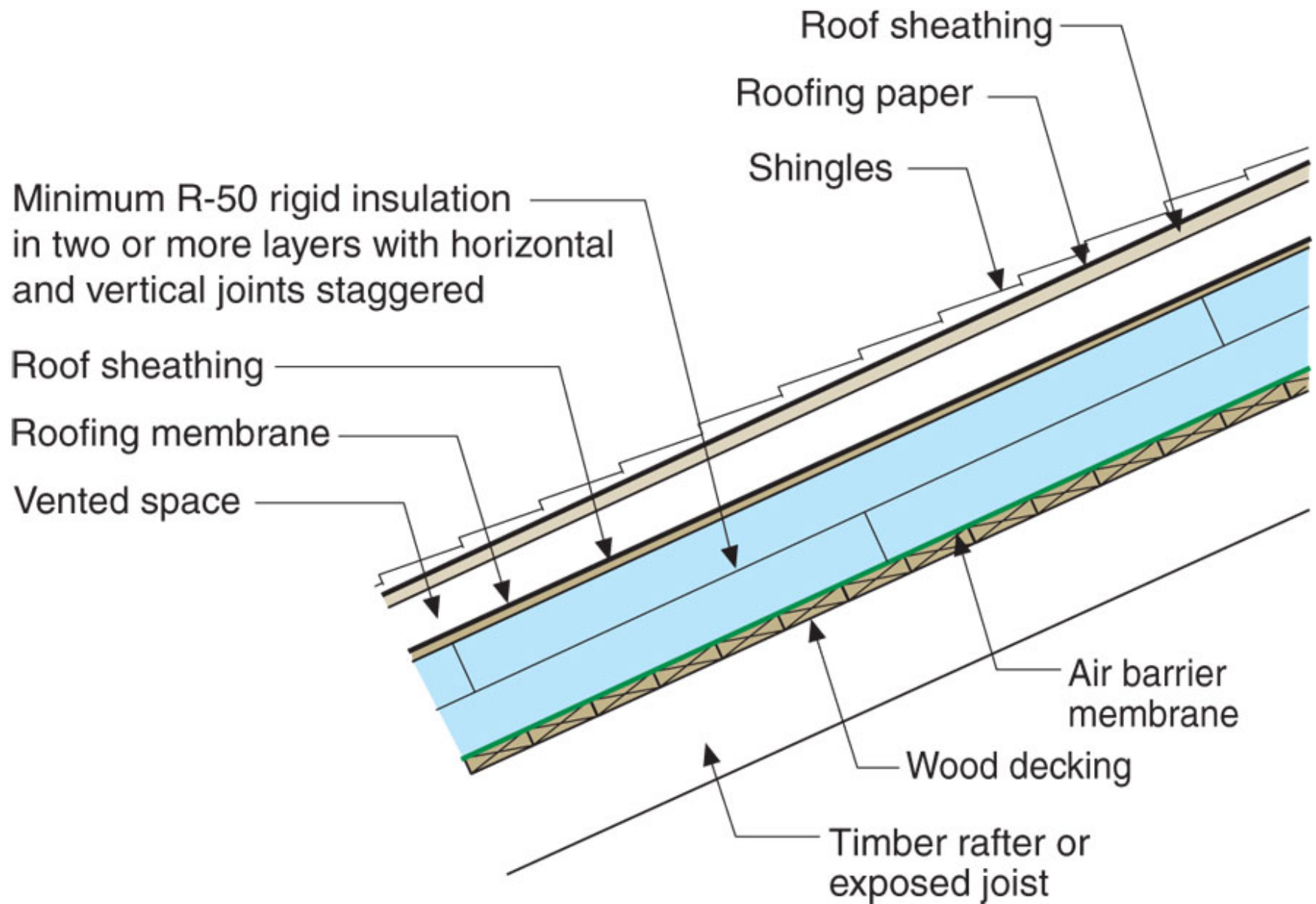


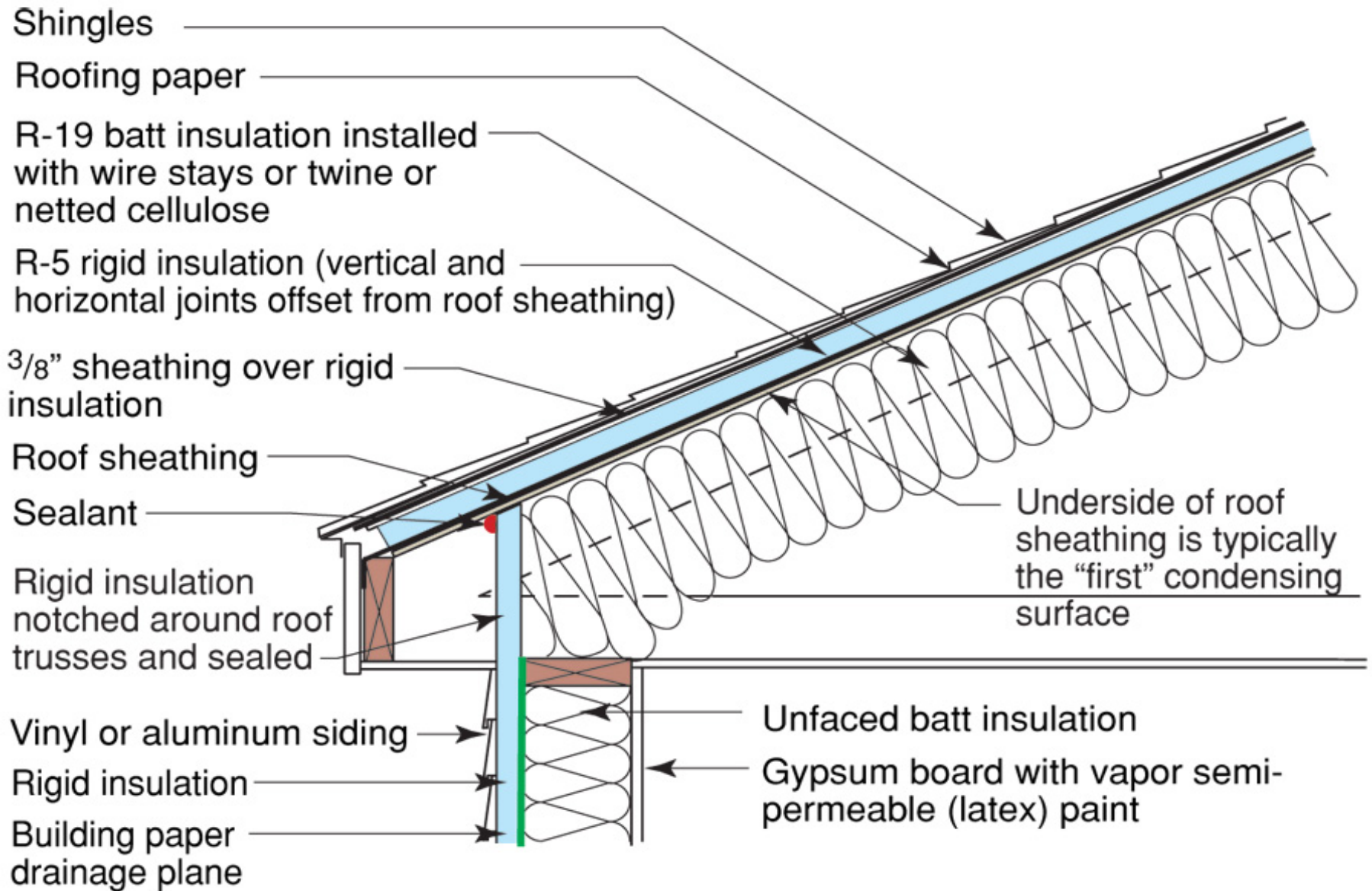
Not Easy To Put Them Inside....

