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# Building Science

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There is No Such Thing as a Free  
Thermodynamic Lunch

# A Building is an Environmental Separator

# Arrhenius Equation

For Every 10 Degree K Rise  
Reaction Rate Doubles

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

Damage Functions

Water

Heat

Ultra-violet Radiation

# 2<sup>nd</sup> 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

# Thermodynamic Potential





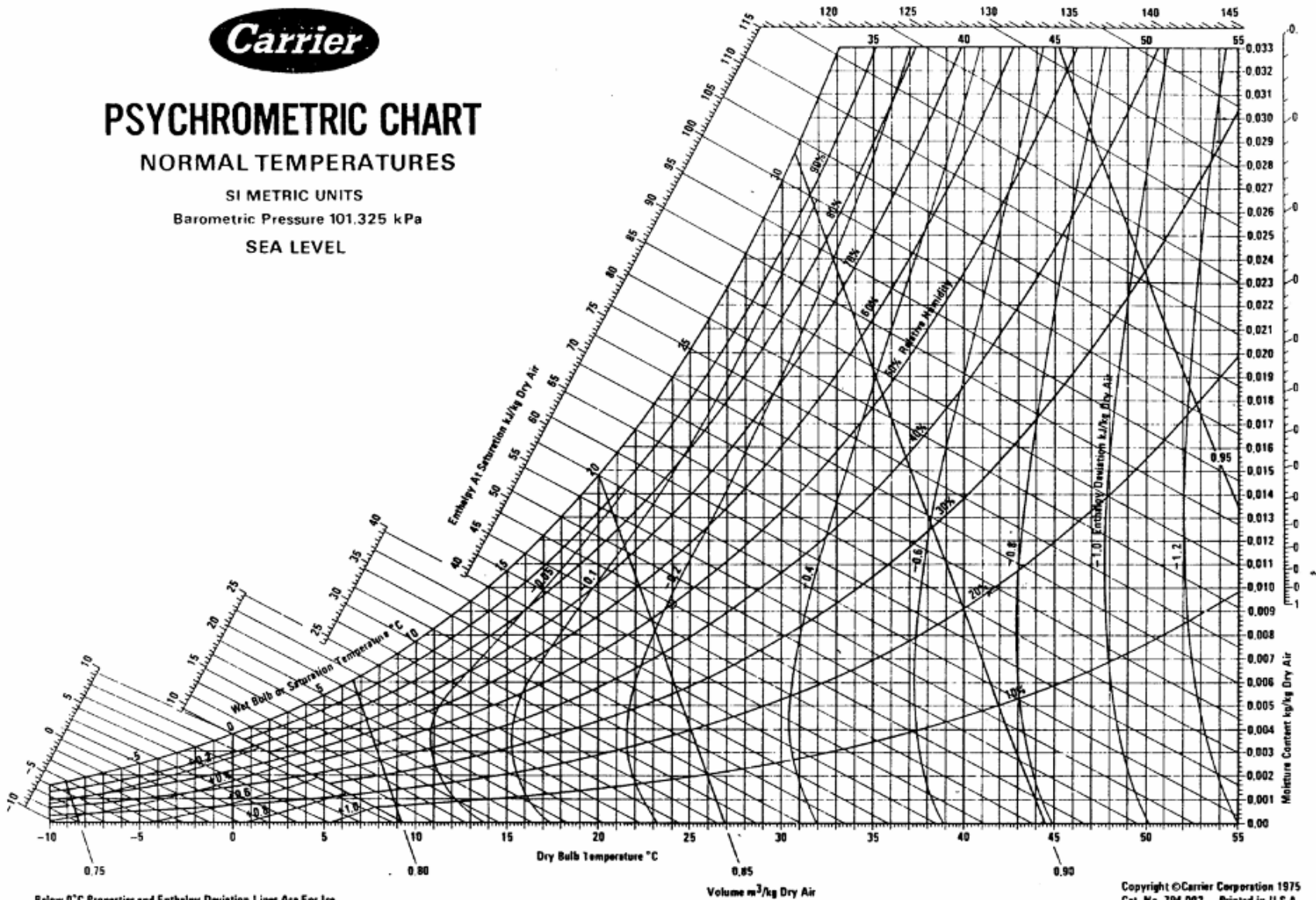
# PSYCHROMETRIC CHART

NORMAL TEMPERATURES

SI METRIC UNITS

Barometric Pressure 101.325 kPa

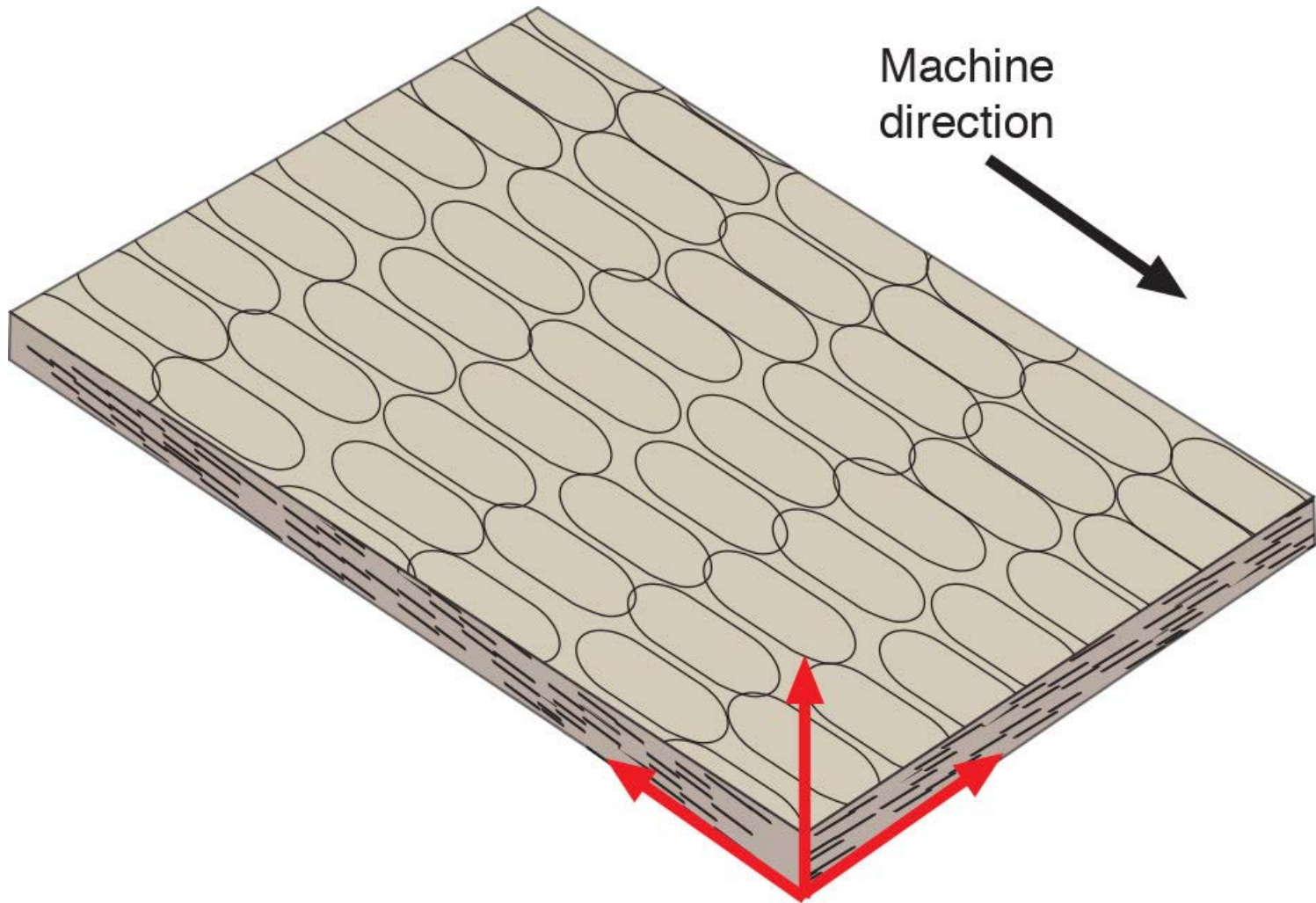
SEA LEVEL