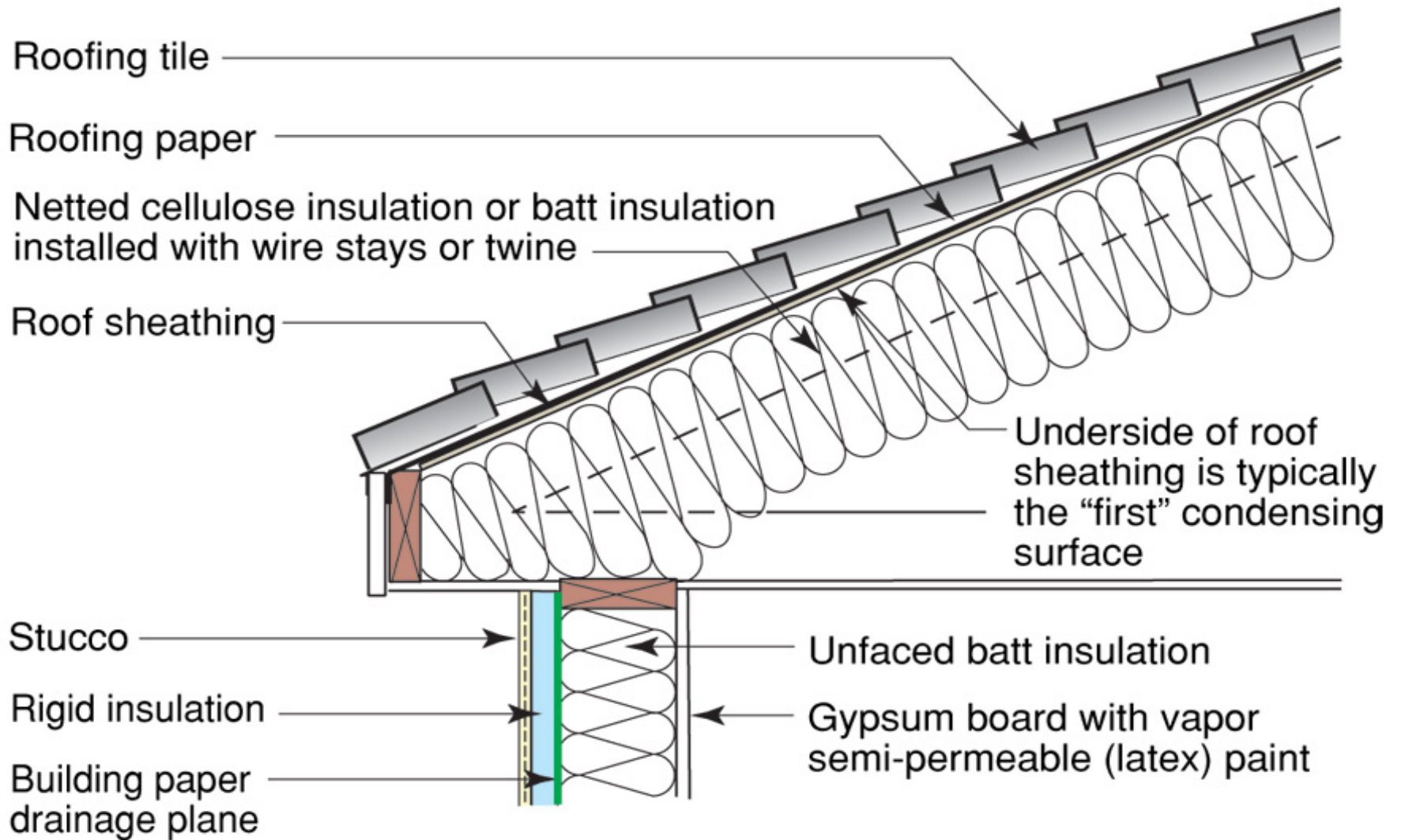








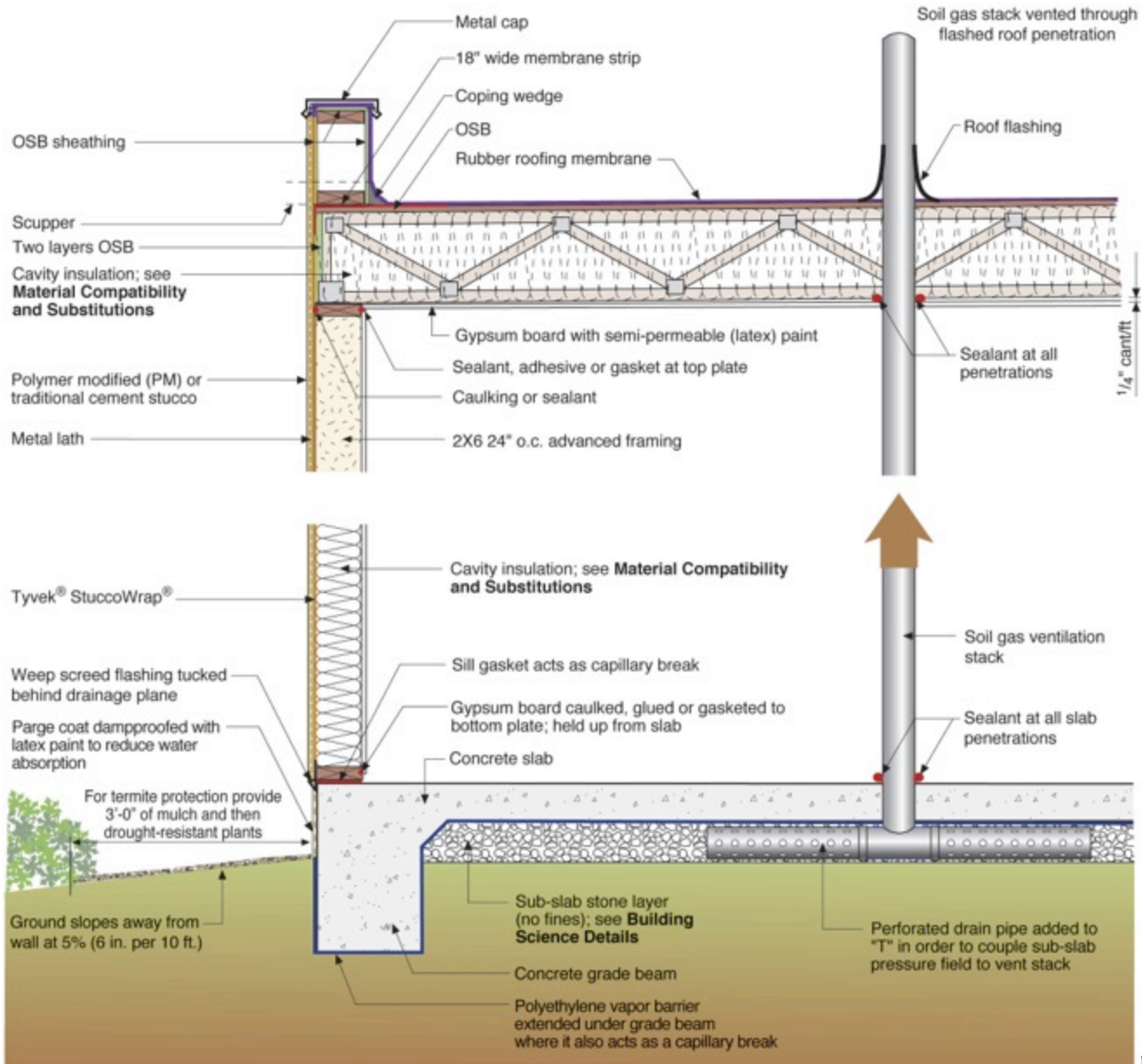




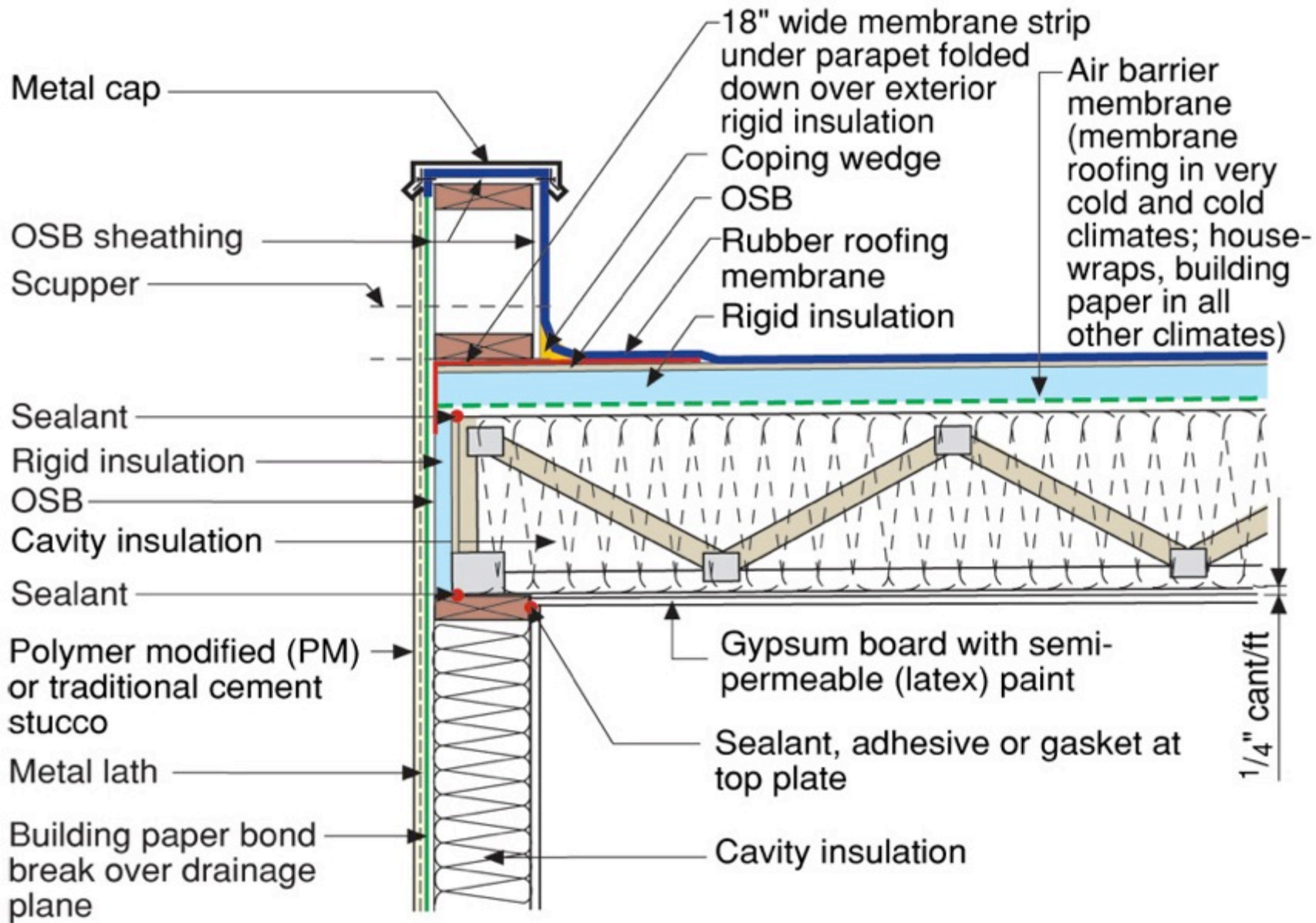


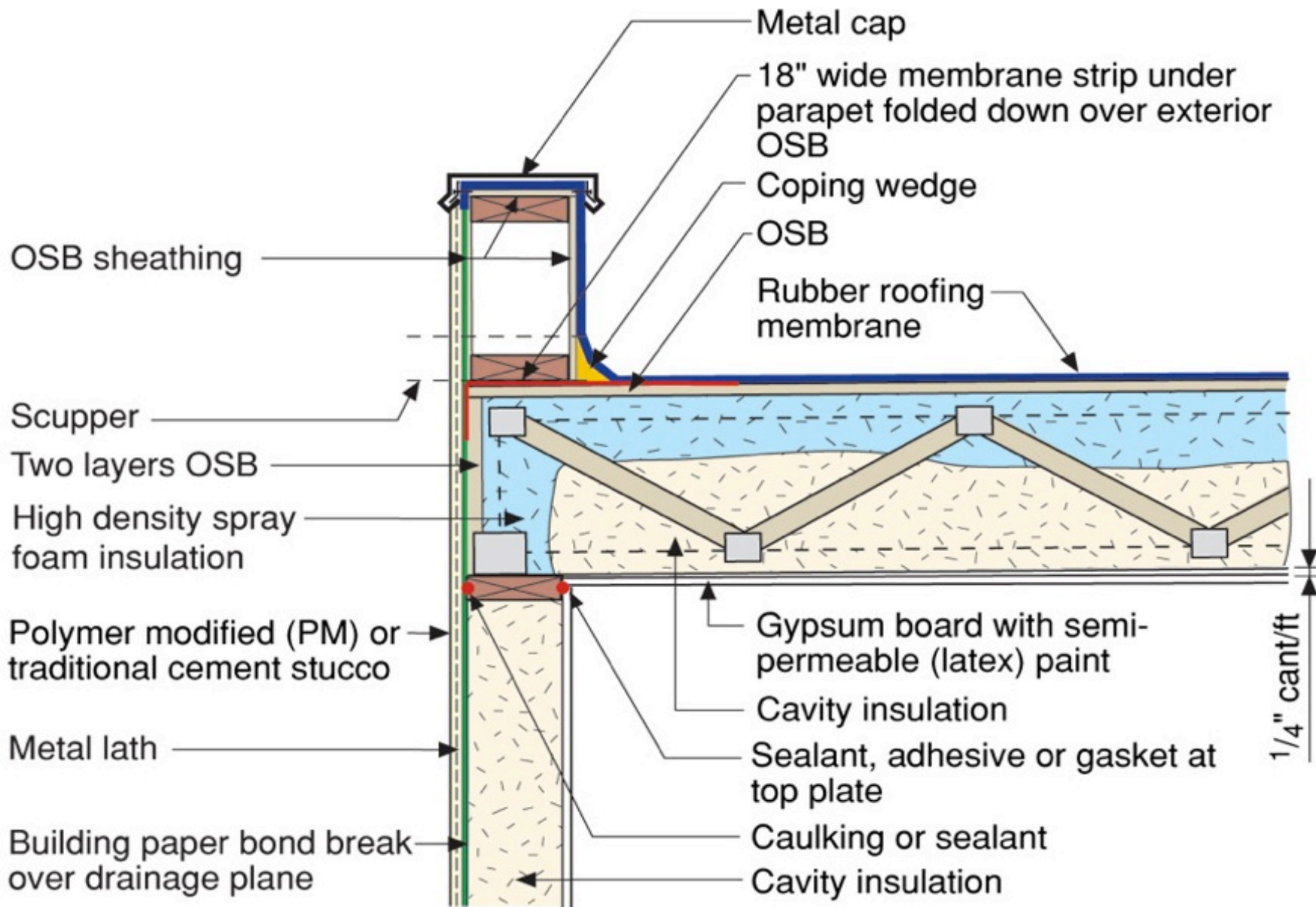


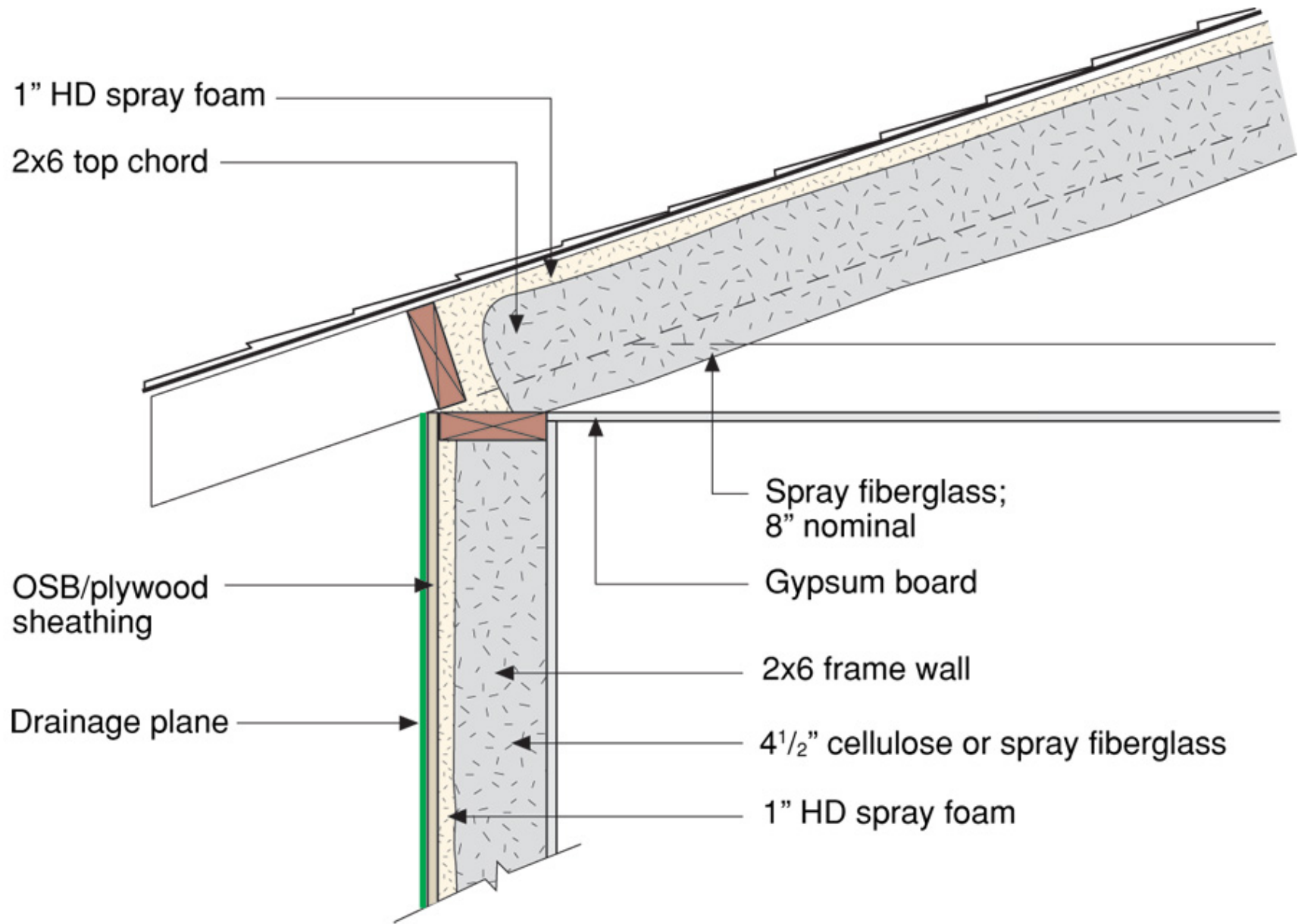


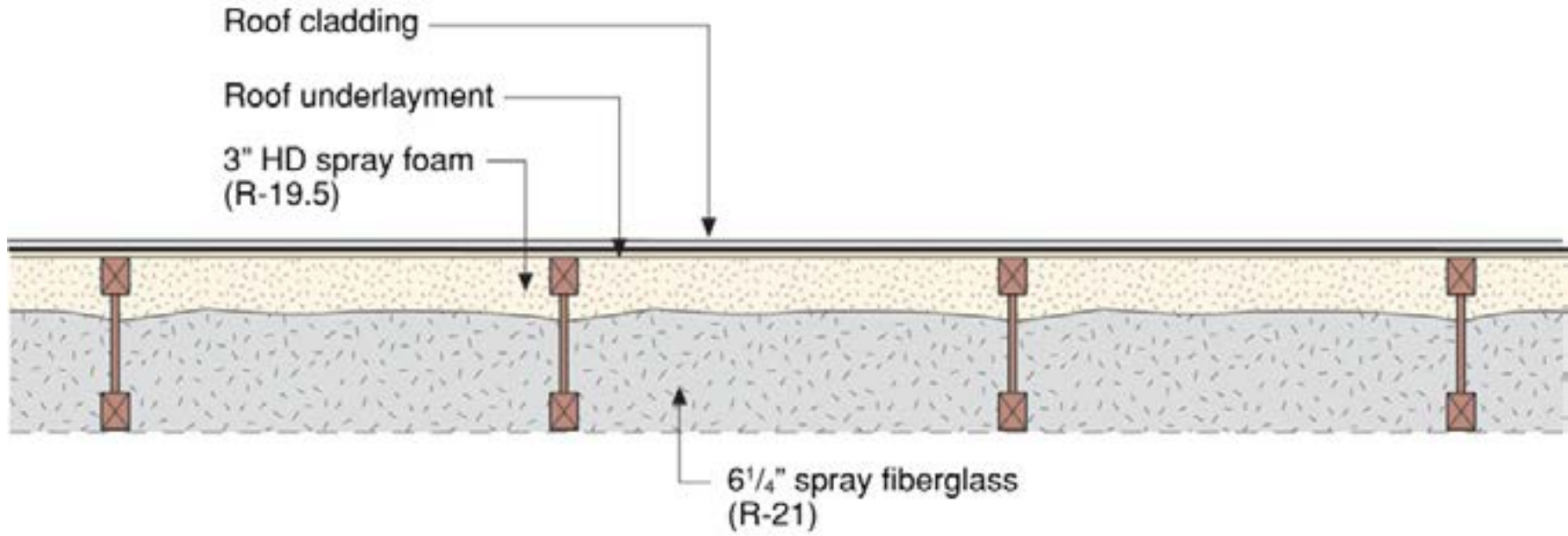


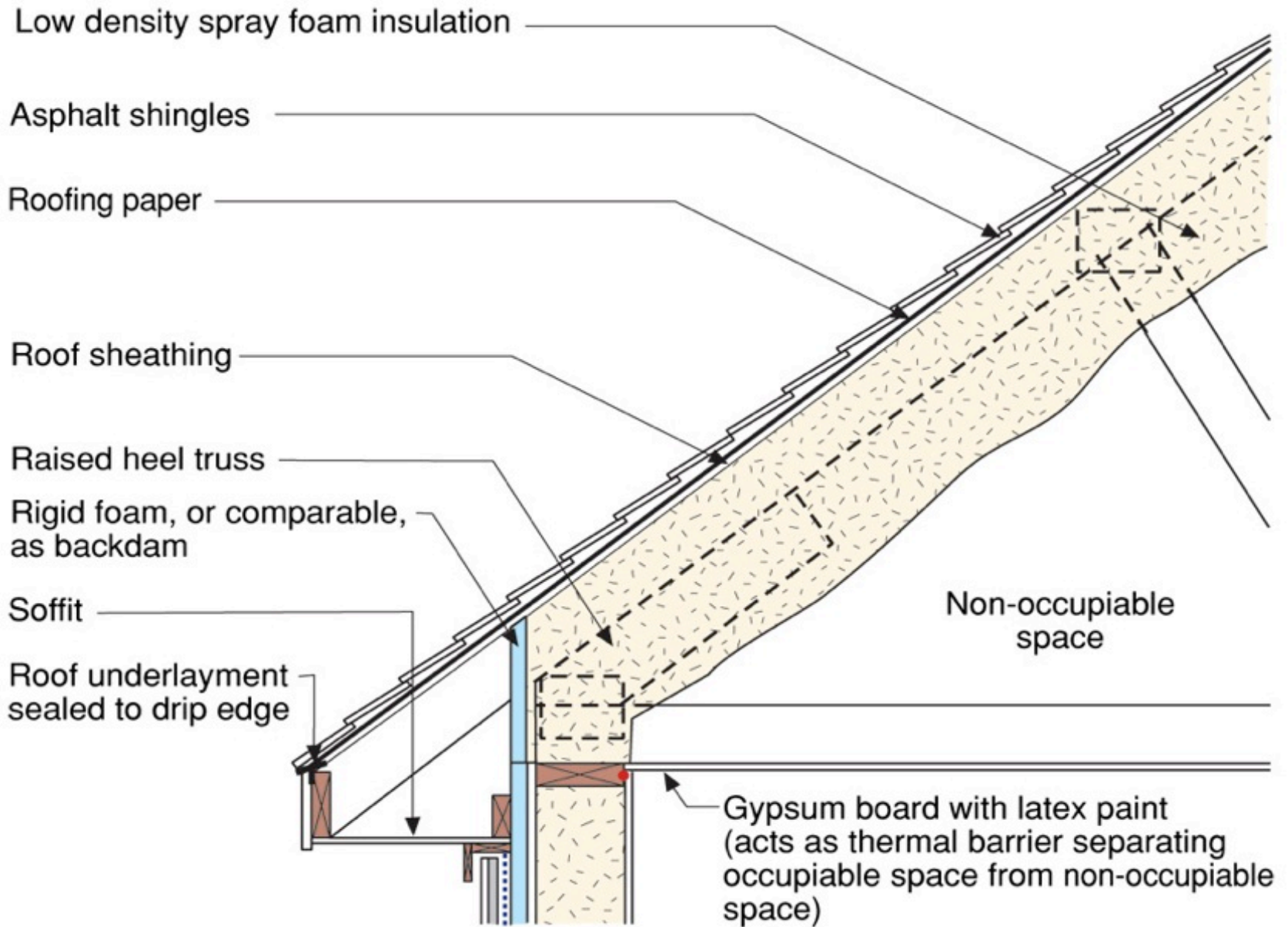