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

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# Change In Materials

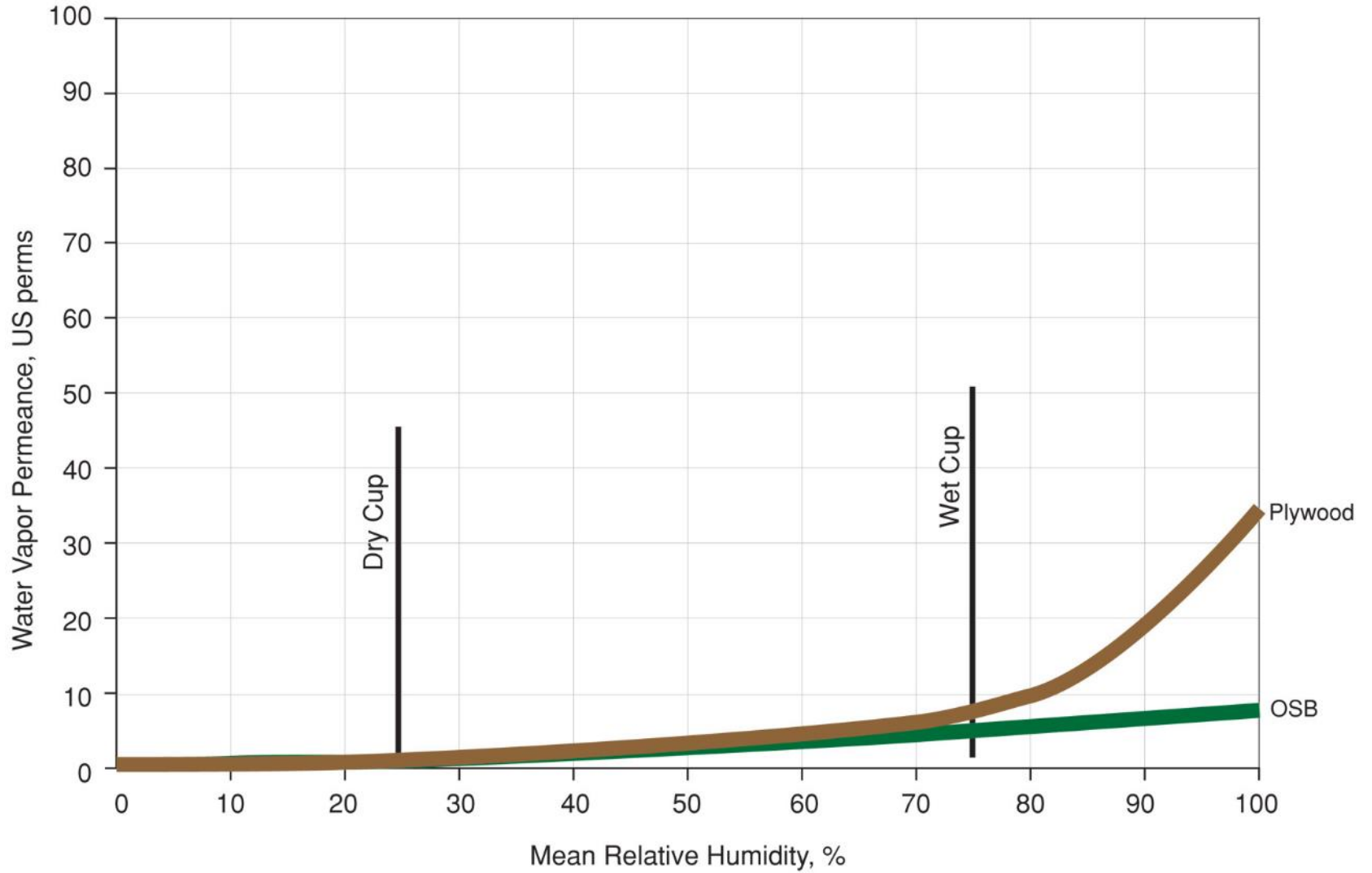


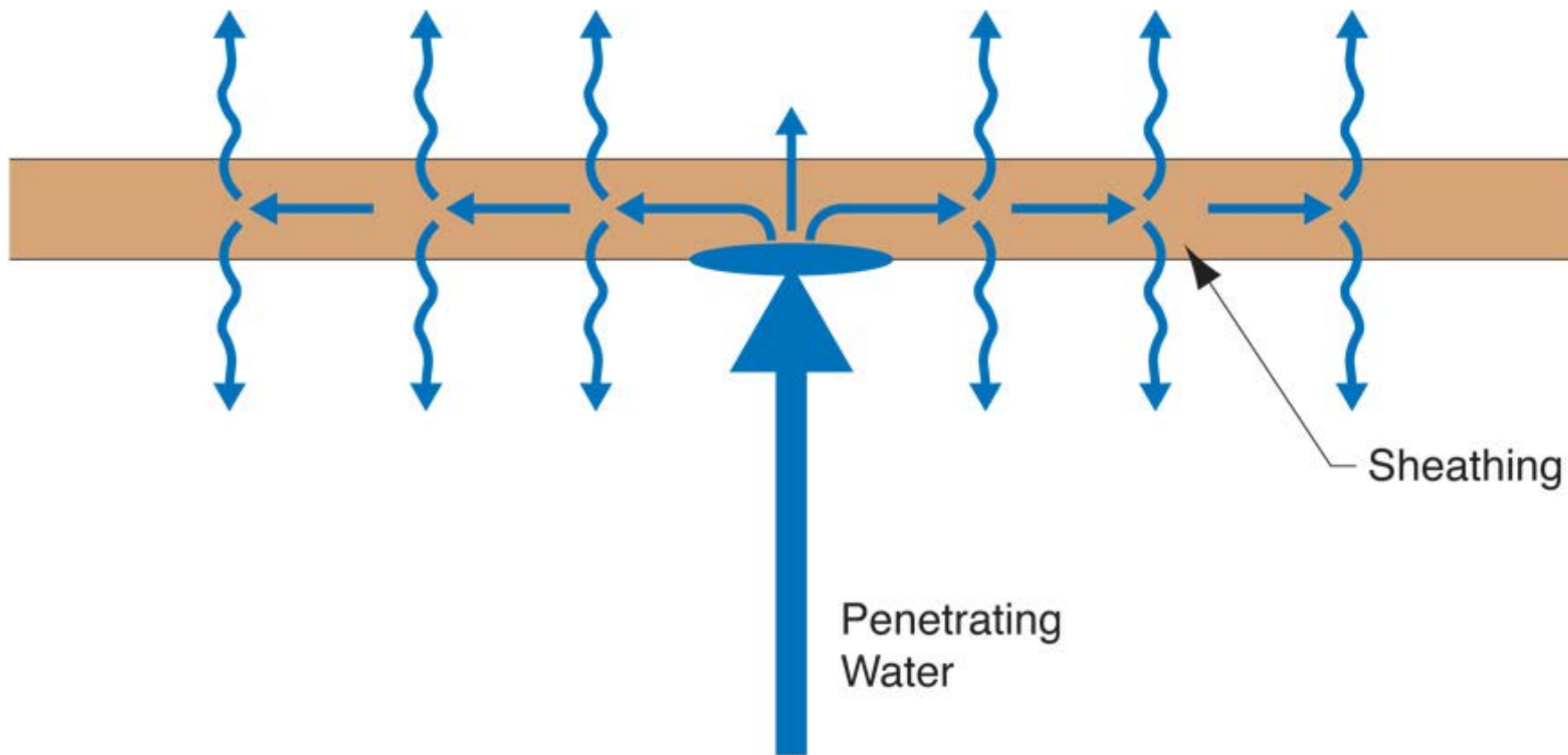




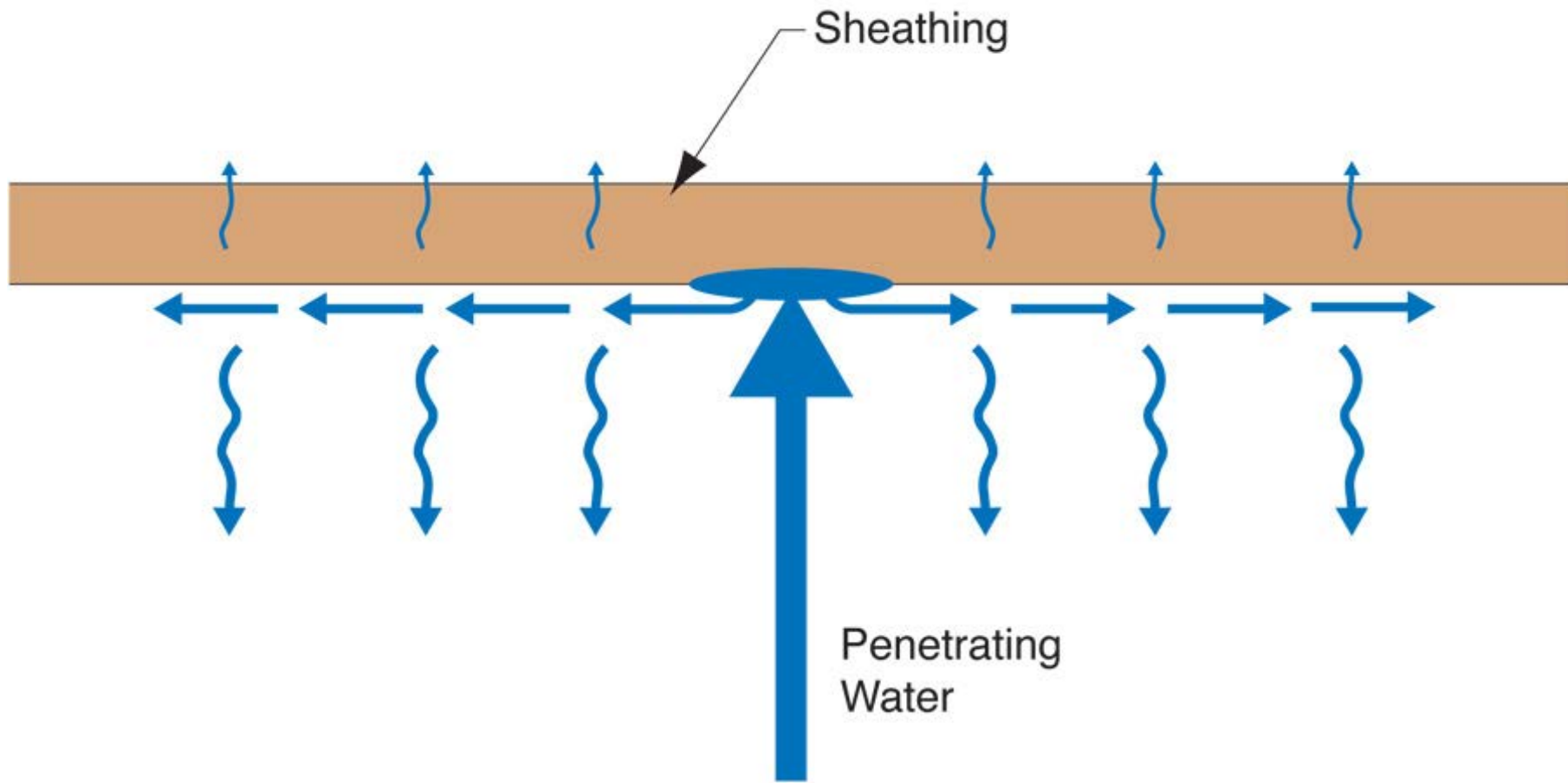


# Water Vapor Permeance of Sheathing Materials



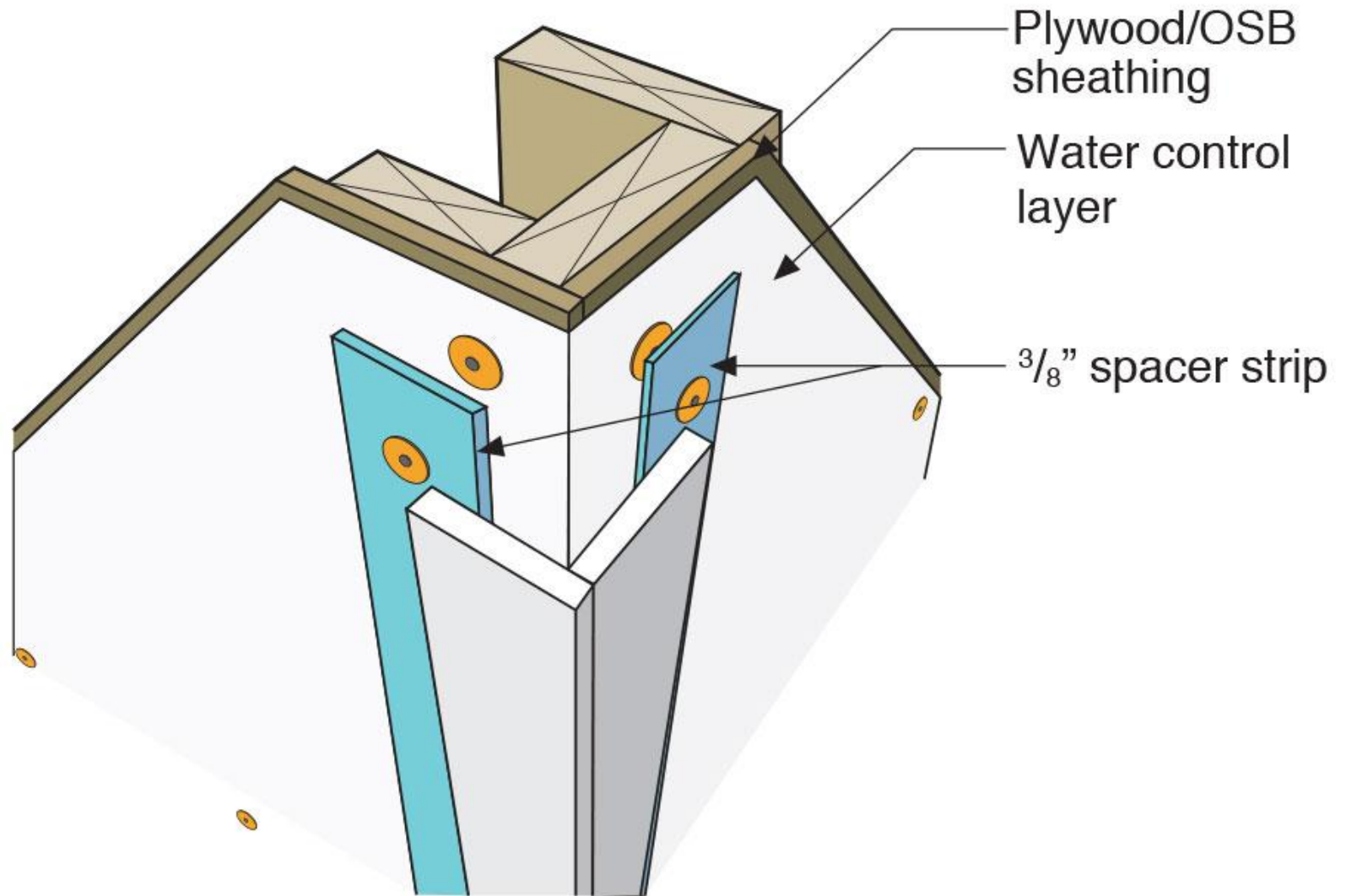