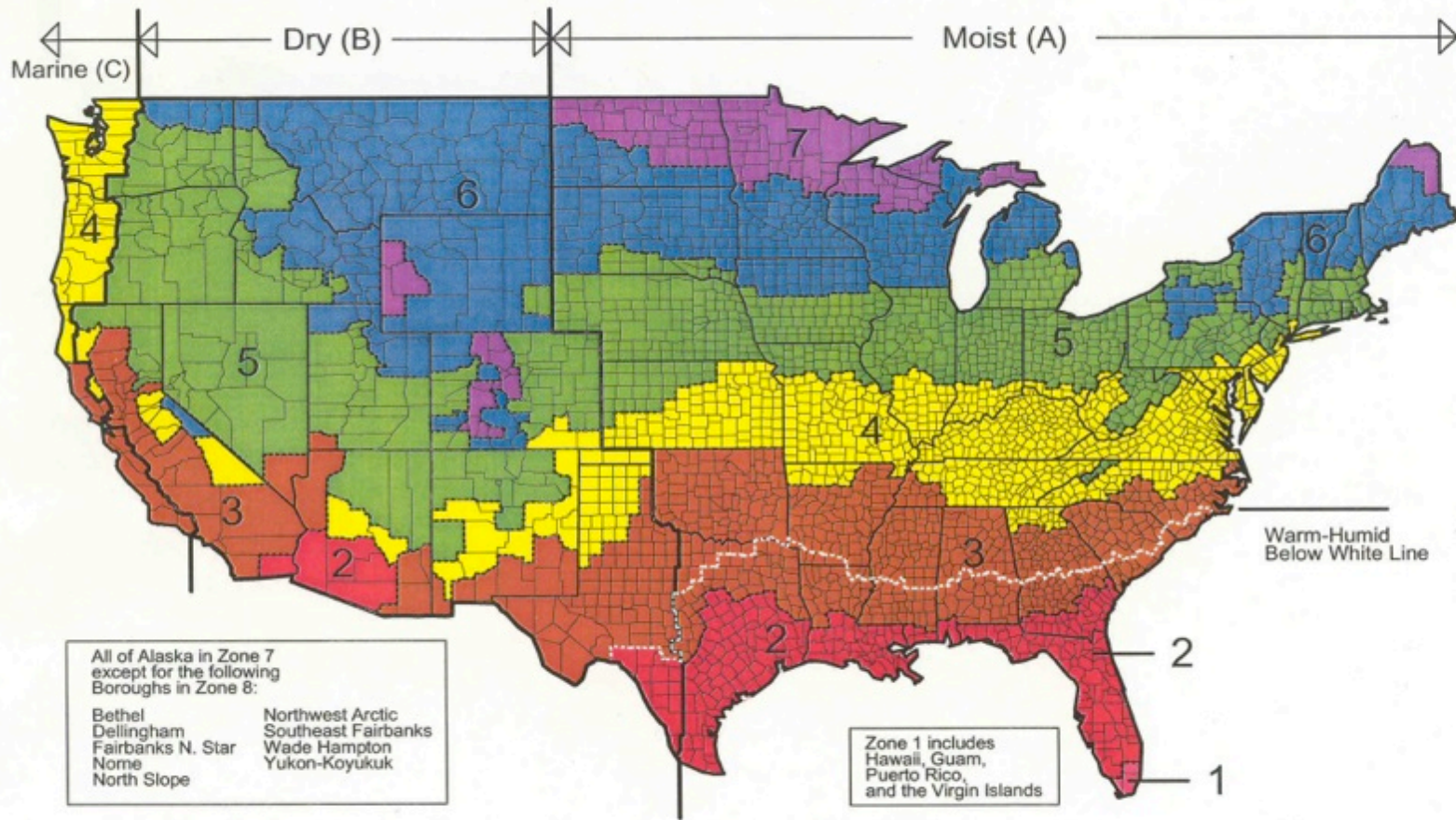






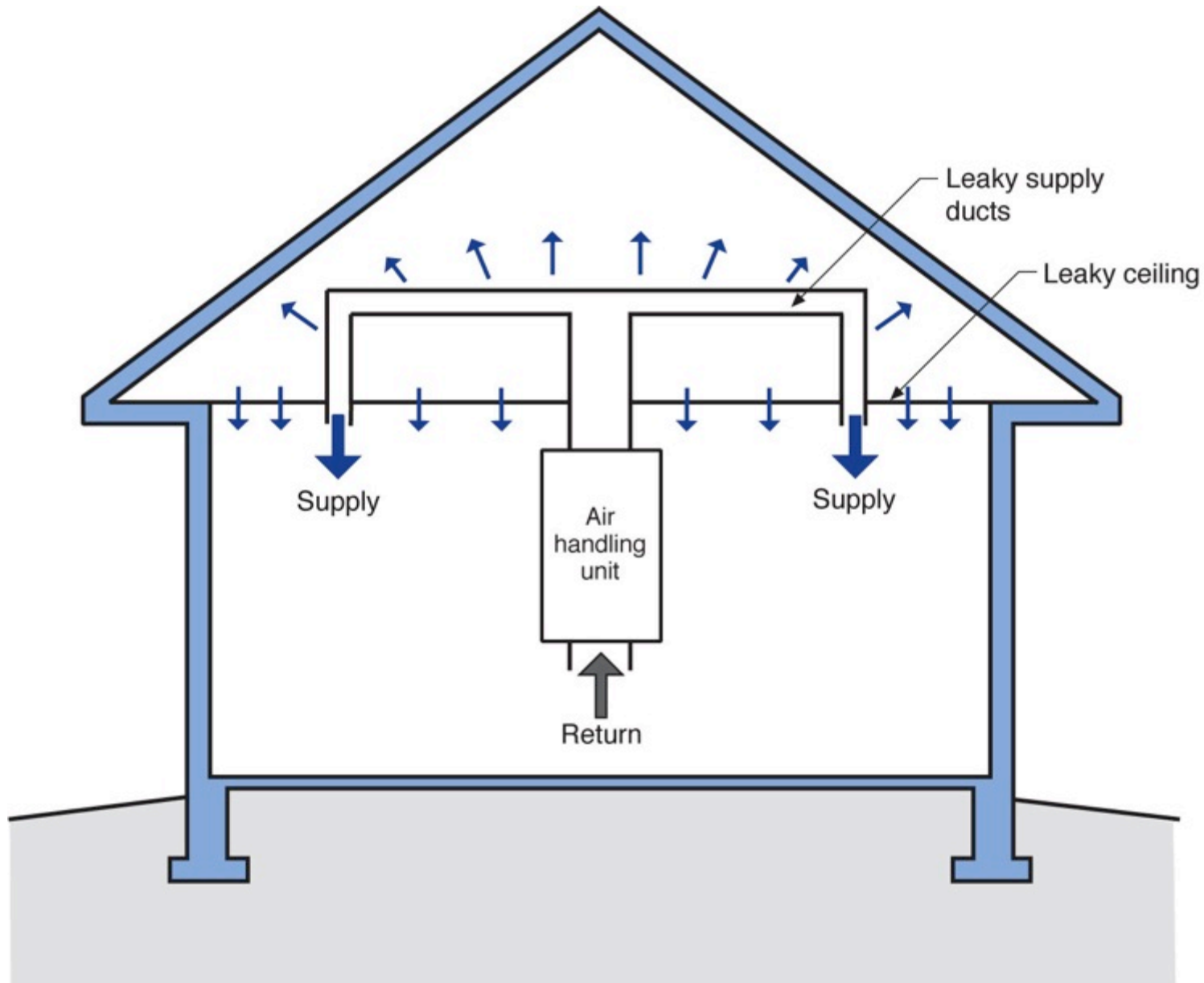


# Map of DOE's Proposed Climate Zones



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 ft<sup>2</sup> of Attic

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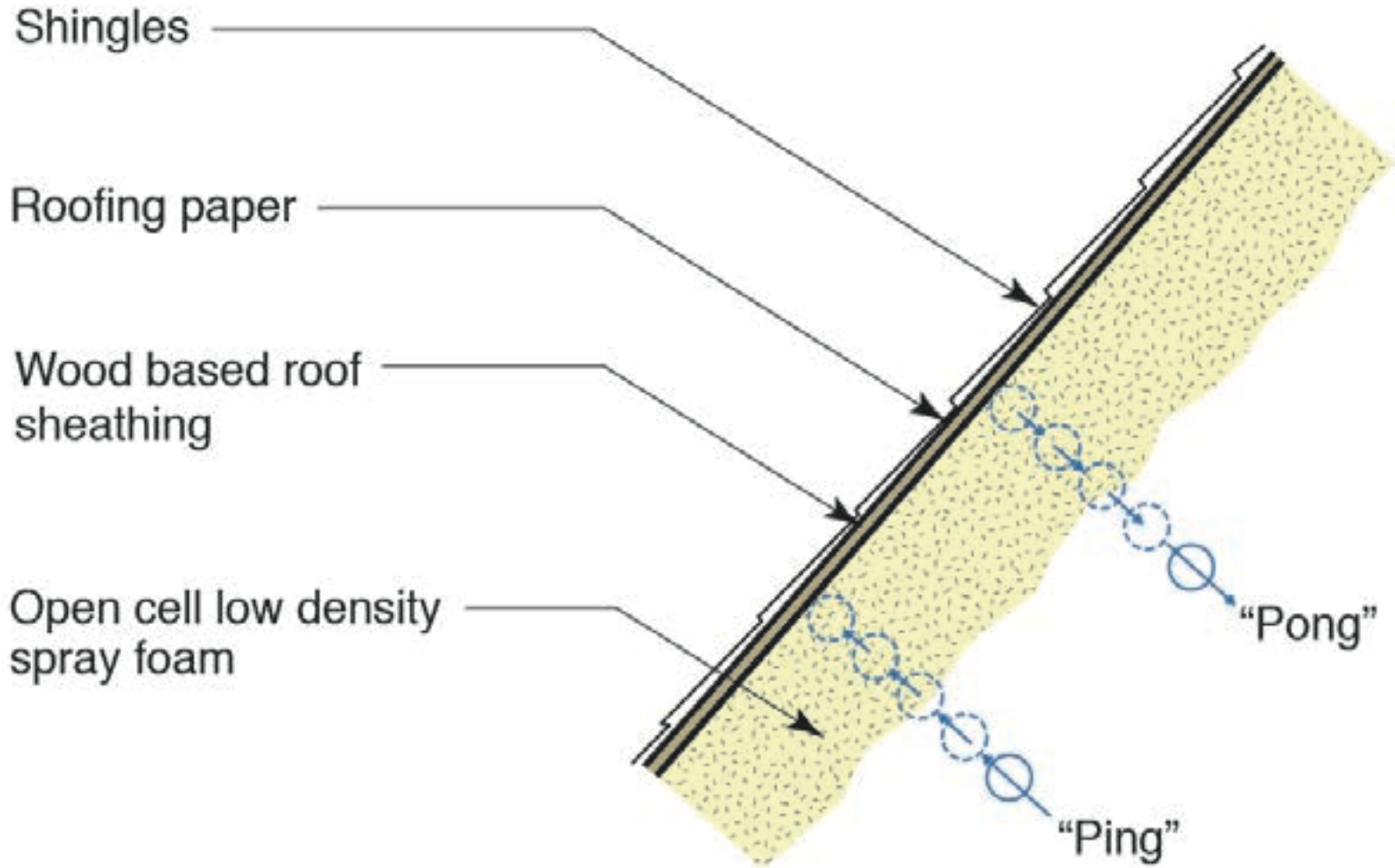
Or  
Dehumidification

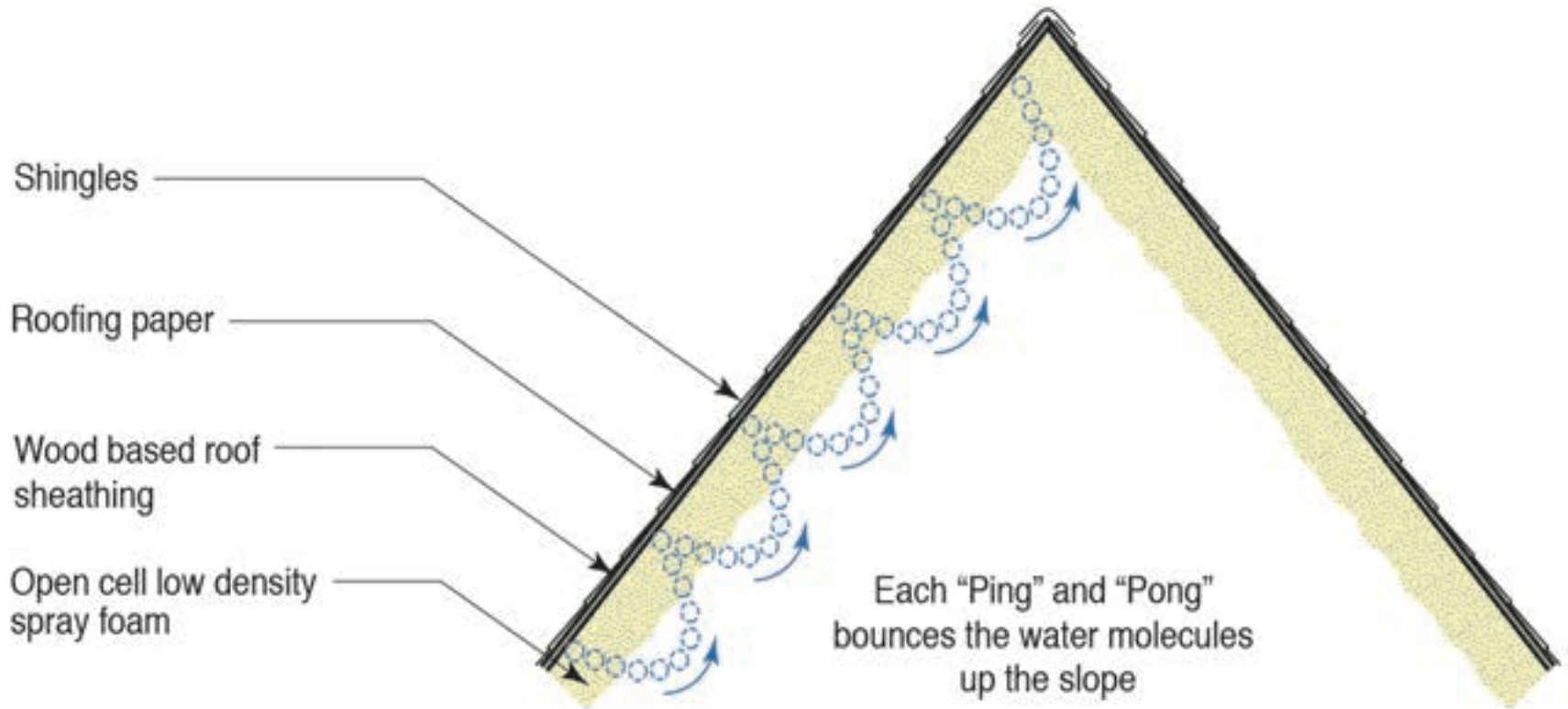


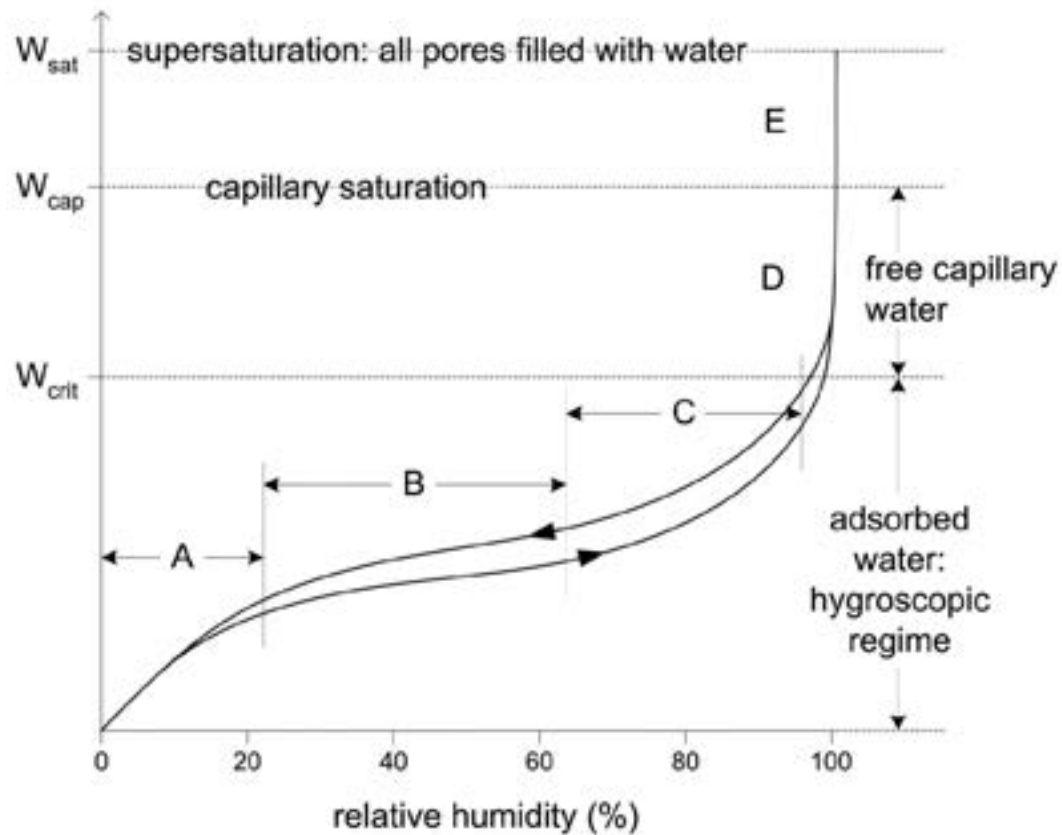
# Low-Density Open-Cell Foam Is The Problem











- A: Single-layer of adsorbed molecules
- B: Multiple layers of adsorbed molecules
- C: Interconnected layers (internal capillary condensation)
- D: Free water in Pores, capillary suction
- E: Supersaturated Regime

Regimes of moisture storage in a hygroscopic porous material  
 From Straube & Burnett, 2005

# SIP Failures



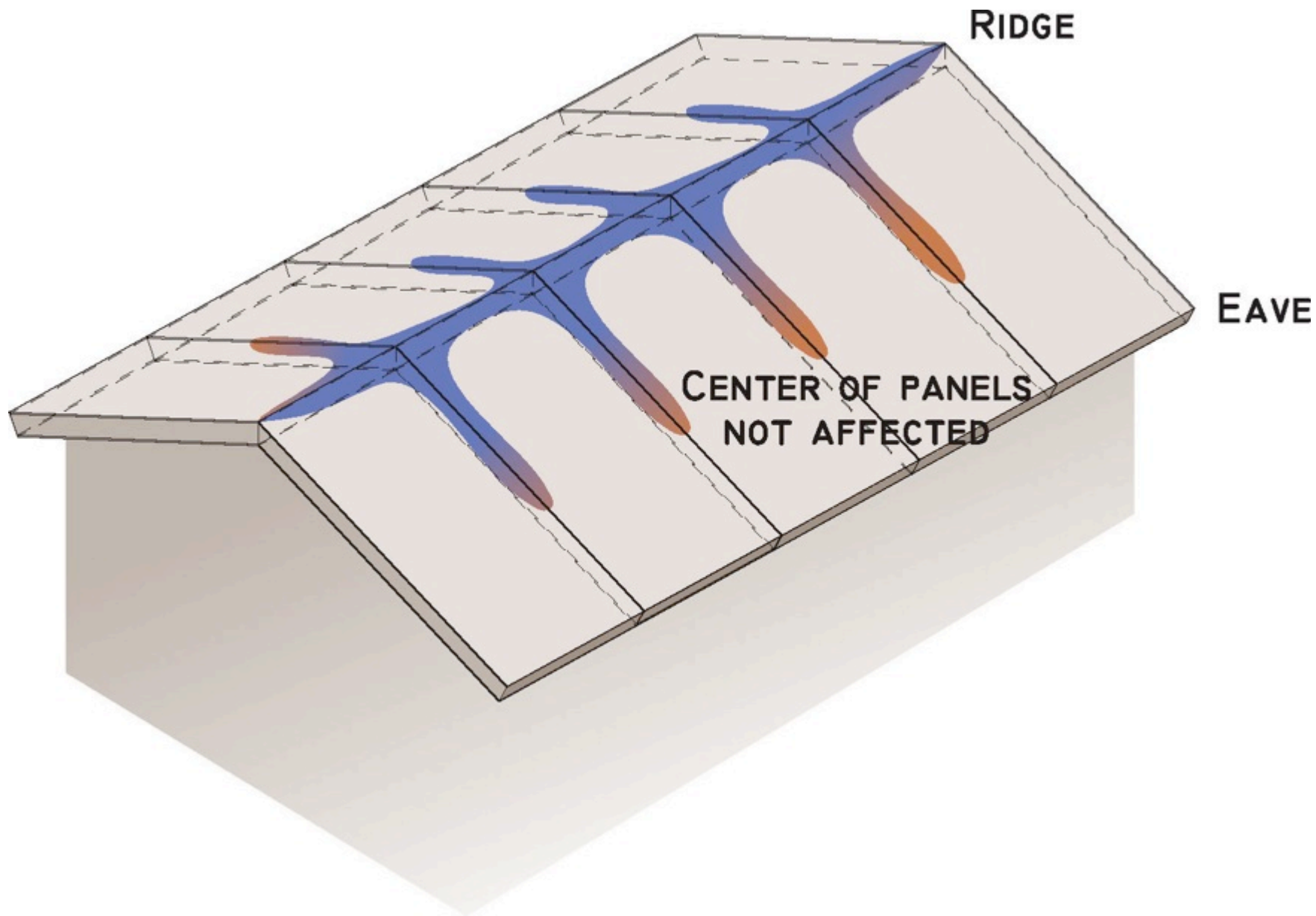
















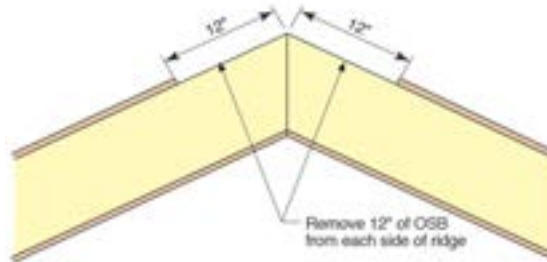






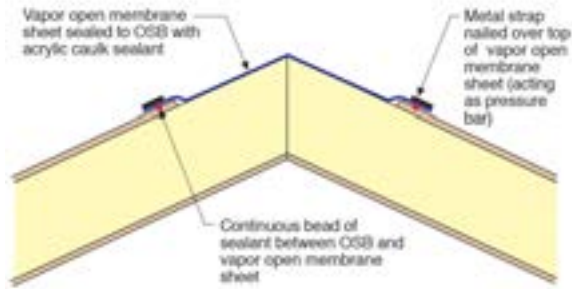
**Step 1**

- Remove strip of OSB from each side of ridge



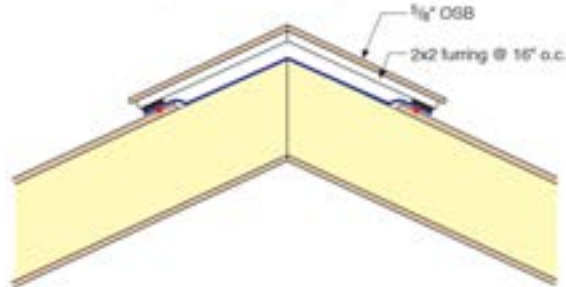
**Step 2**

- 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





















An Oops....That Became A Gift....