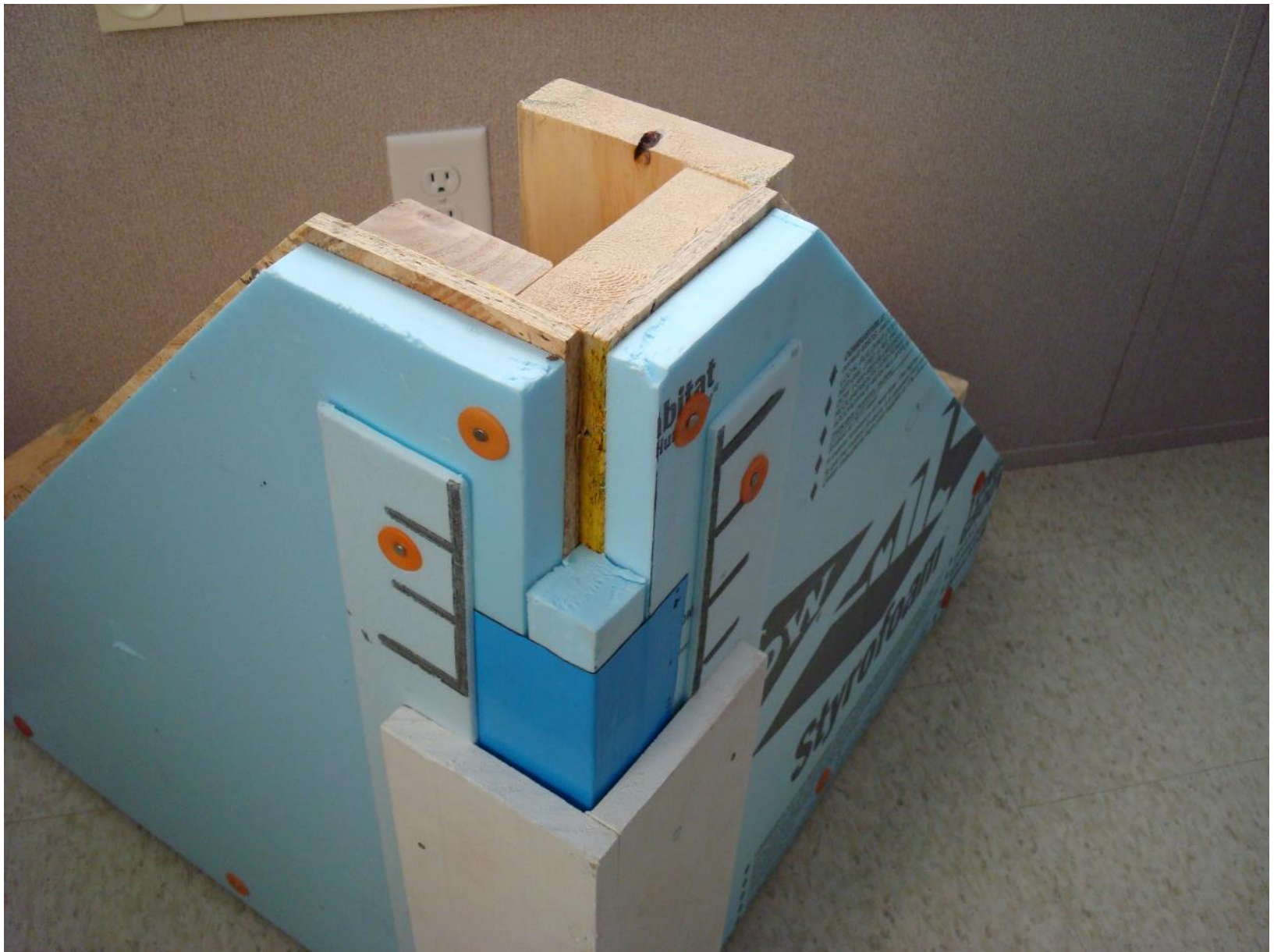




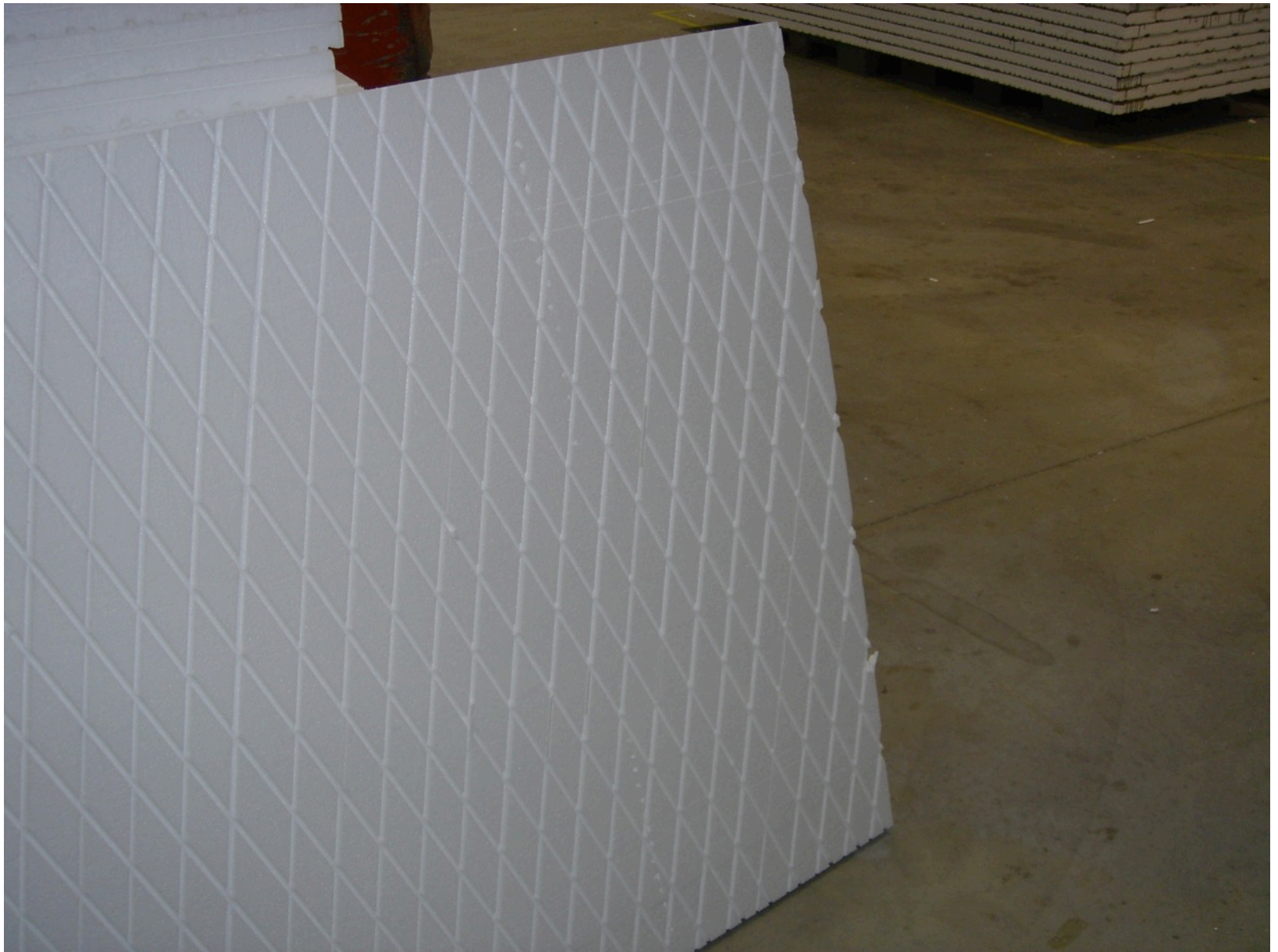






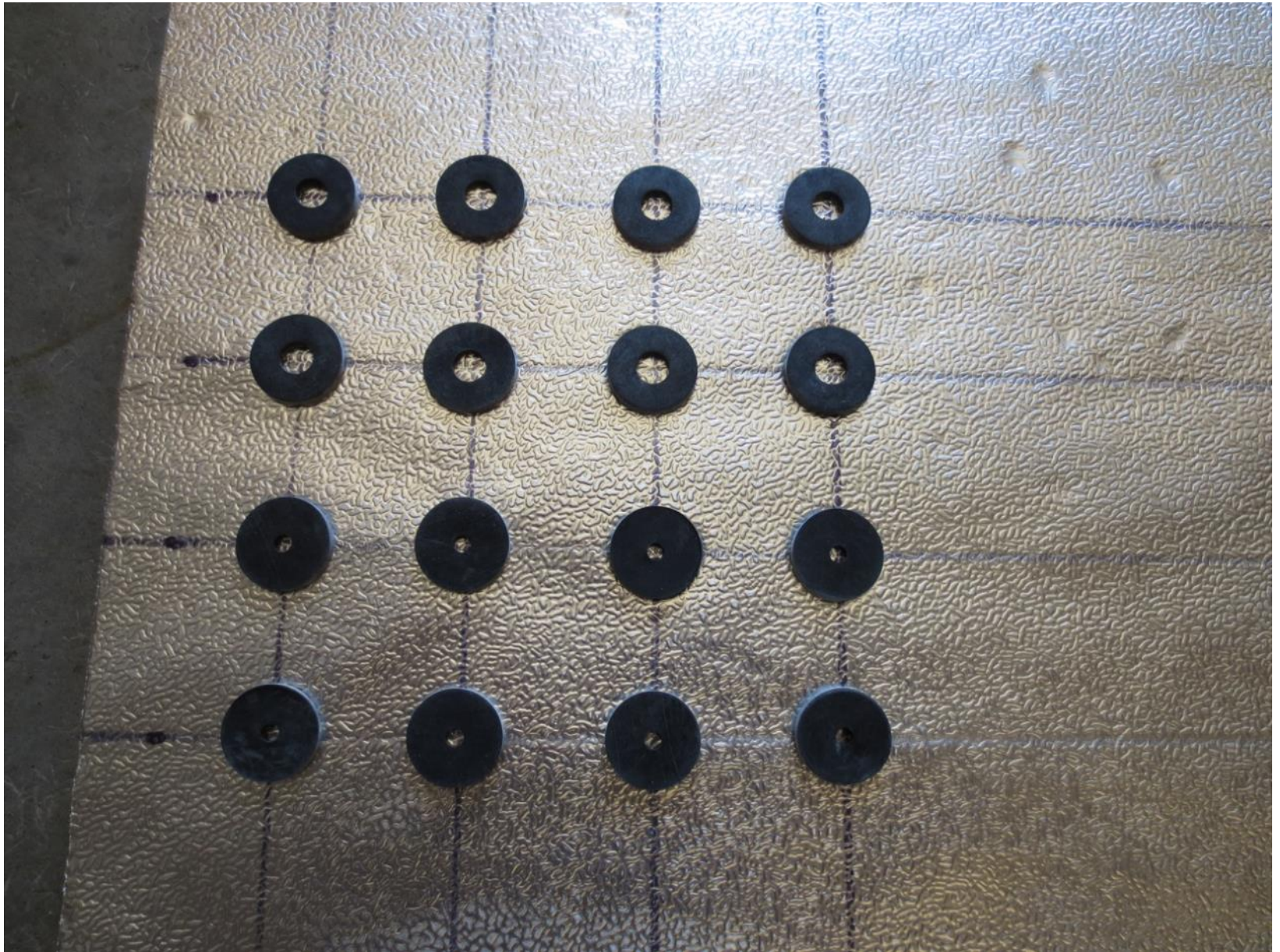




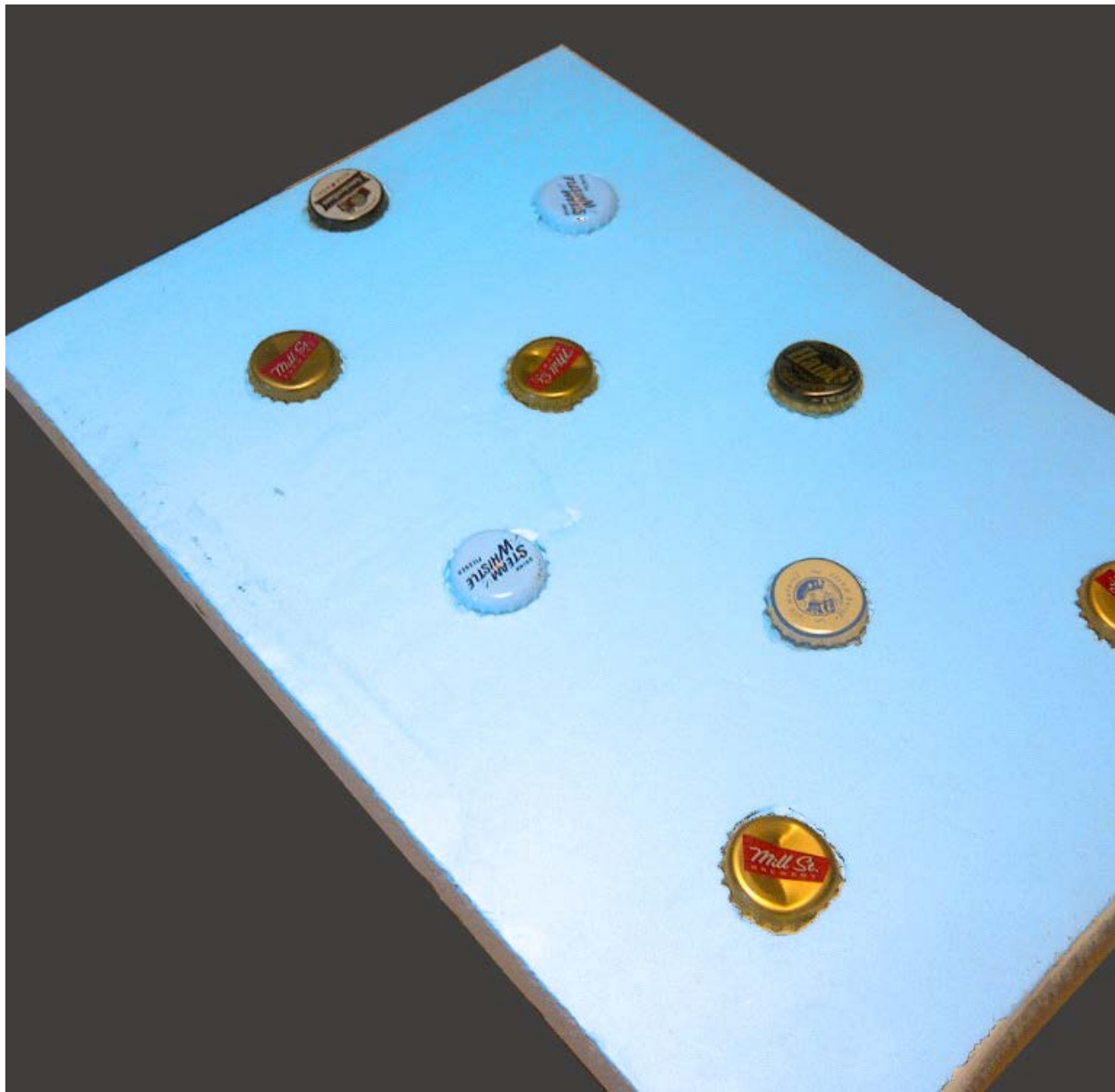


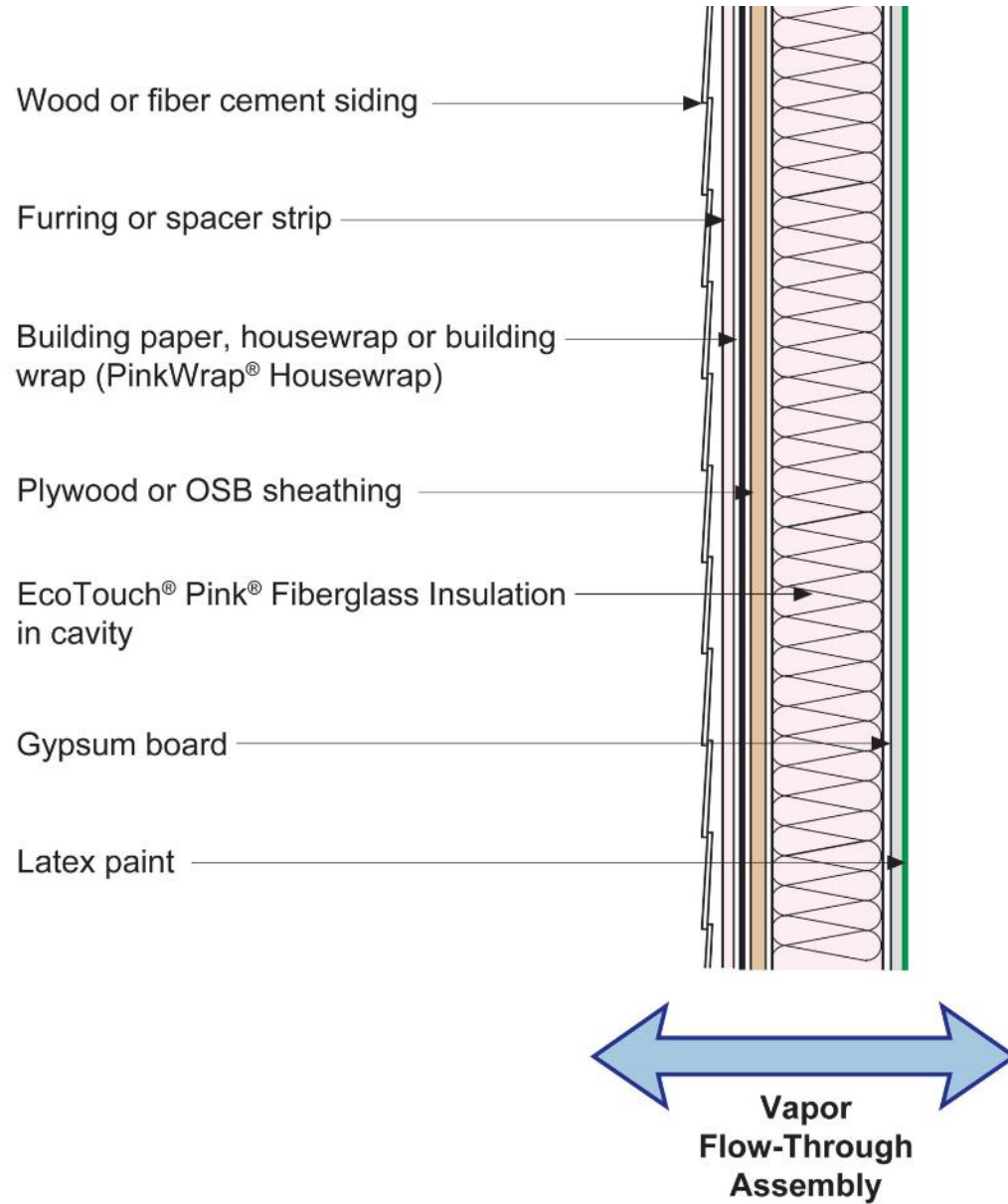
# Rain Screen

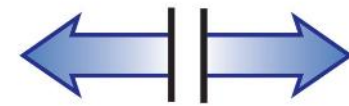
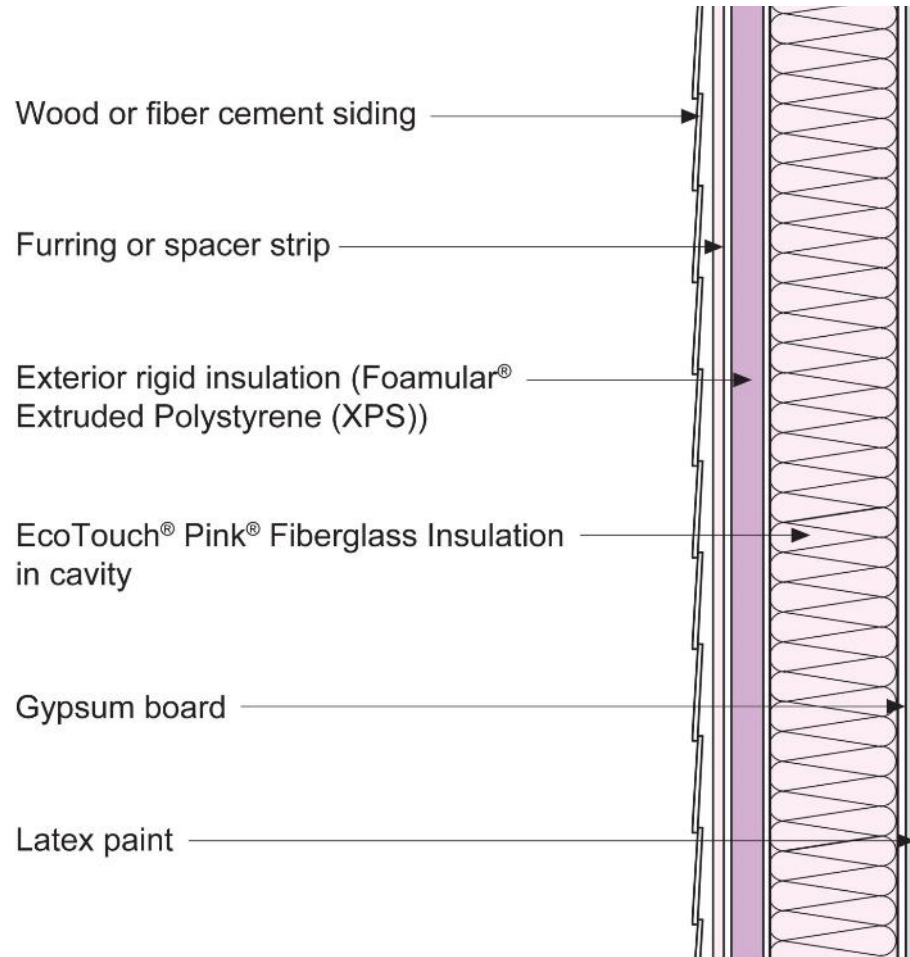




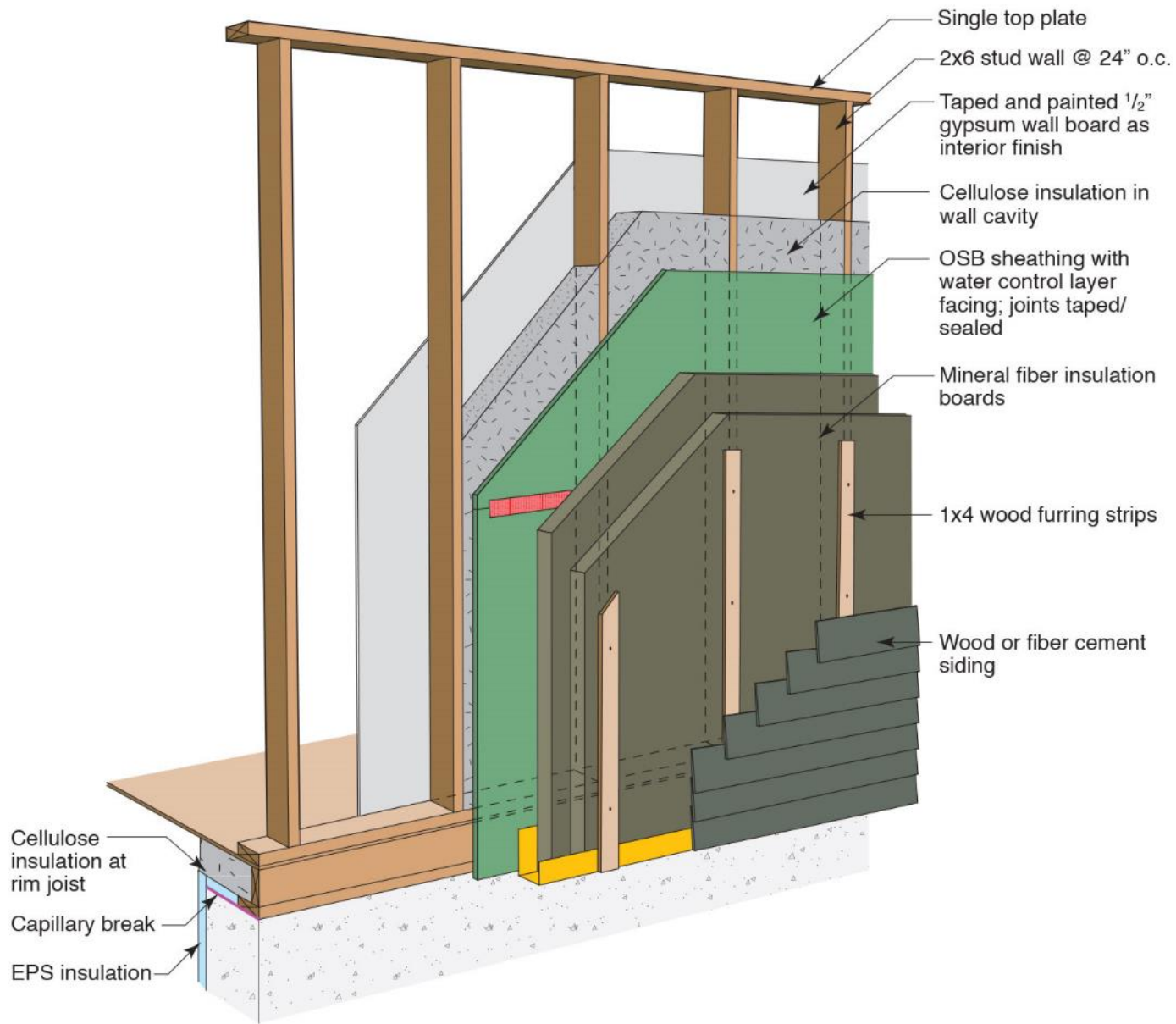
# Beer Screen?