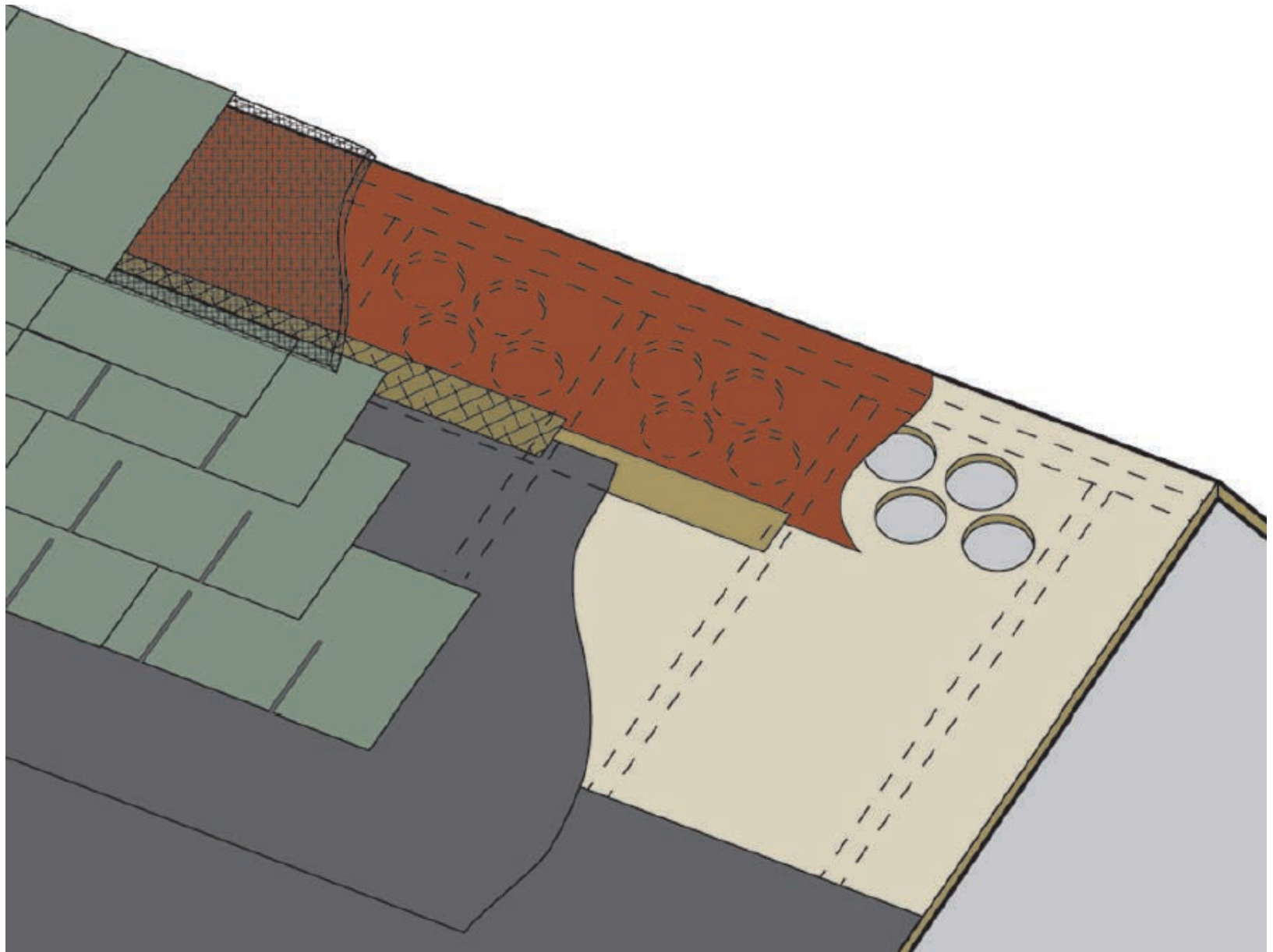
# Failures Lead To Success

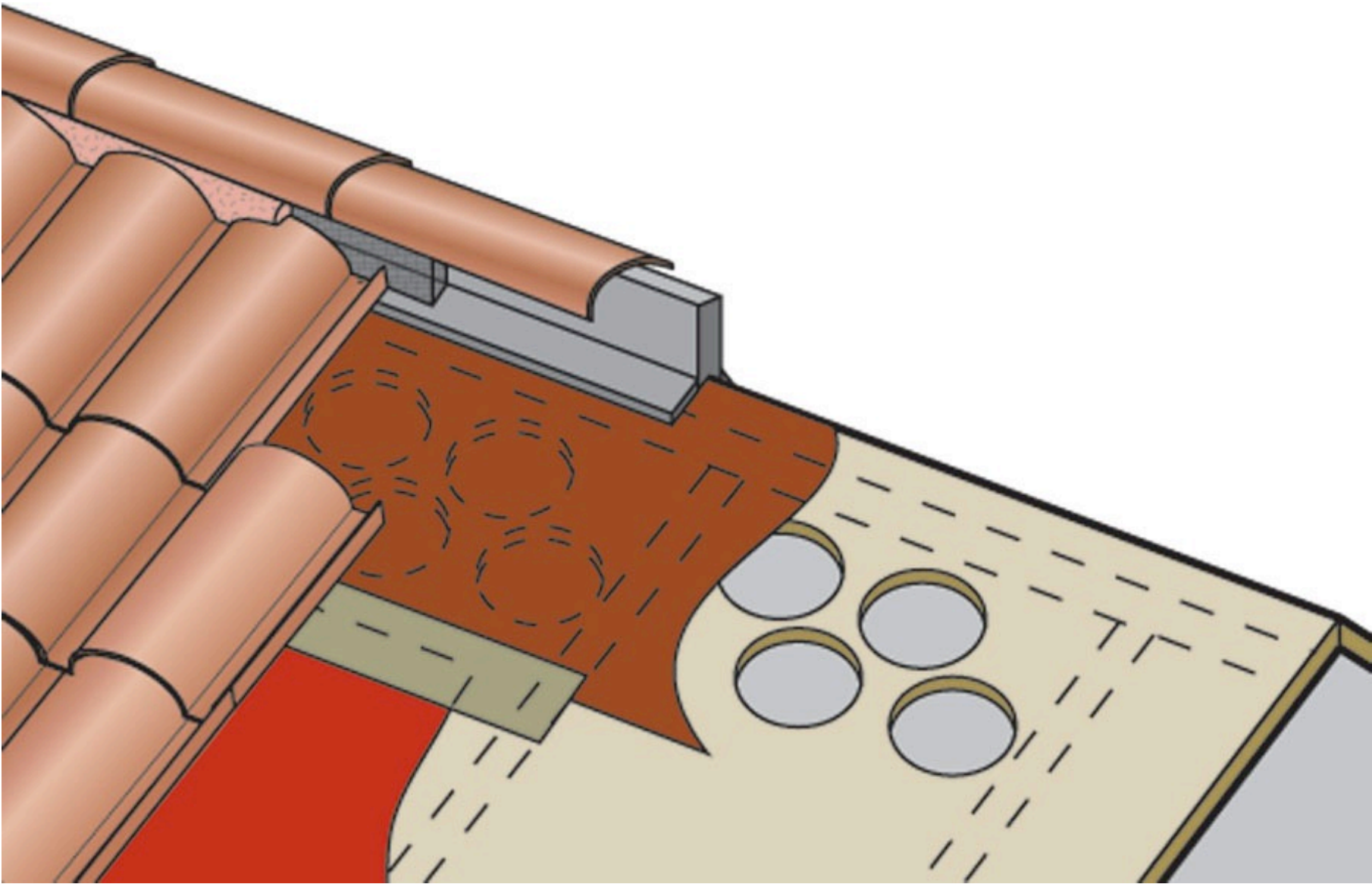


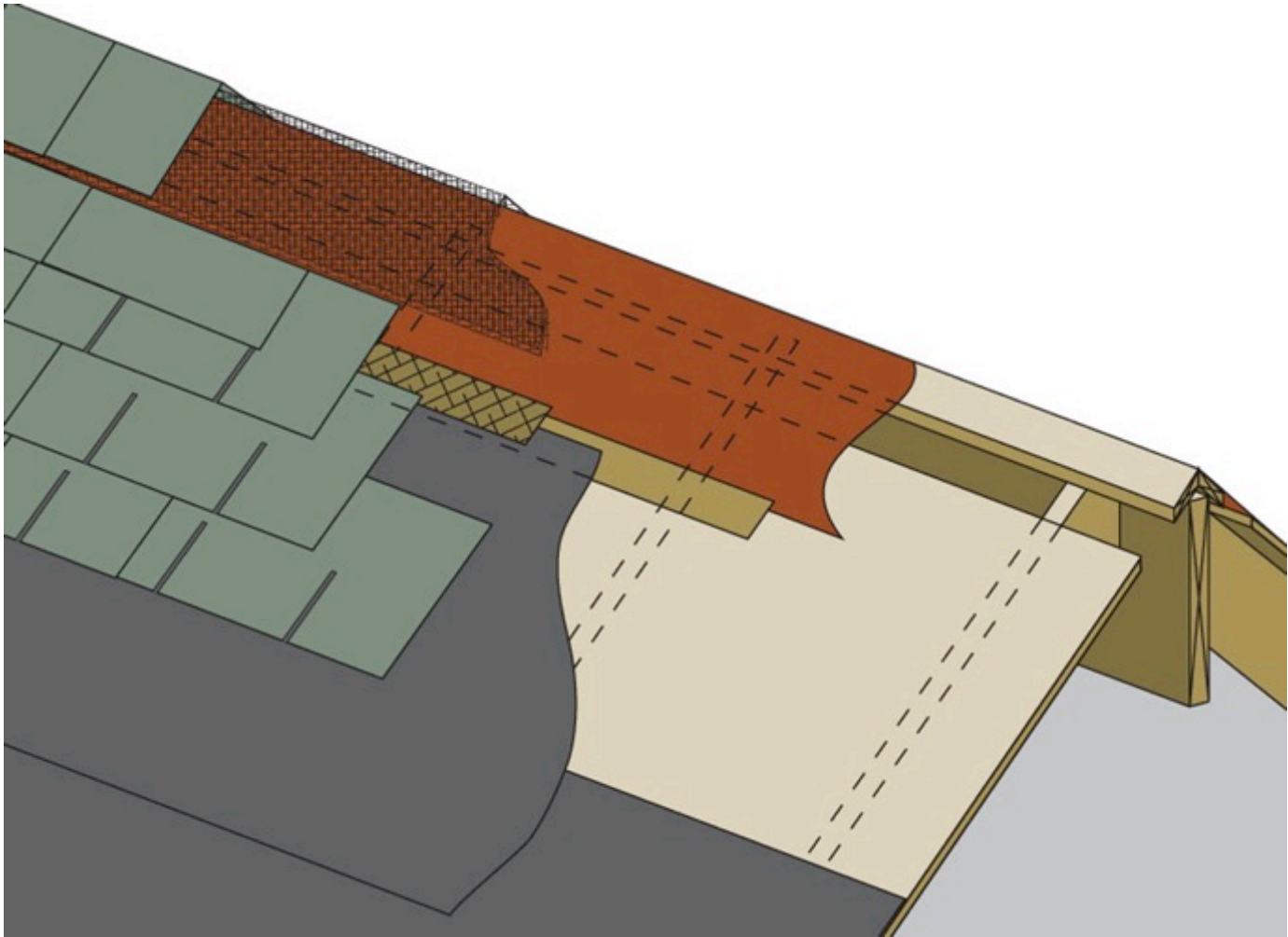


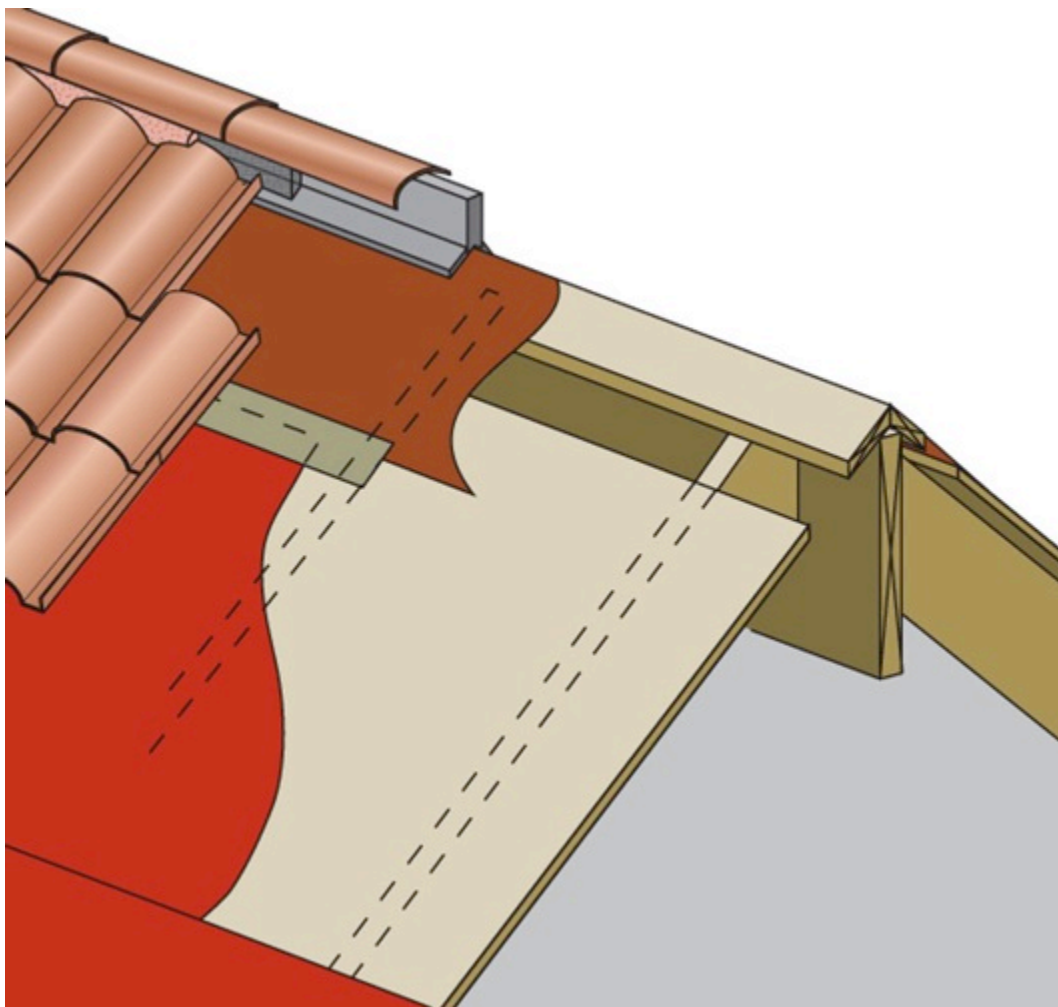


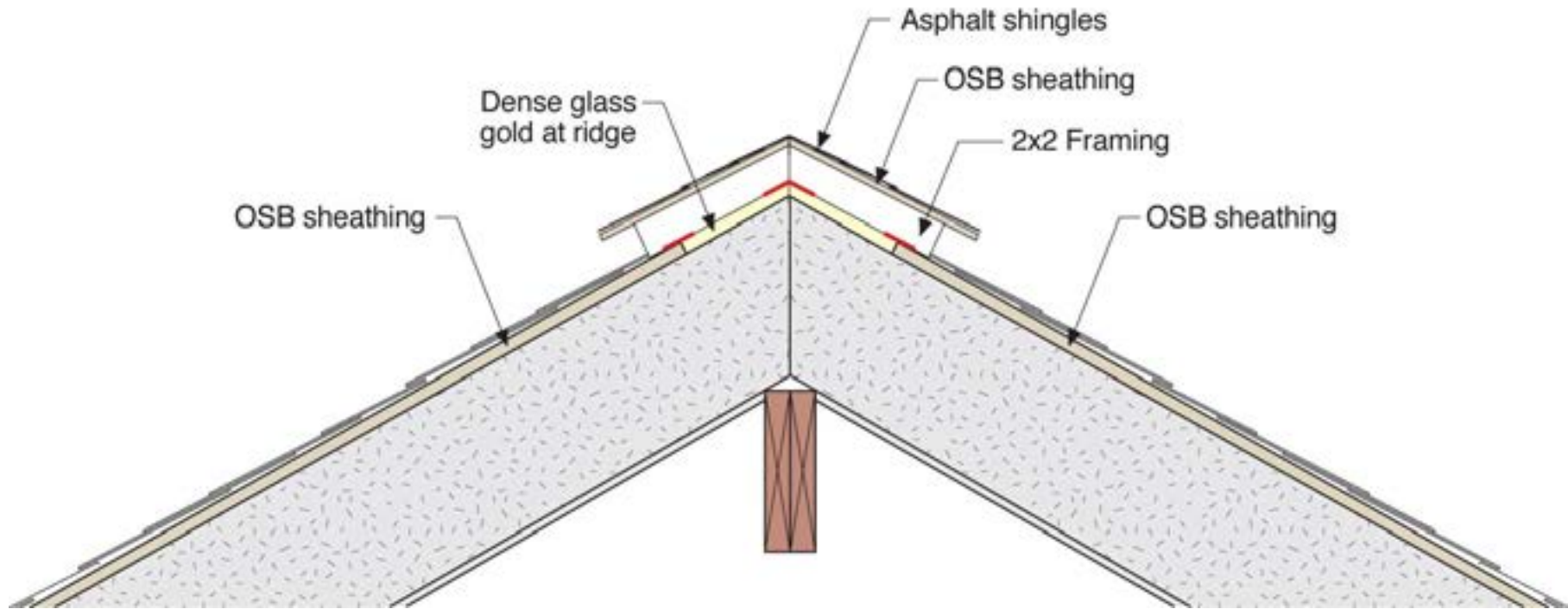






























# Hygric Buoyancy



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 (H<sub>2</sub>O) is 18  
 Dry Air is 29