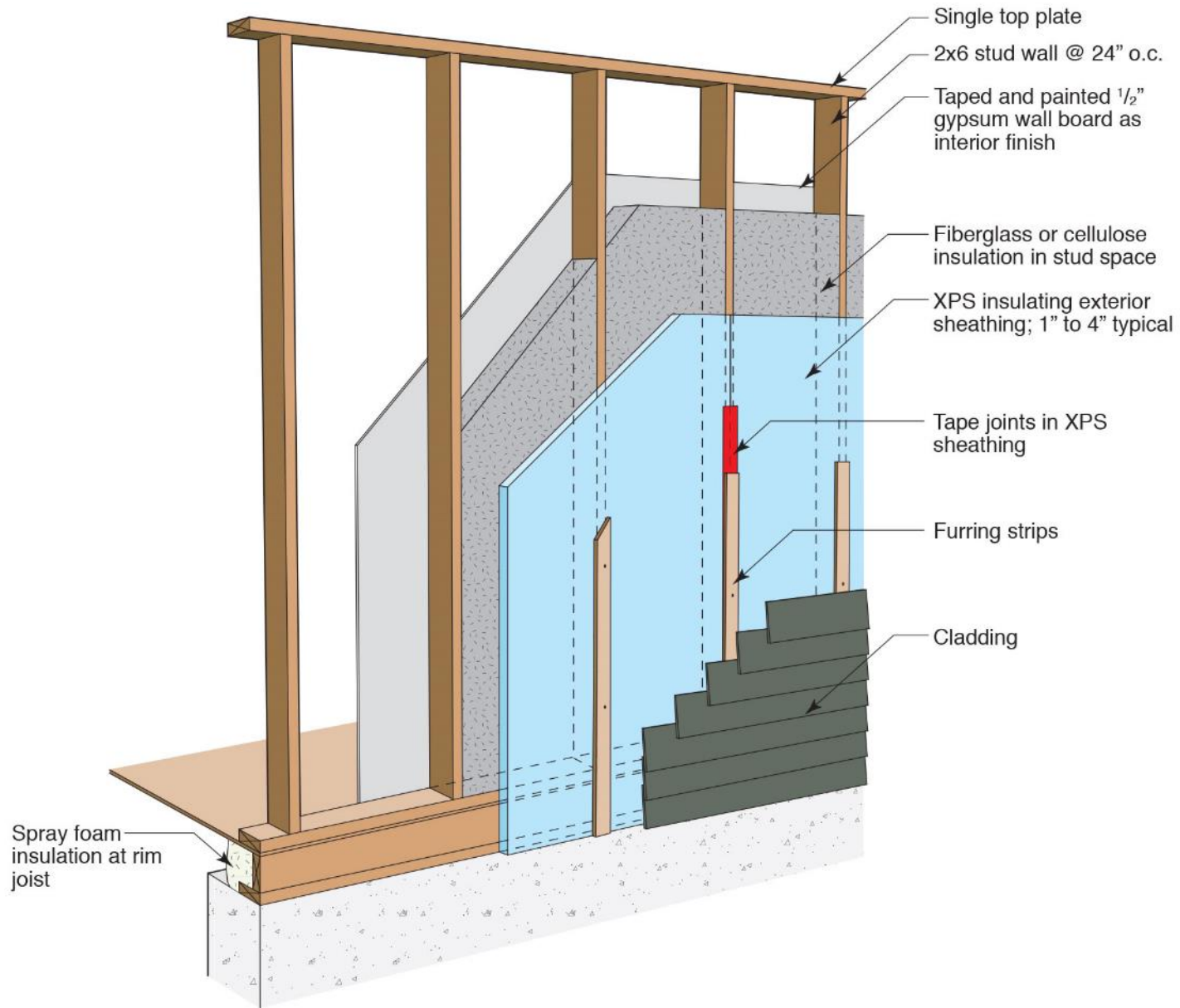






**Control of Condensing  
Surface Temperature  
Assembly**





# Exterior Insulation Finish Systems EIFS....aka “Synthetic Stucco”





Exterior Insulation Finish Systems

EIFS

Barrier System

Face-Sealed Not Water Managed



















# Stucco











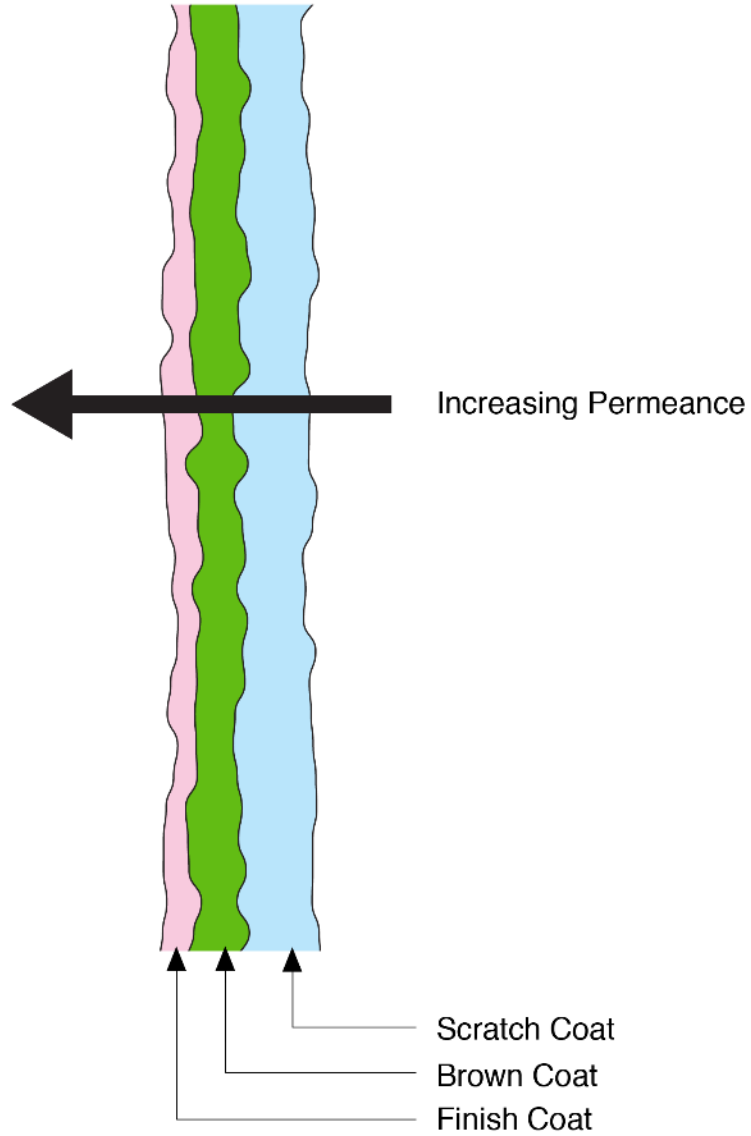


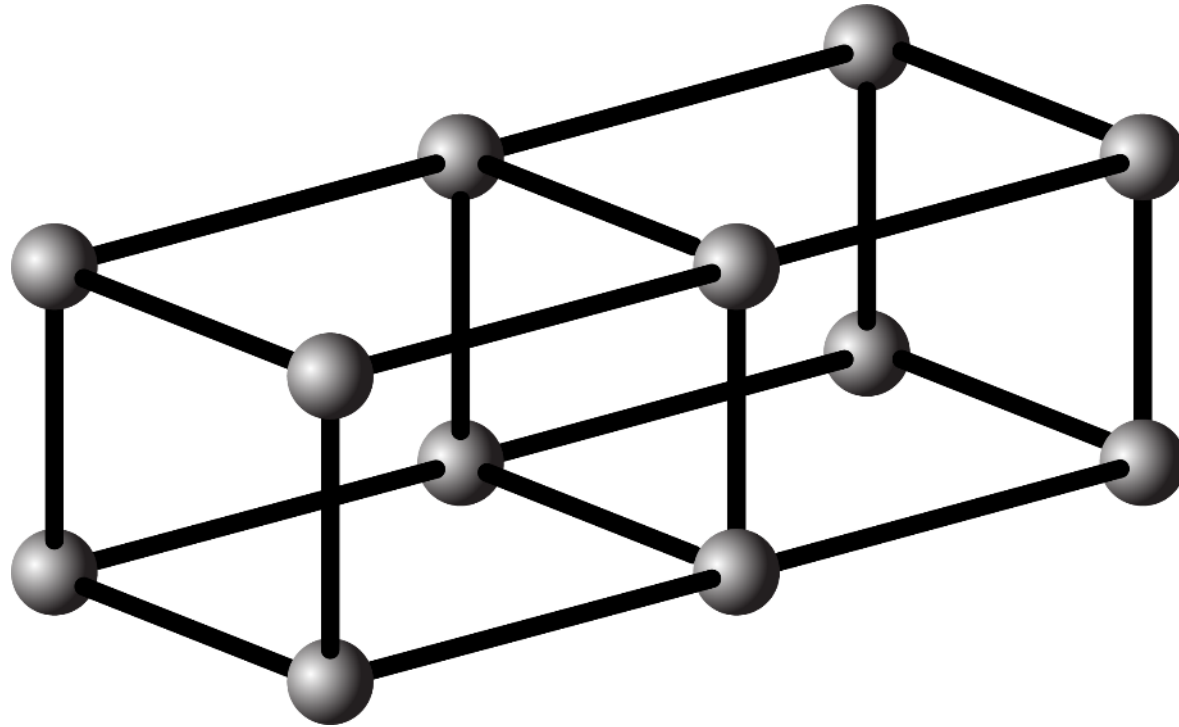


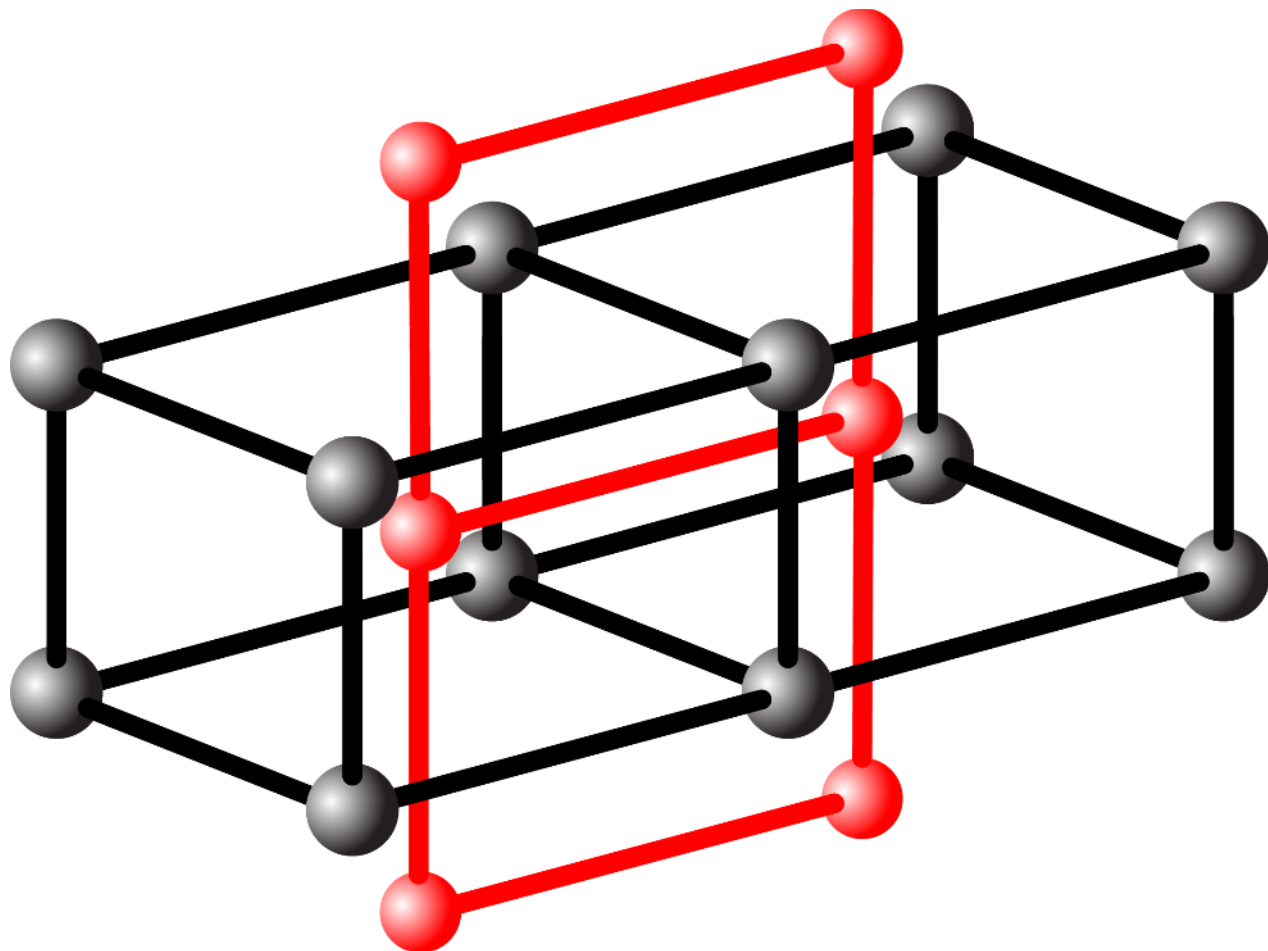


# Materials Inward Drive Energy

Traditional Lime Stucco	Greater than 20 perms
Lime/Portland Cement Stucco	5 to 10 perms
Portland Cement Stucco	1 to 5 perms
Polymer Modification	Less than 1







# Ancient Modification Additives

Cow Dung

Egg Whites

Pig Blood



# Non Traditional Building Wraps













































# Back To Lumpy Stucco....



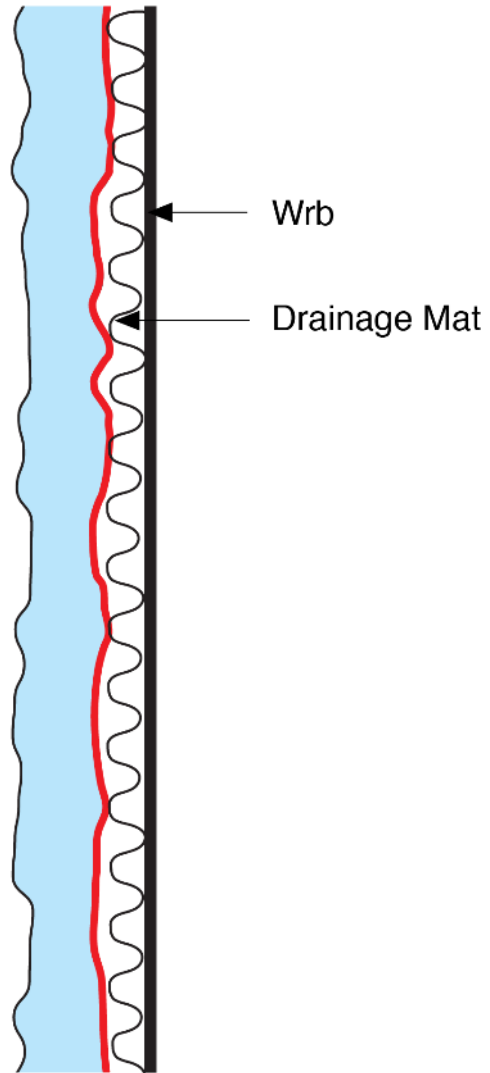






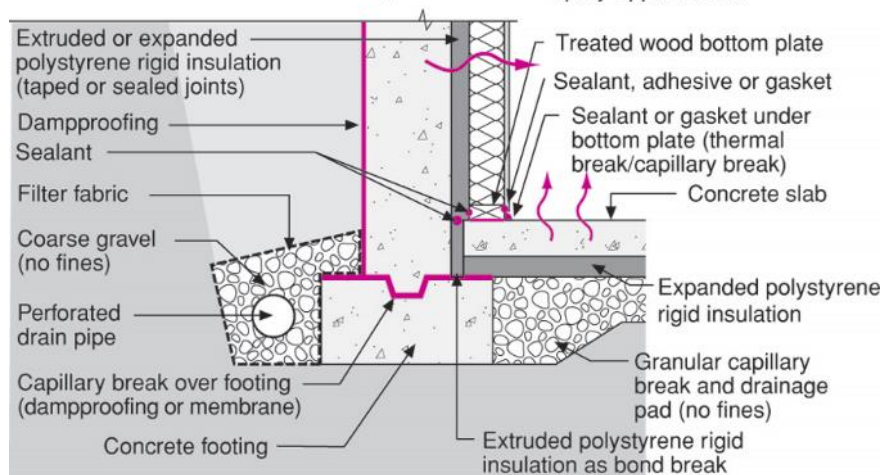
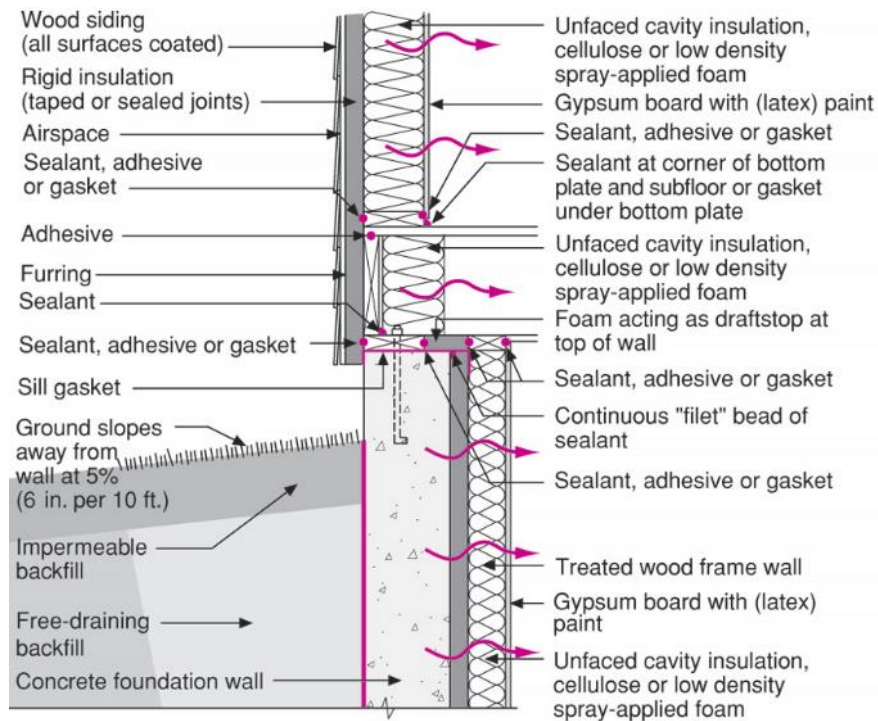


Easy Solution....