# Ratios

1:150

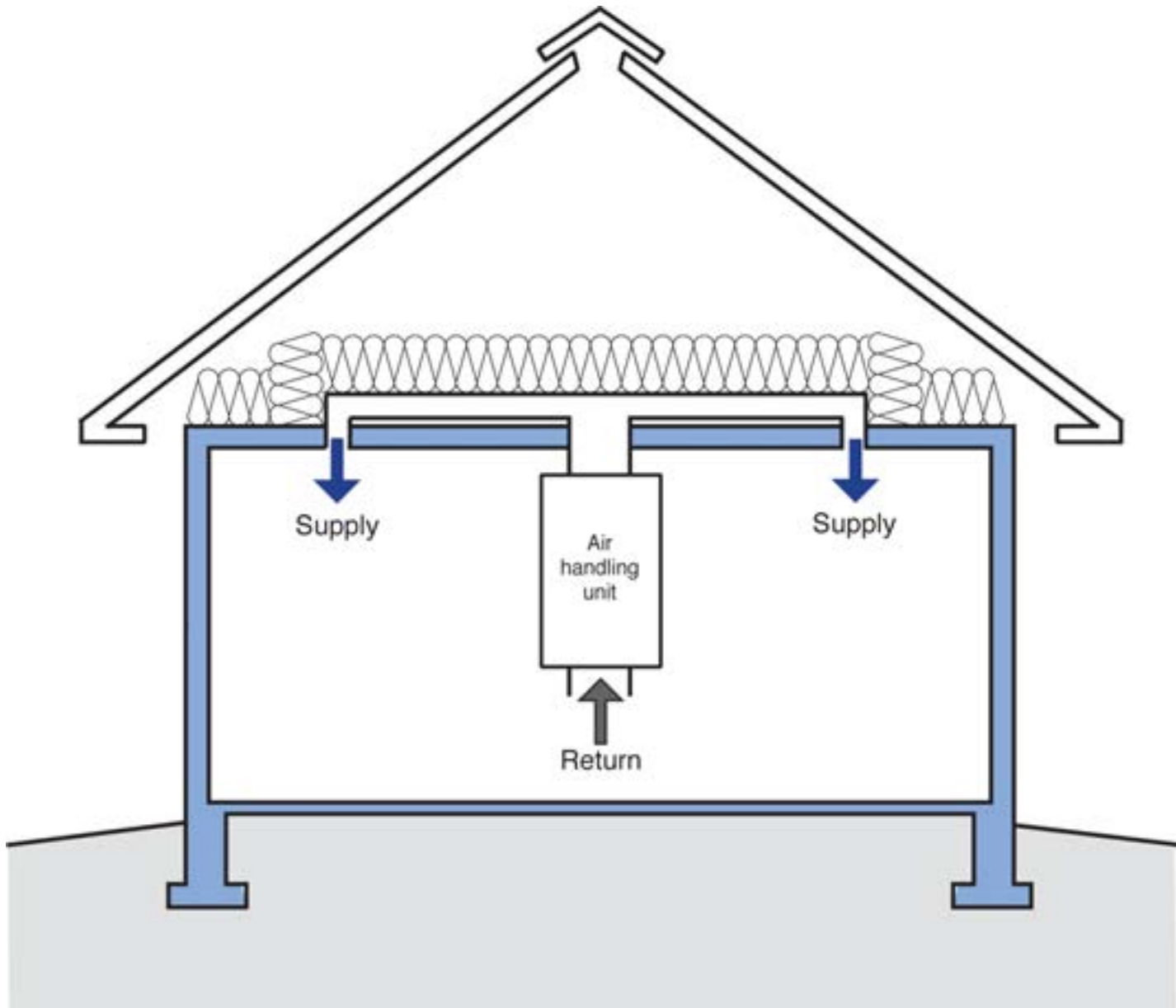
1:300

1:600

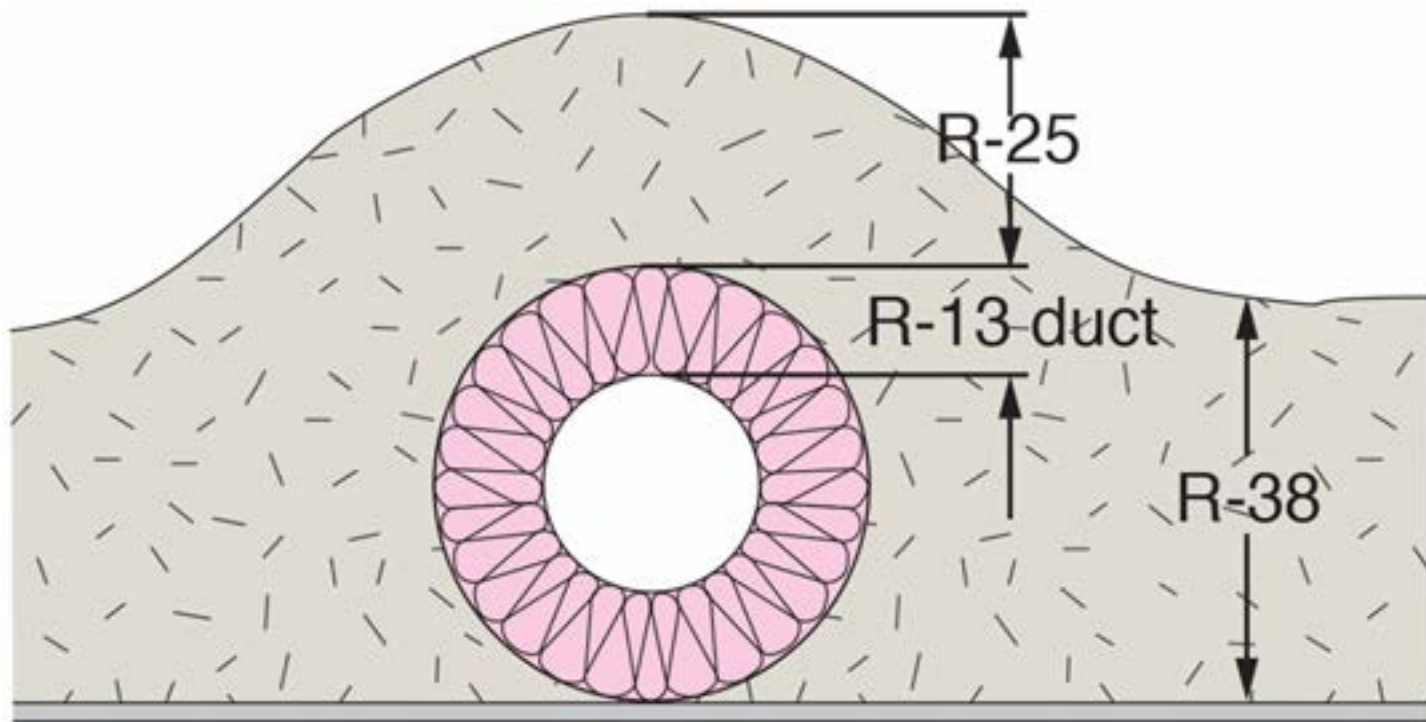
Conditioned Attics Not Unvented Attics  
Need Supply Air  
50 cfm/1000 ft<sup>2</sup> of Attic

Or  
Dehumidification

# Burying Ducts



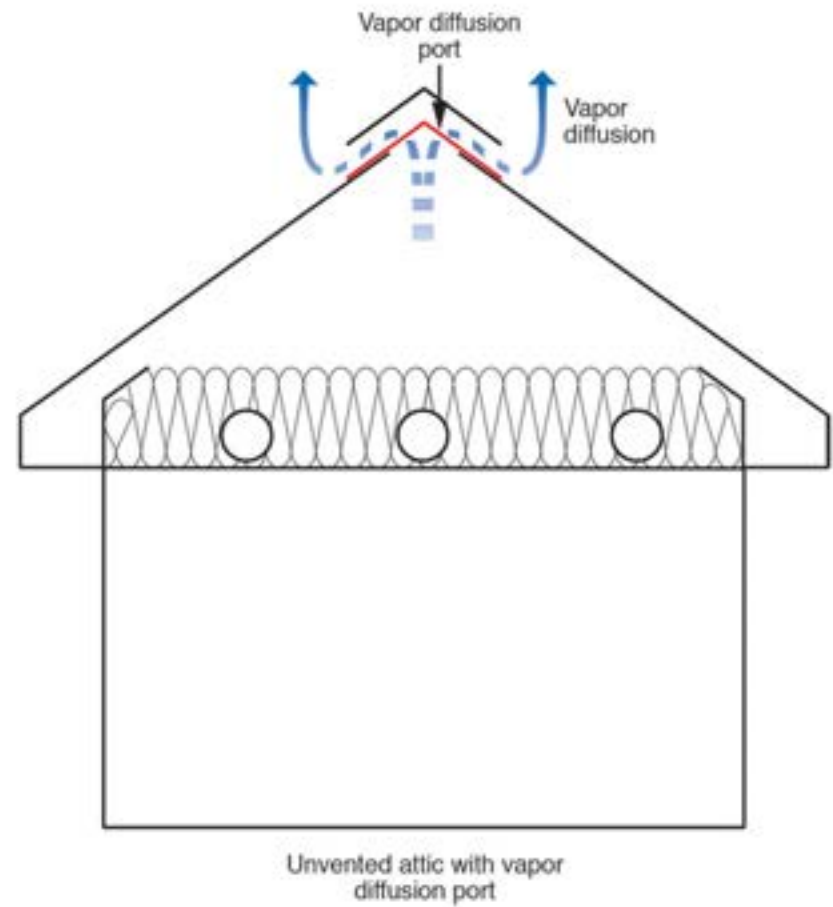
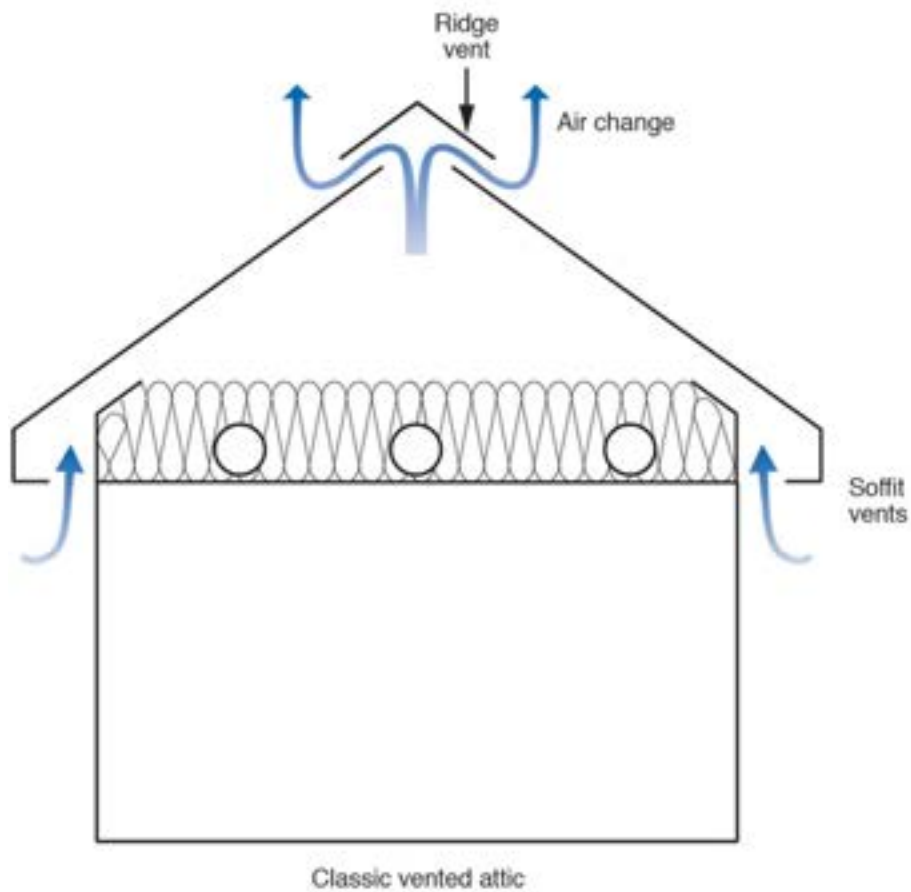