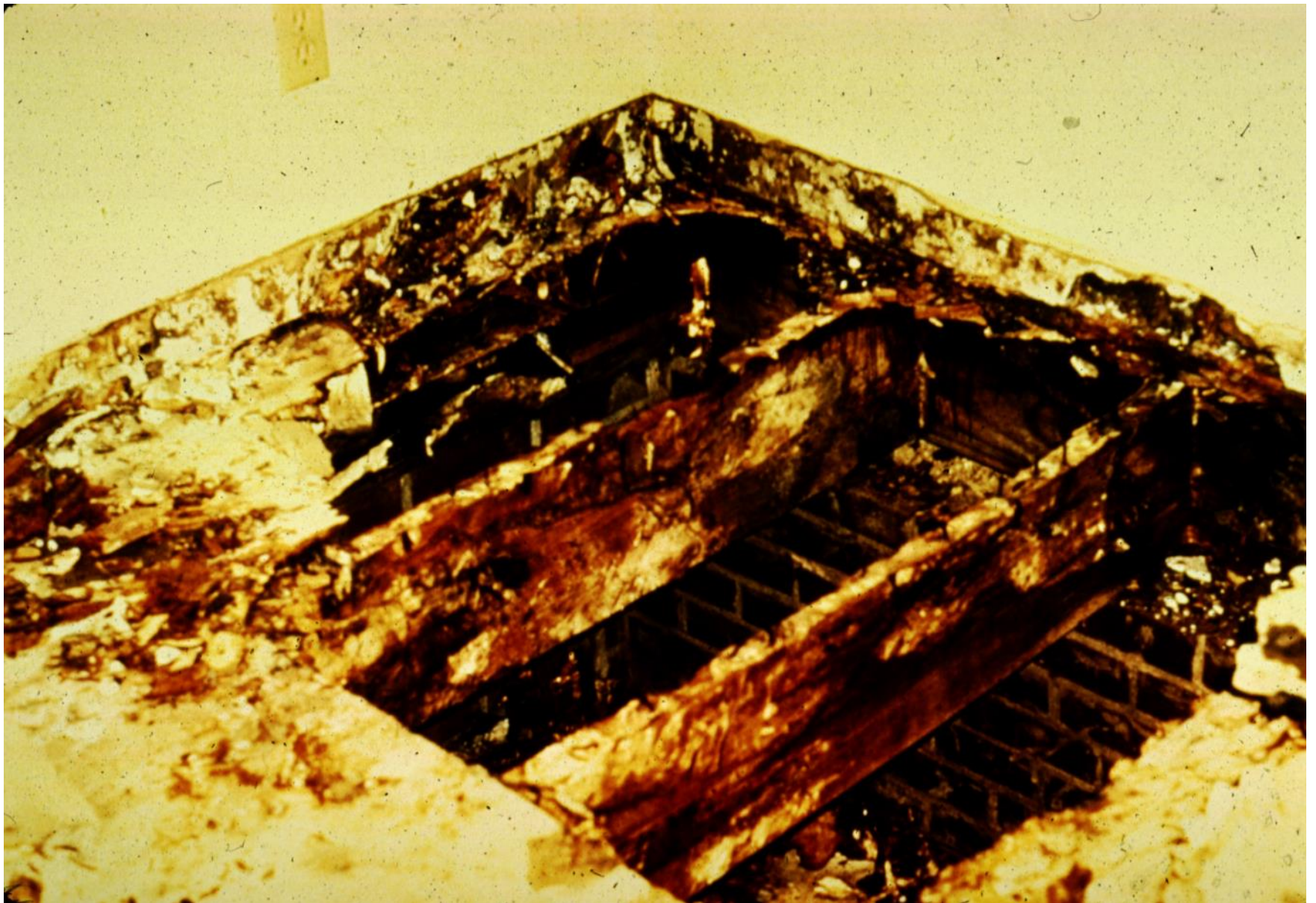
















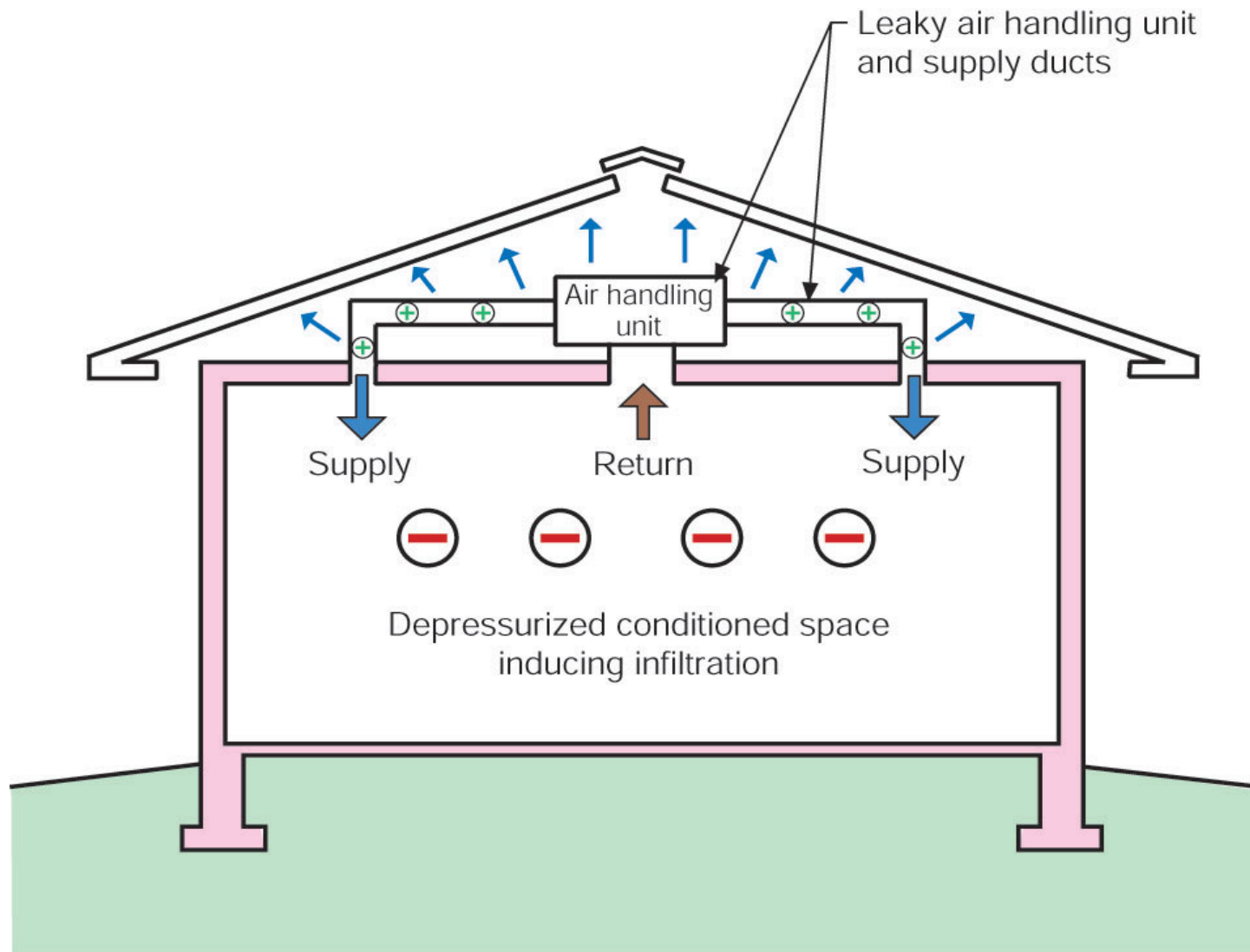




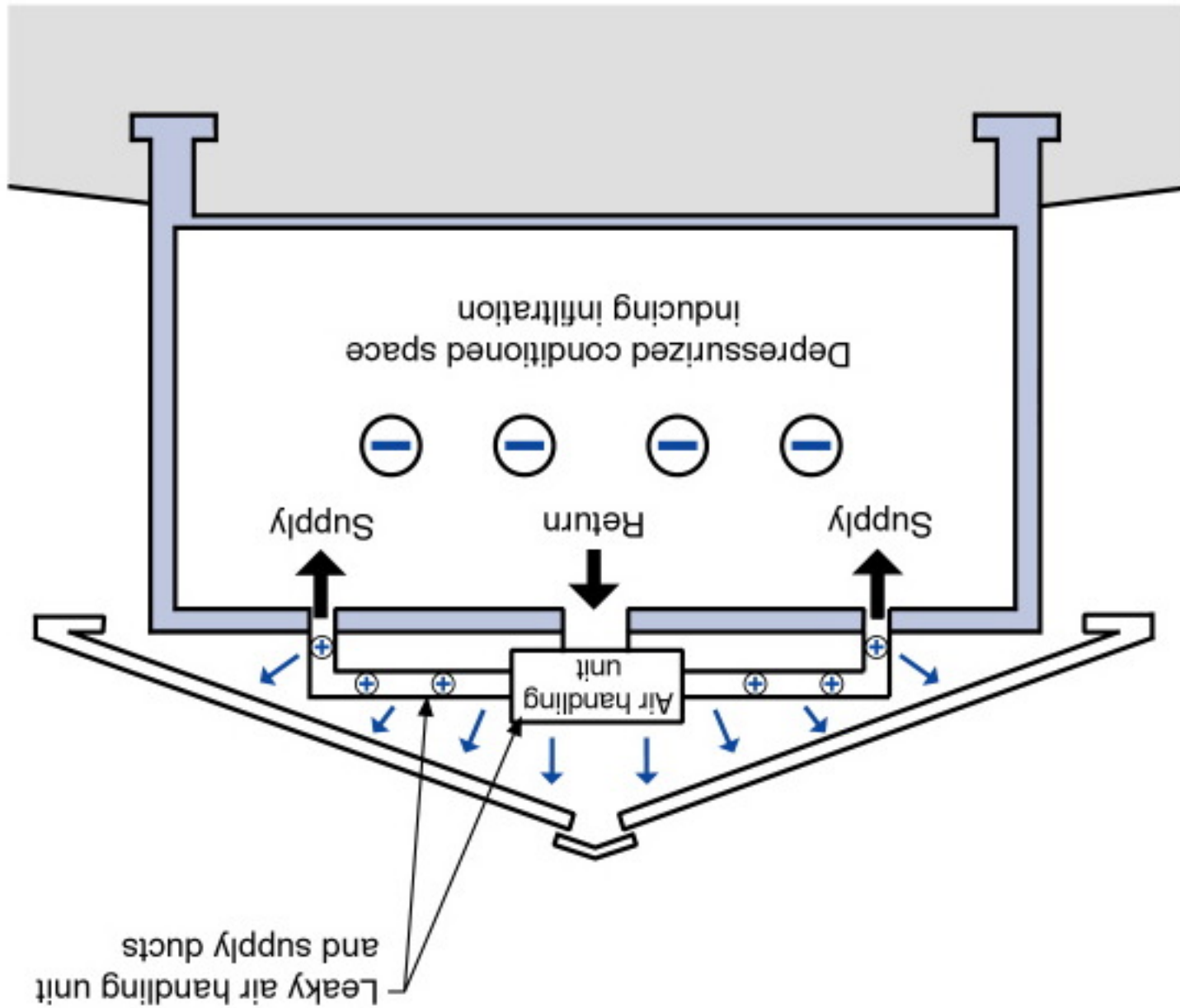


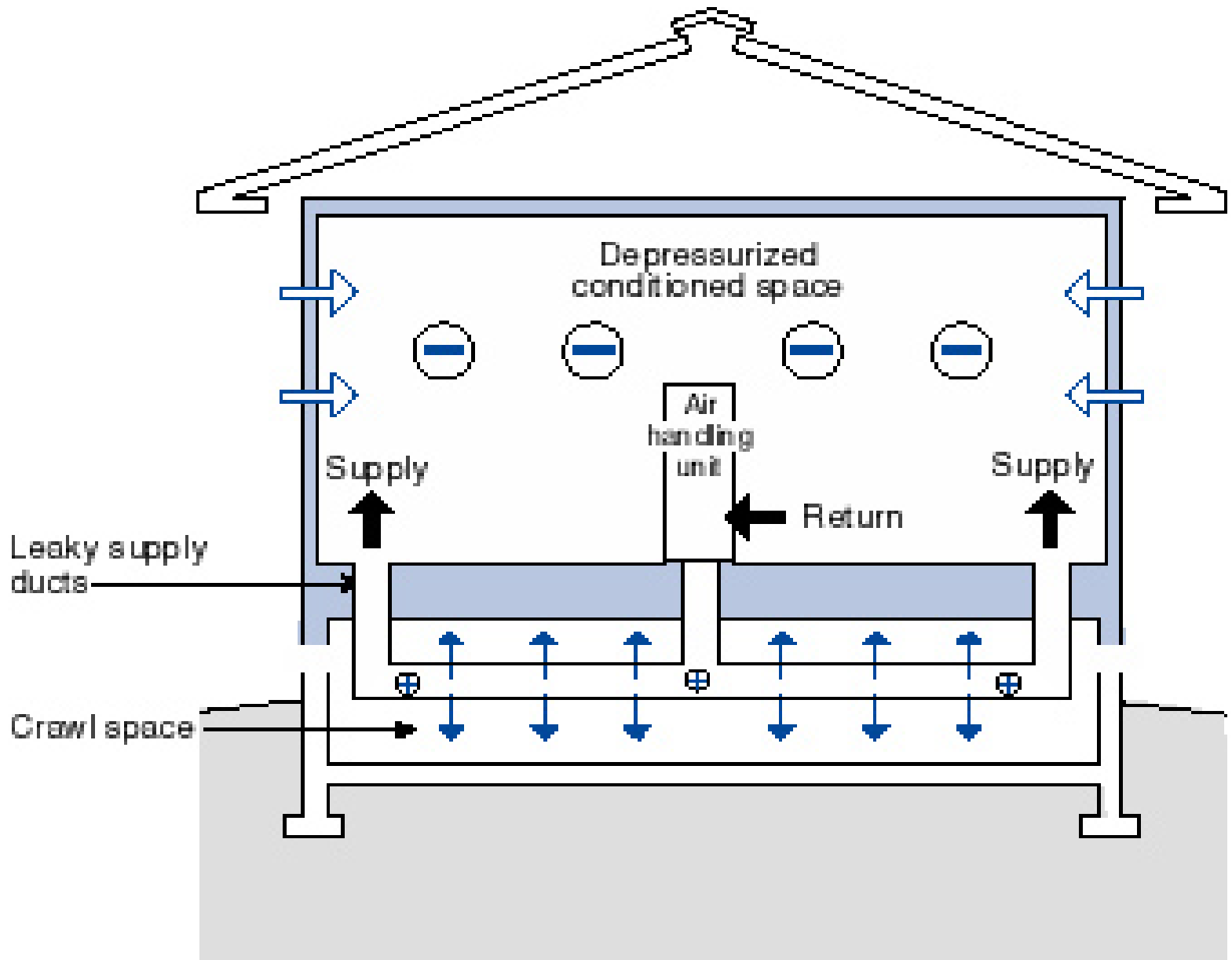






Note: Colored shading depicts the building's thermal barrier and pressure boundary. The thermal barrier and pressure boundary enclose the conditioned space.