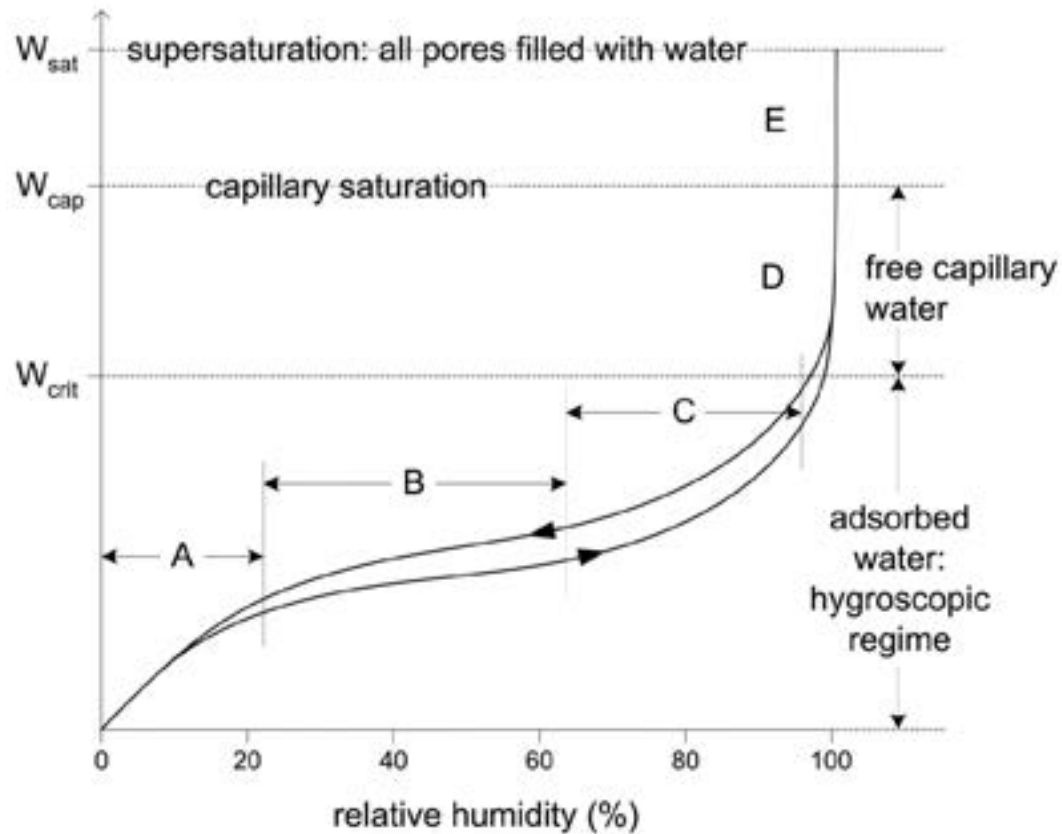






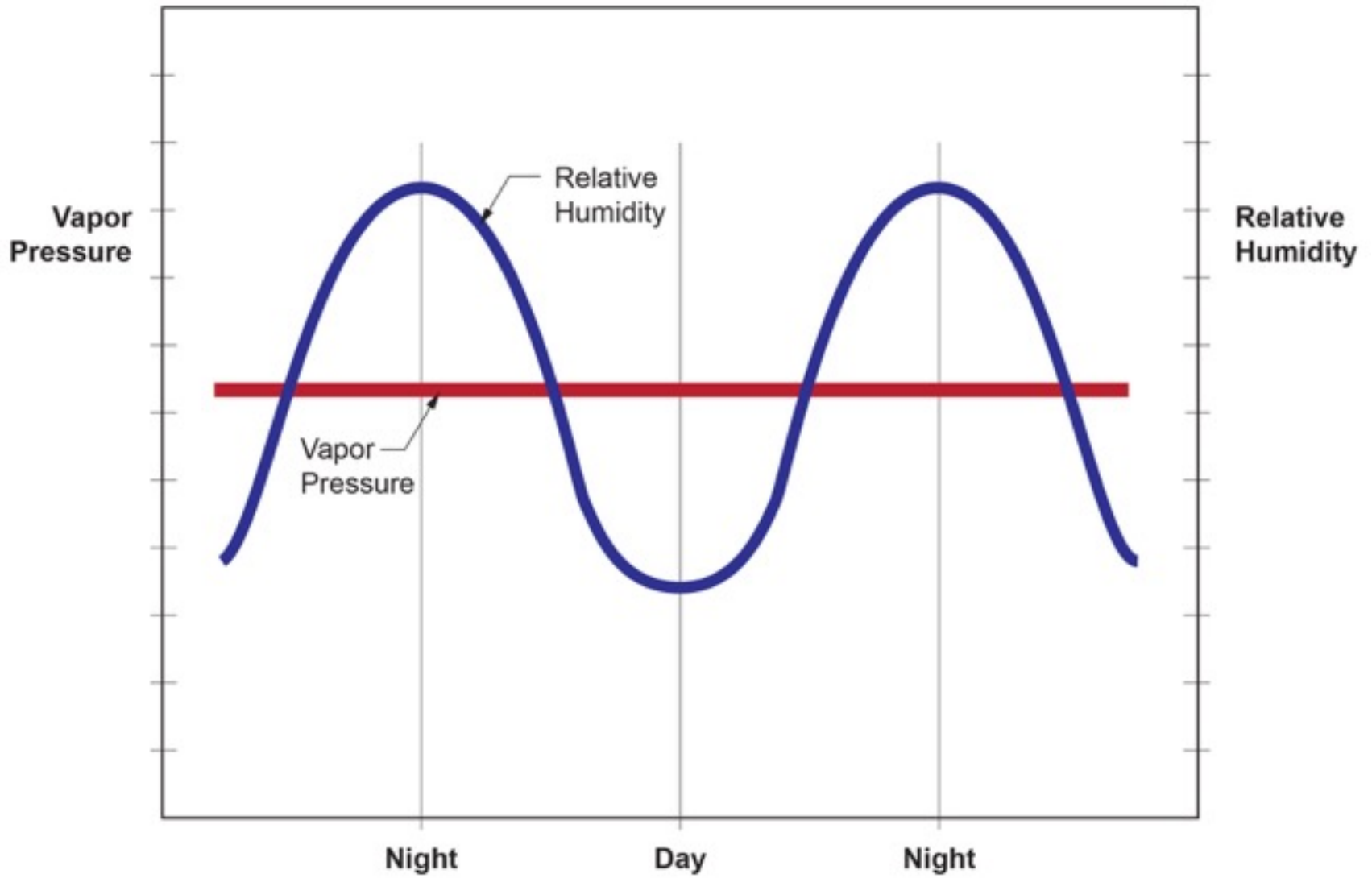


# Vancouver Mold

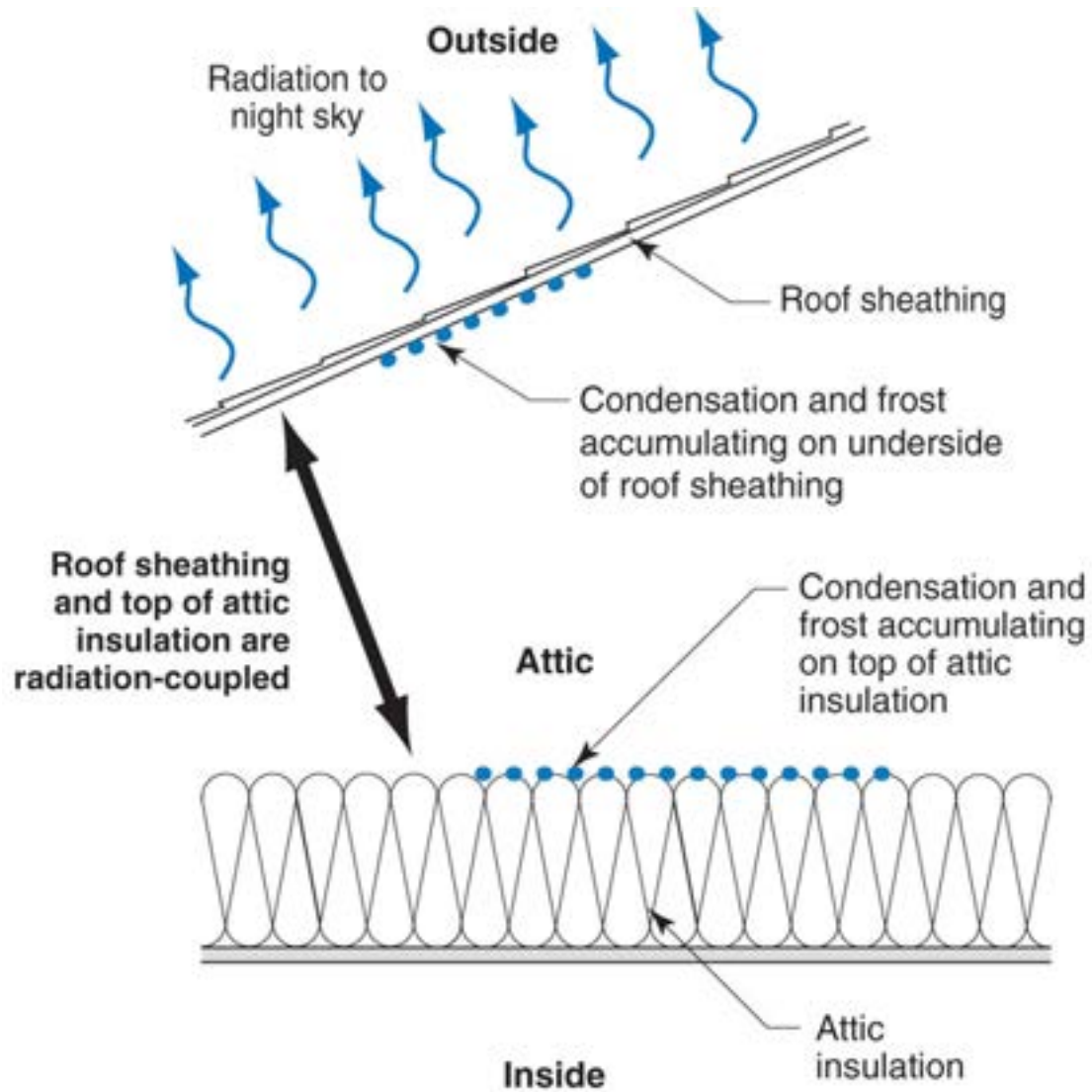


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From Straube & Burnett, 2005



























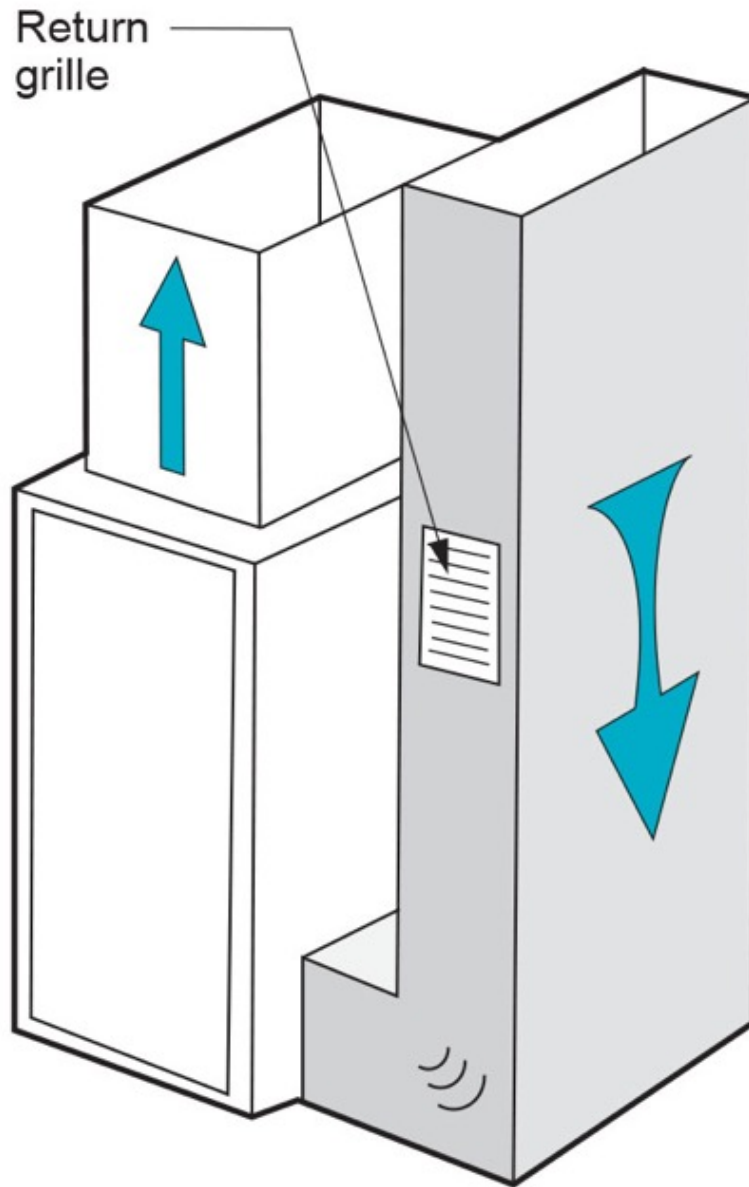




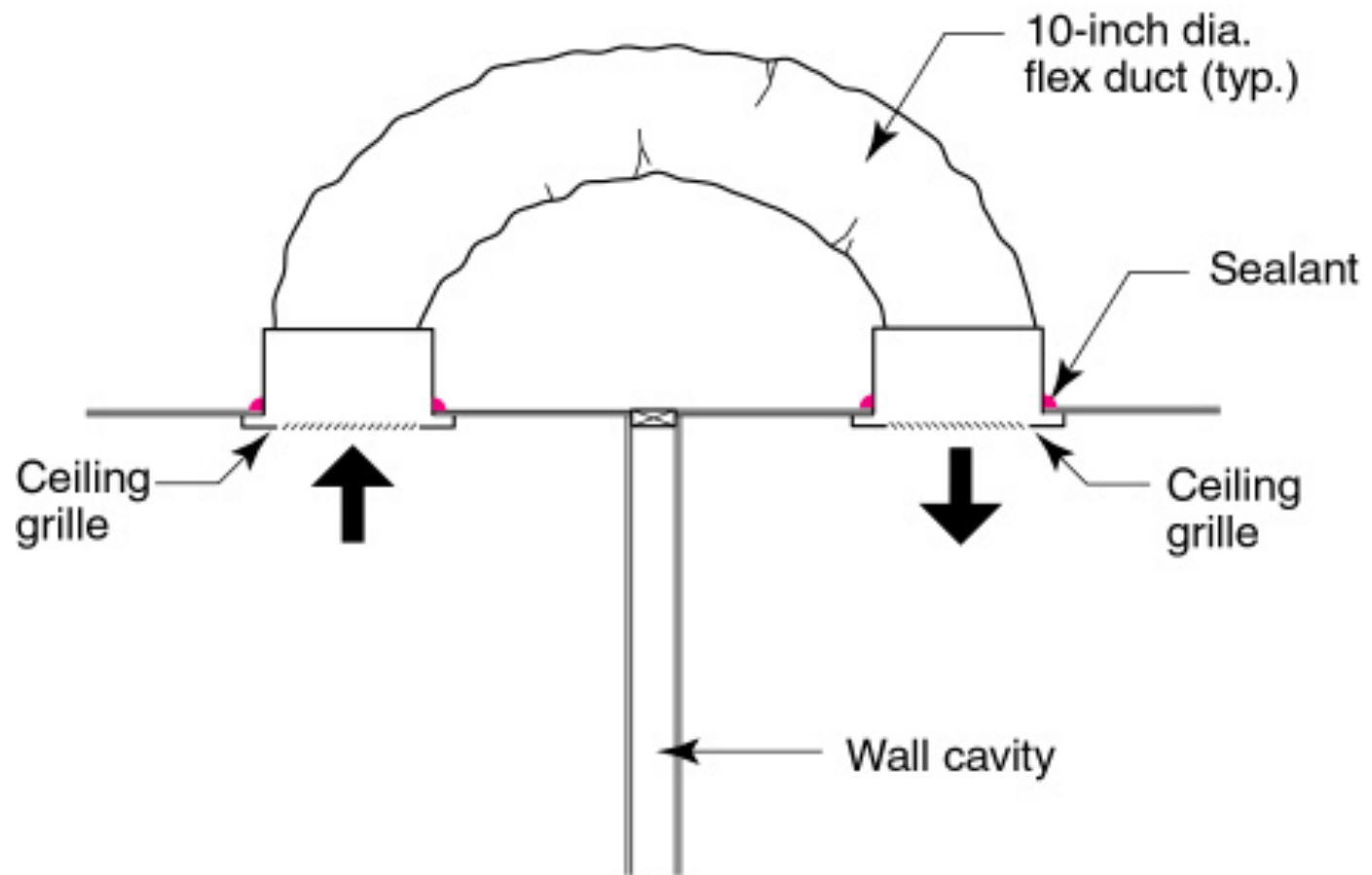


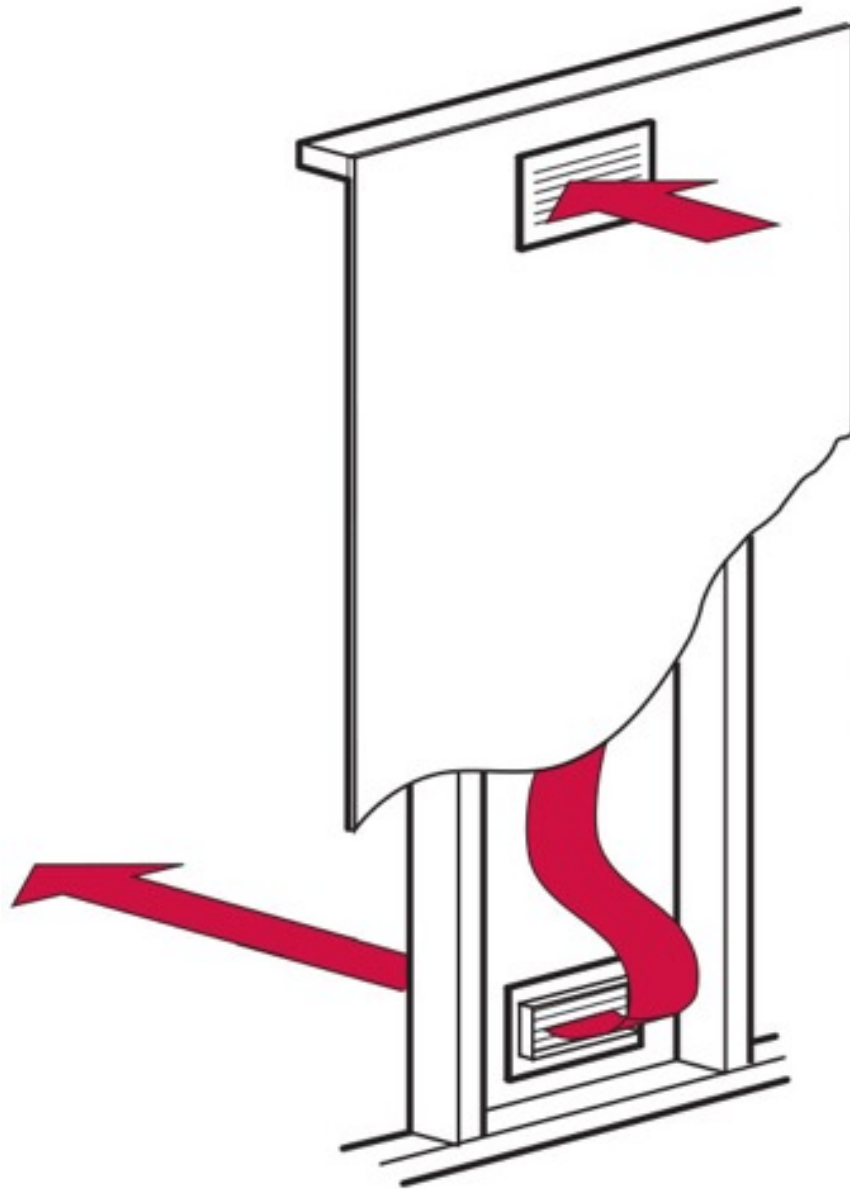






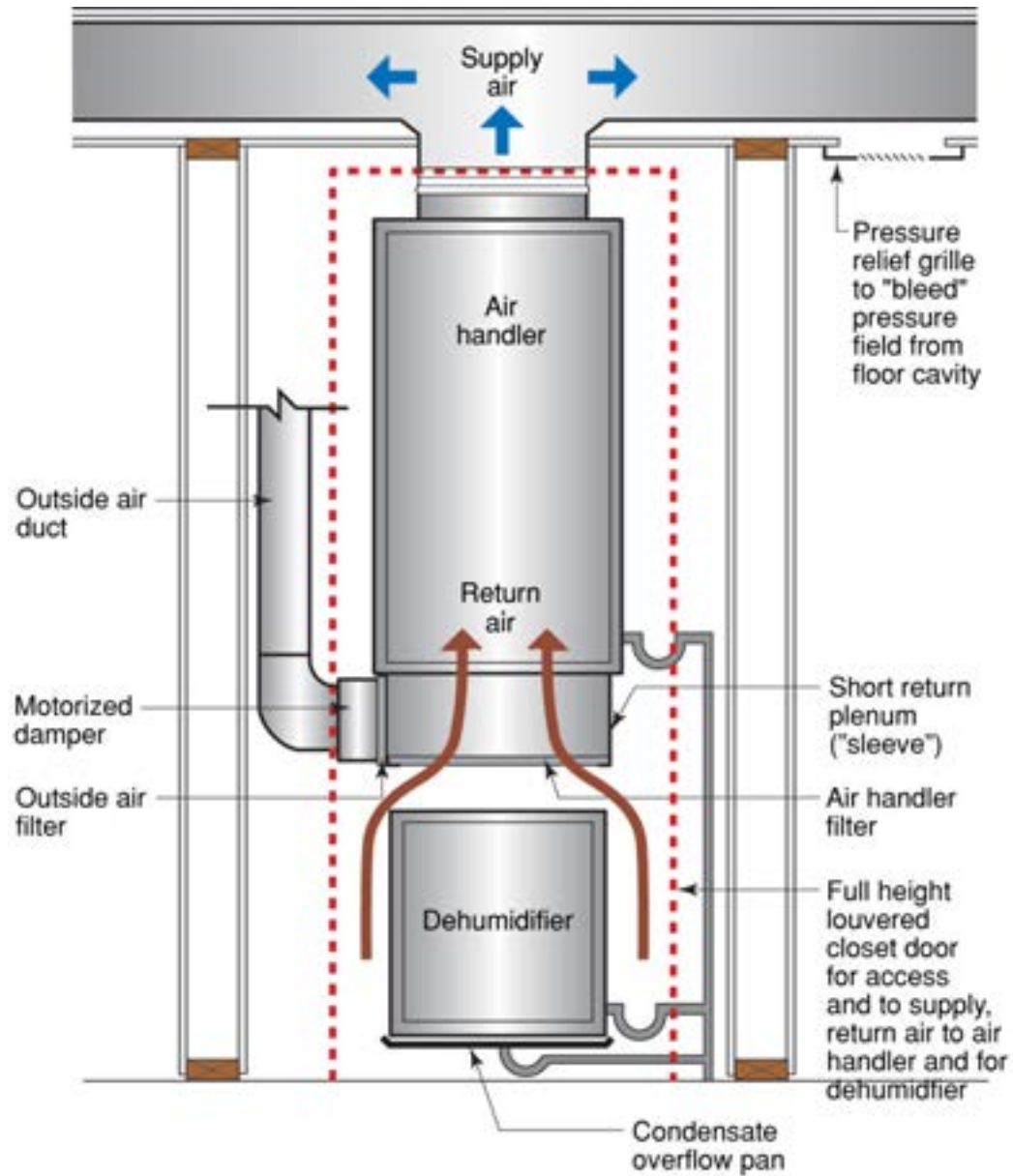


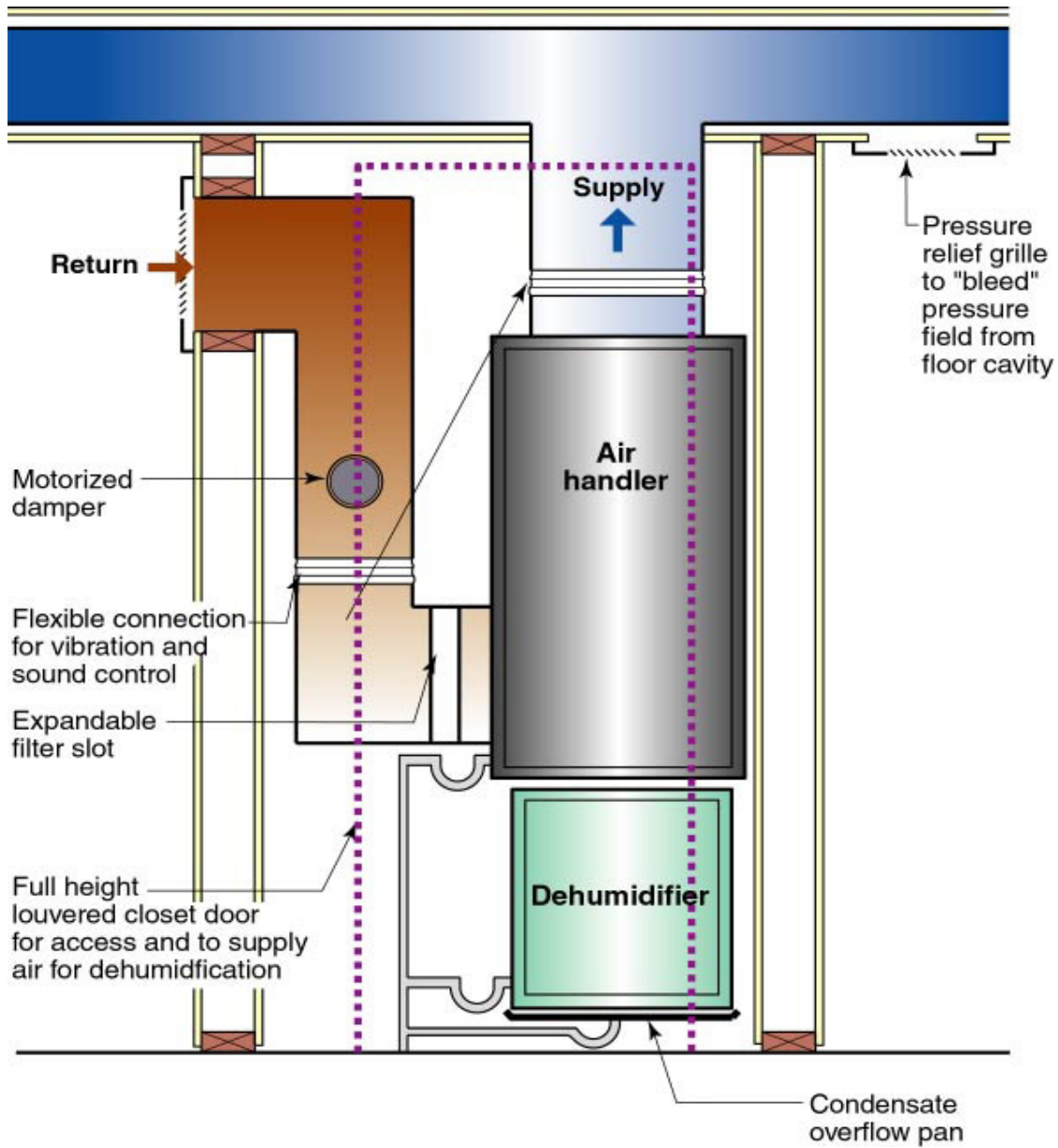


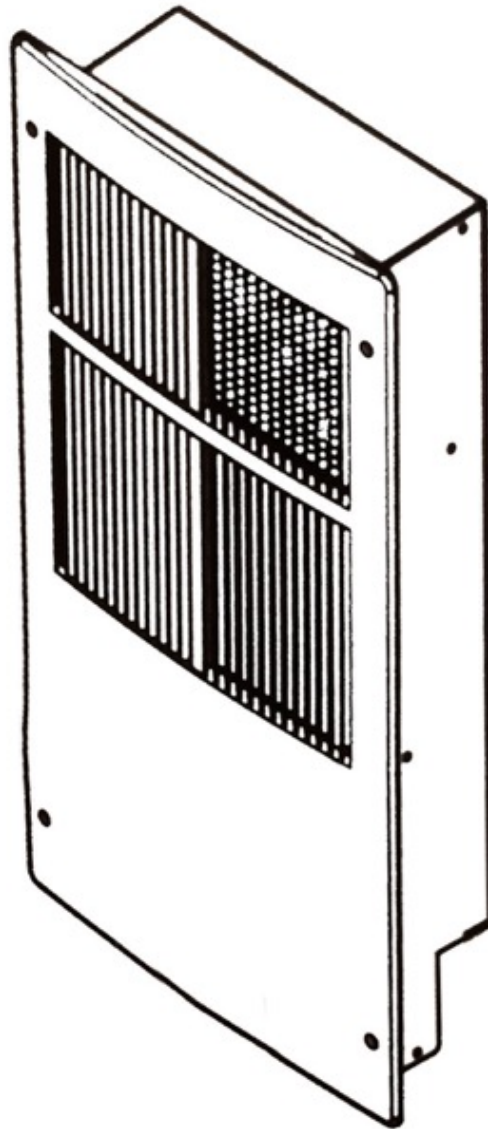


Cavity is sealed tight,  
drywall glued to studs and  
plates on both sides











# Where It Started.....





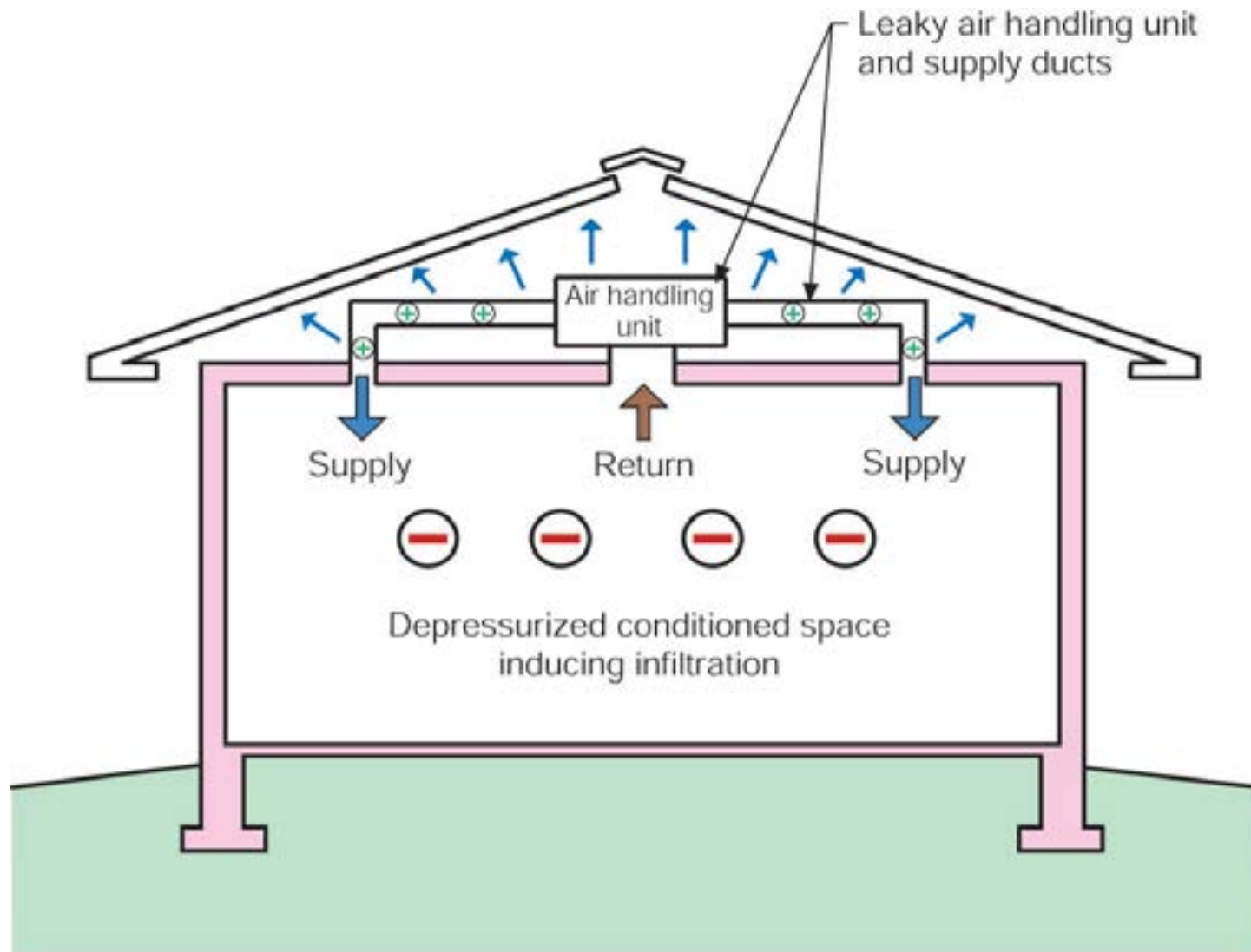




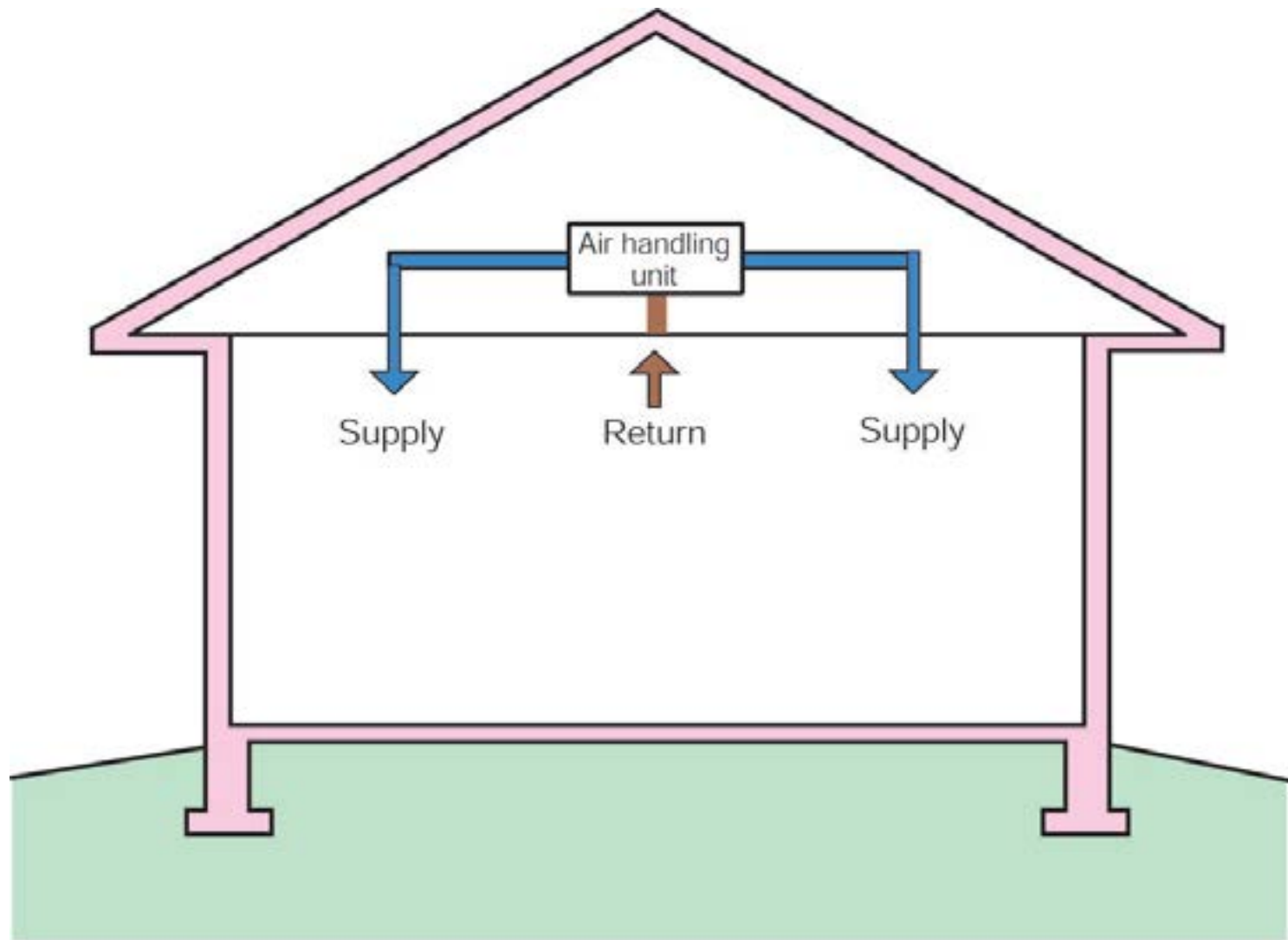








Note: Colored shading depicts the building's thermal barrier and pressure boundary. The thermal barrier and pressure boundary enclose the conditioned space.



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