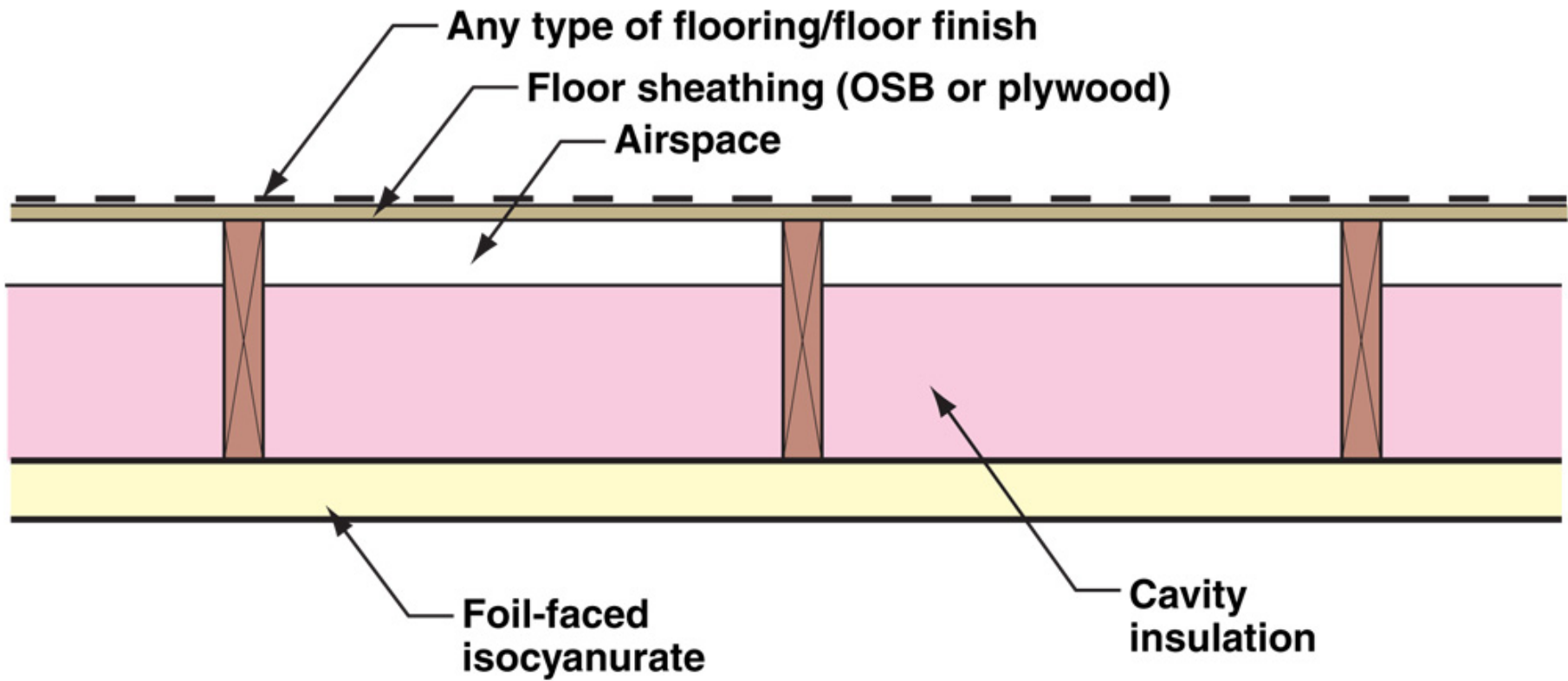










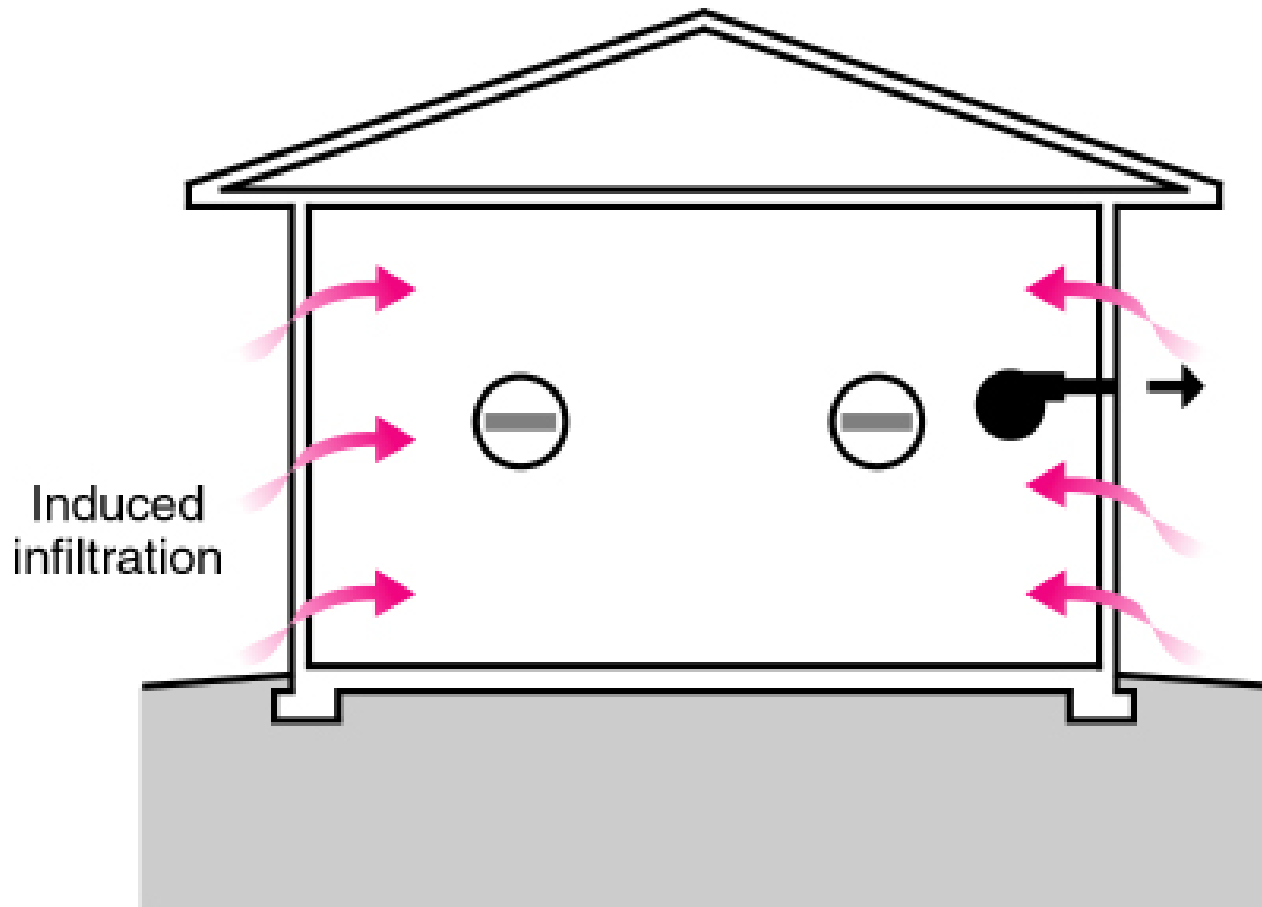


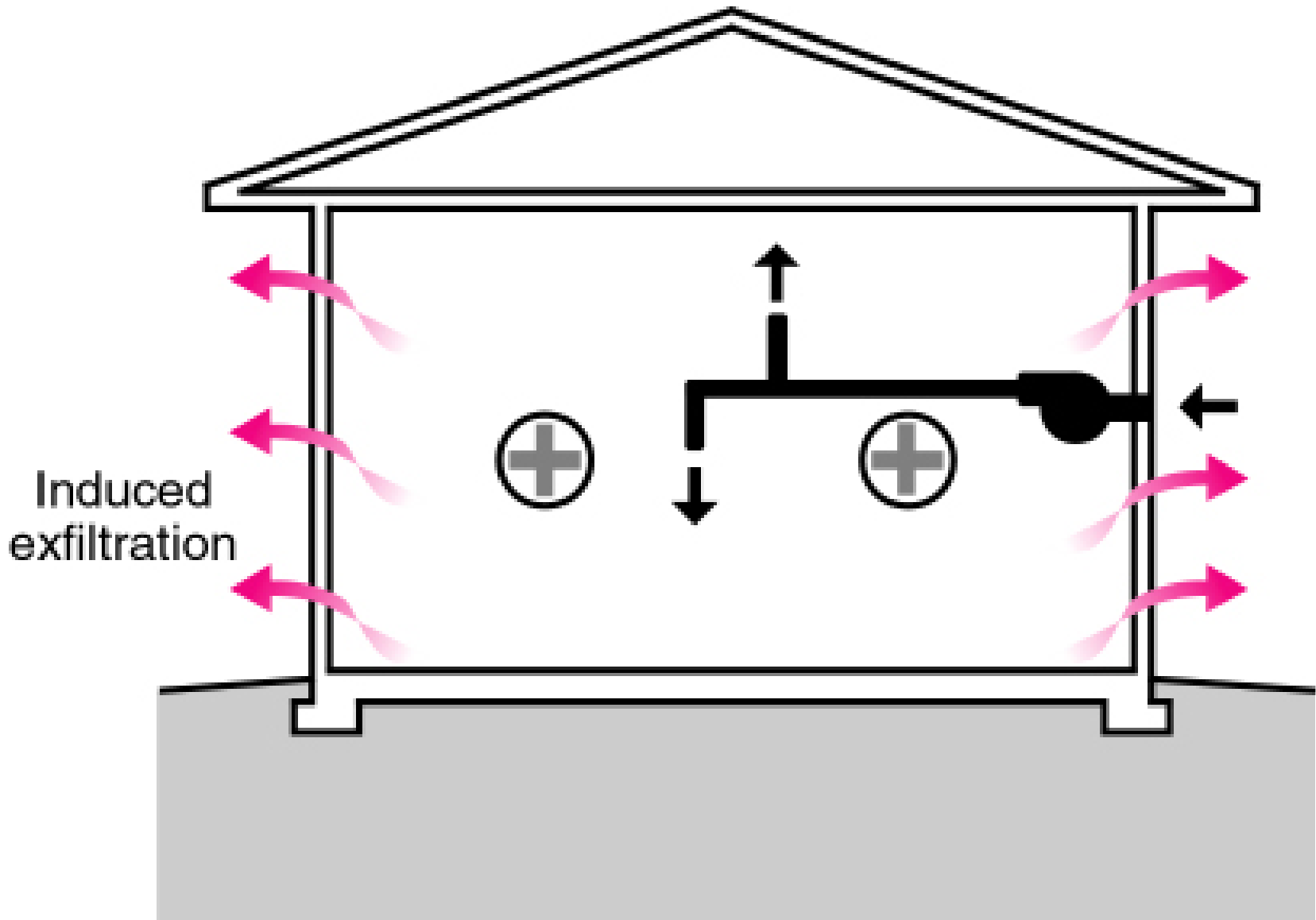
# Three Types of Controlled Ventilation Systems

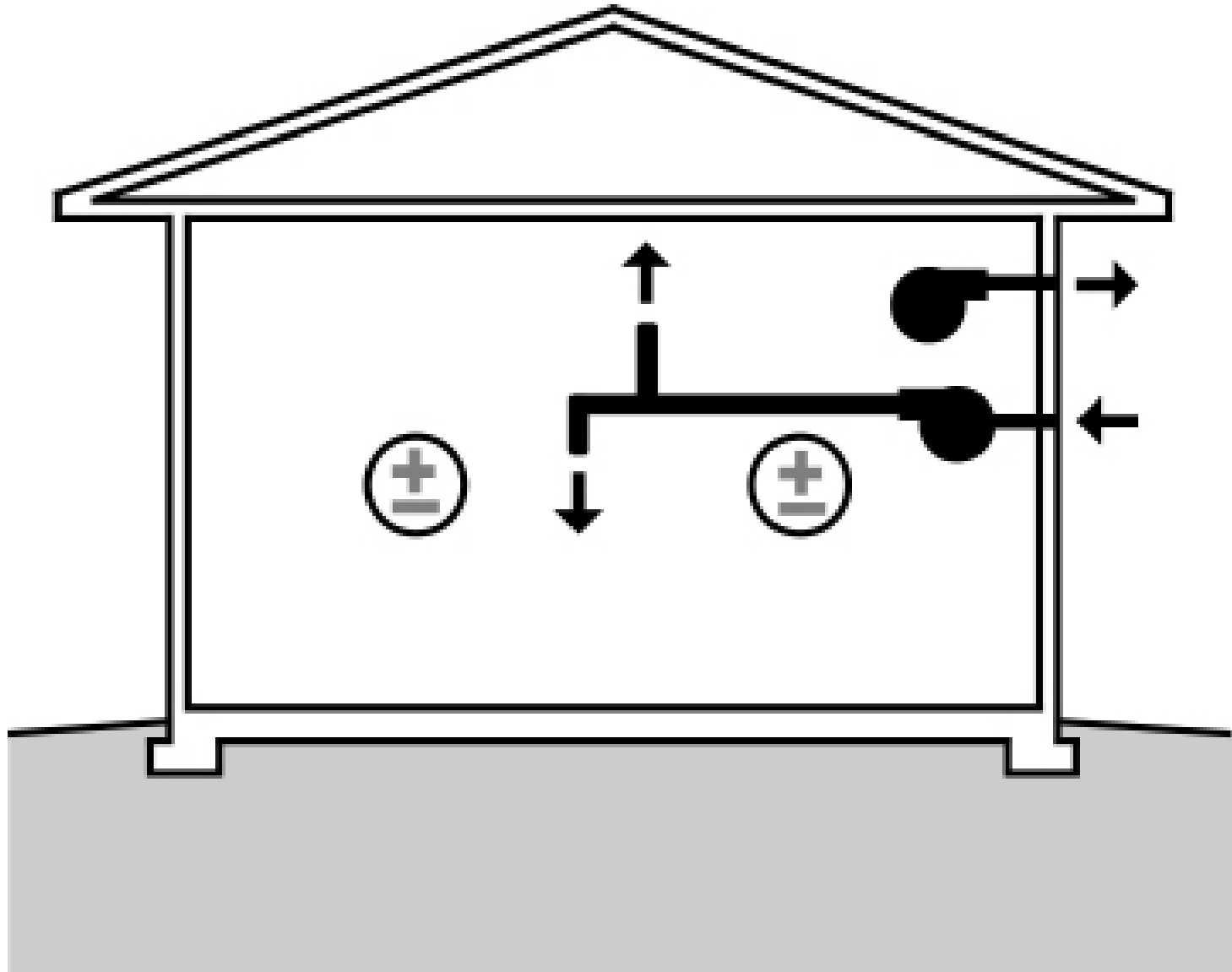
Exhaust Ventilation

Supply Ventilation

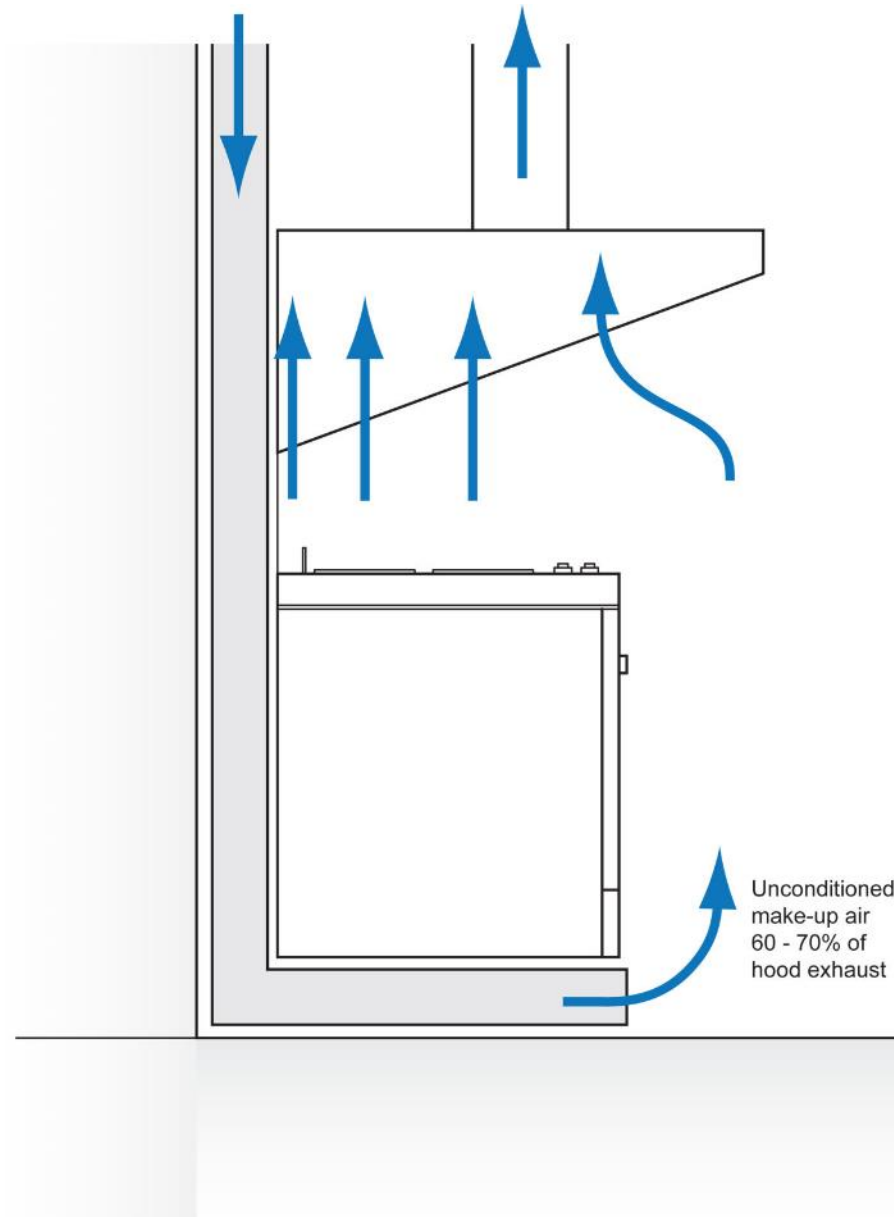
Balanced Ventilation







# Kitchen Exhaust Hoods







# Clothes Dryers





# Fireplaces



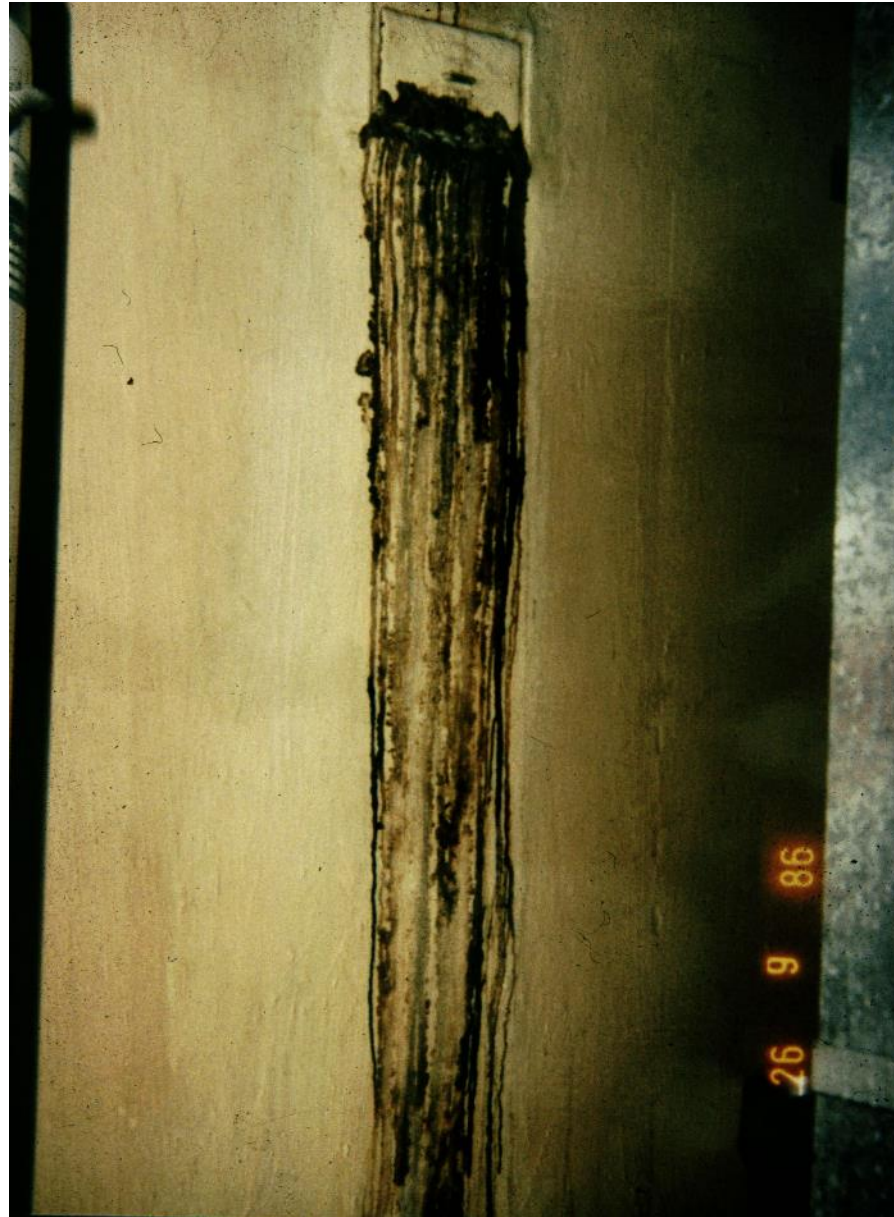
















# Sweating Ducts

Sweating Ducts

Light Colored Roofs

Cool Roofs

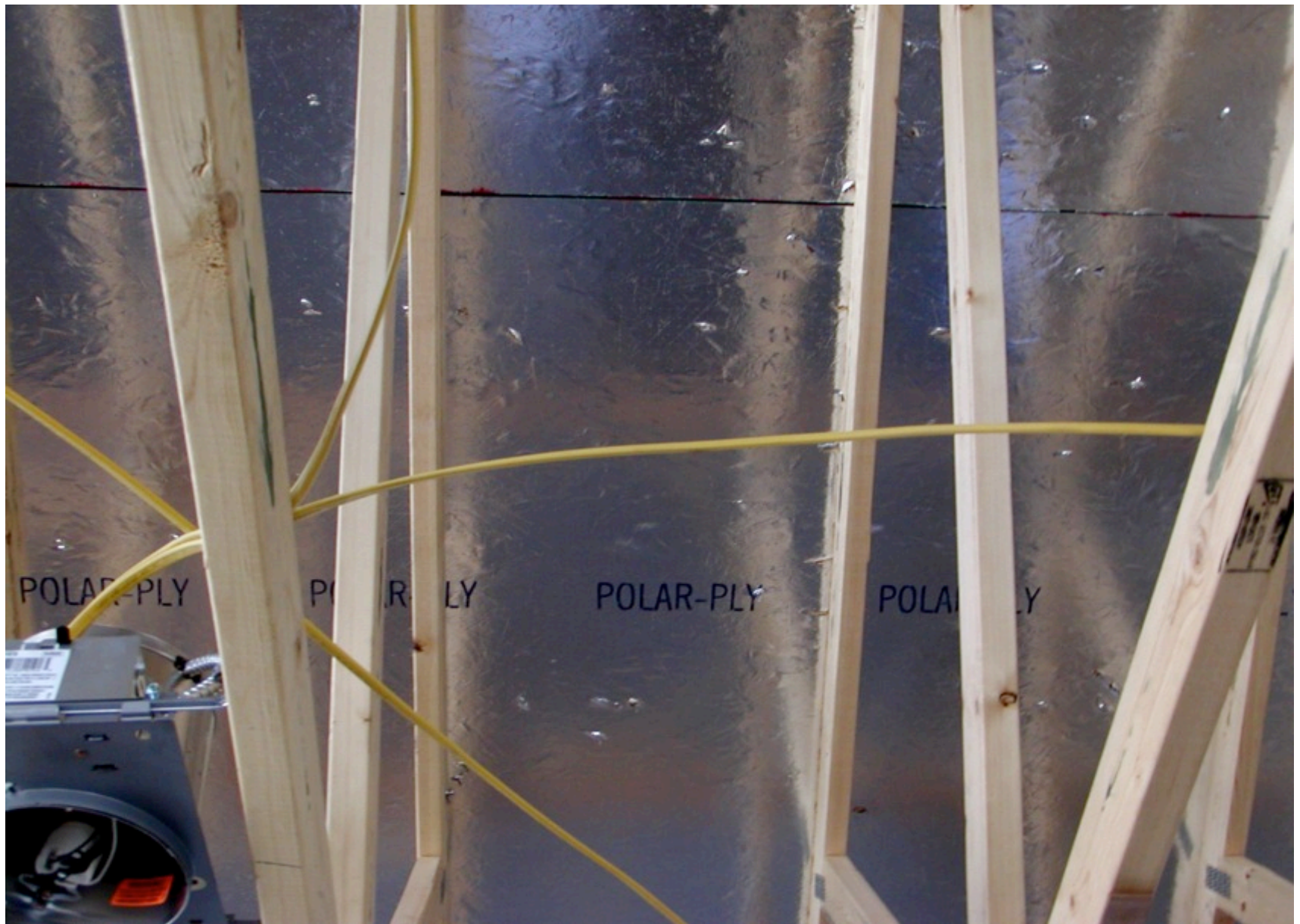
Radiant Barriers

ACCA Manual J, S and D

ASHRAE 62.2

# Ductwork Attic Dehumidification System



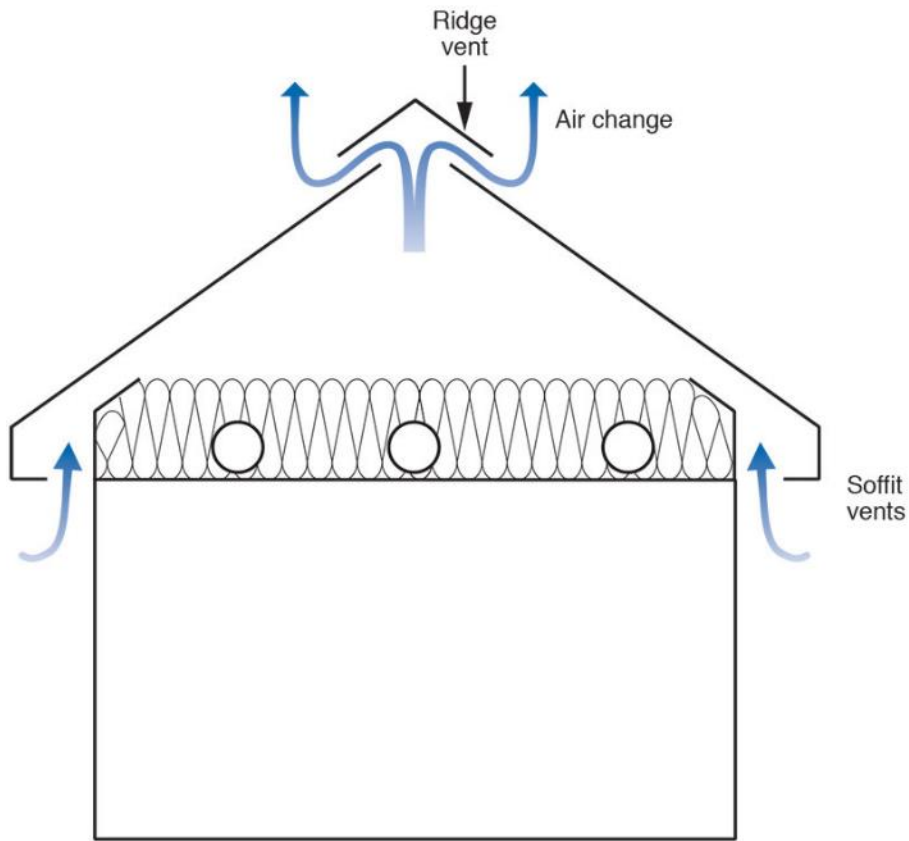




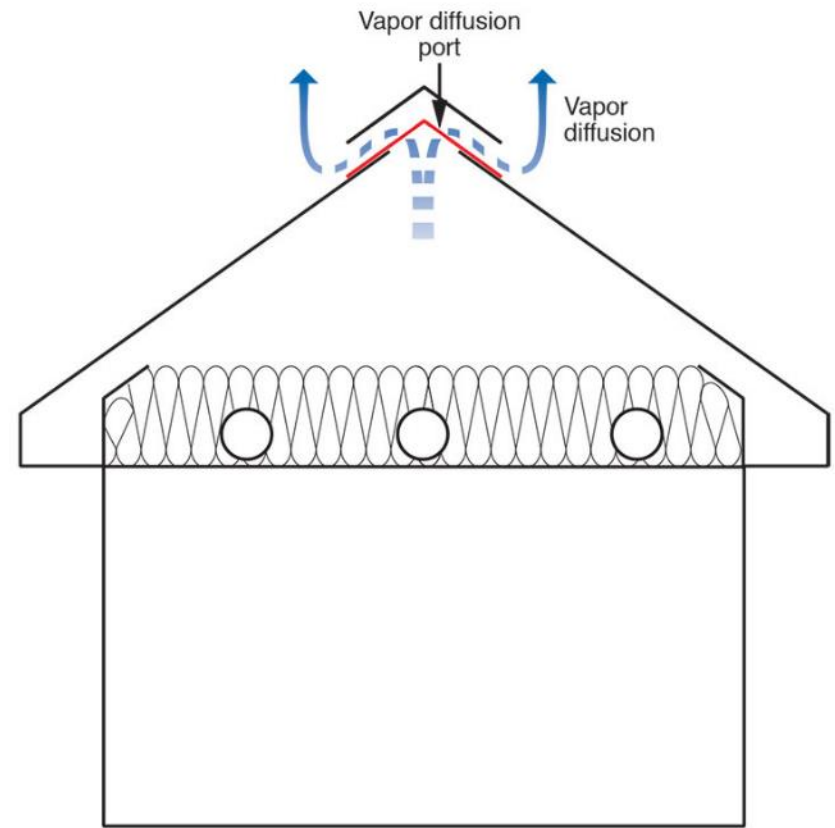








Classic vented attic



Unvented attic with vapor diffusion port













