RESILIENT
Home Building Conference
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Resilient Walls, Roofs & Fenestration: The Building Enclosure

Michael Grote, GCCDS

GCCDS Gulf Coast Community Design Studio

Community & Regional Resilience Institute
CARRI

Strengthening Homes and Safeguarding Families
FLASH
FEDERAL ALLIANCE FOR SAFE HOMES
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FEMA

The Building Enclosure

- Hold up the building (structure)
- Keep rain out
- Keep groundwater out
- Keep the wind out
- Keep the water vapor out
- Let the water and vapor out if they get in
- Keep the soil gas out
- Keep the heat in during the winter
- Keep the heat out during the summer
- Keep the noise out

Special Topics

- Attic Venting or ***To Vent or Not To Vent***
- Old Dogs & New Materials or ***"I have been doing this for 30 years , and this is always the way we have done it."***

Enclosure Components

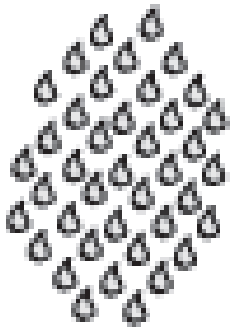
- Walls
- Floors
- Roofs
- Windows & Doors

Component Assembly

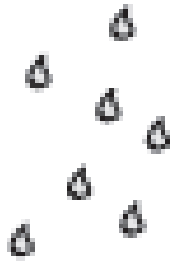
- Structure
- Air & Moisture Control
- Thermal Control (Insulation)
- Exterior Cladding
- Interior Finishes
- Windows & Doors and other Big Holes in the enclosure
- Penetrations, Flashing, Caulking, and other things to fill gaps, cracks & hide undesirable situations

Quick Physics Lessons

- Heat is heat, Cool/cold is only less heat
- Heat moves in one direction to where there is less heat.
- Water Vapor moves from more humid areas or materials to less humid areas or materials through vapor pressure difference or temperature difference. This is Vapor Diffusion, which is independent of Air Flow with water vapor in it.
- Air Flow with is created by Pressure differential. Without this driving force the others have to use other means



DIFFUSION



Higher Dewpoint Temperature
Higher Water Vapor Density
or Concentration
(Higher Vapor Pressure)
on Warm Side of Assembly

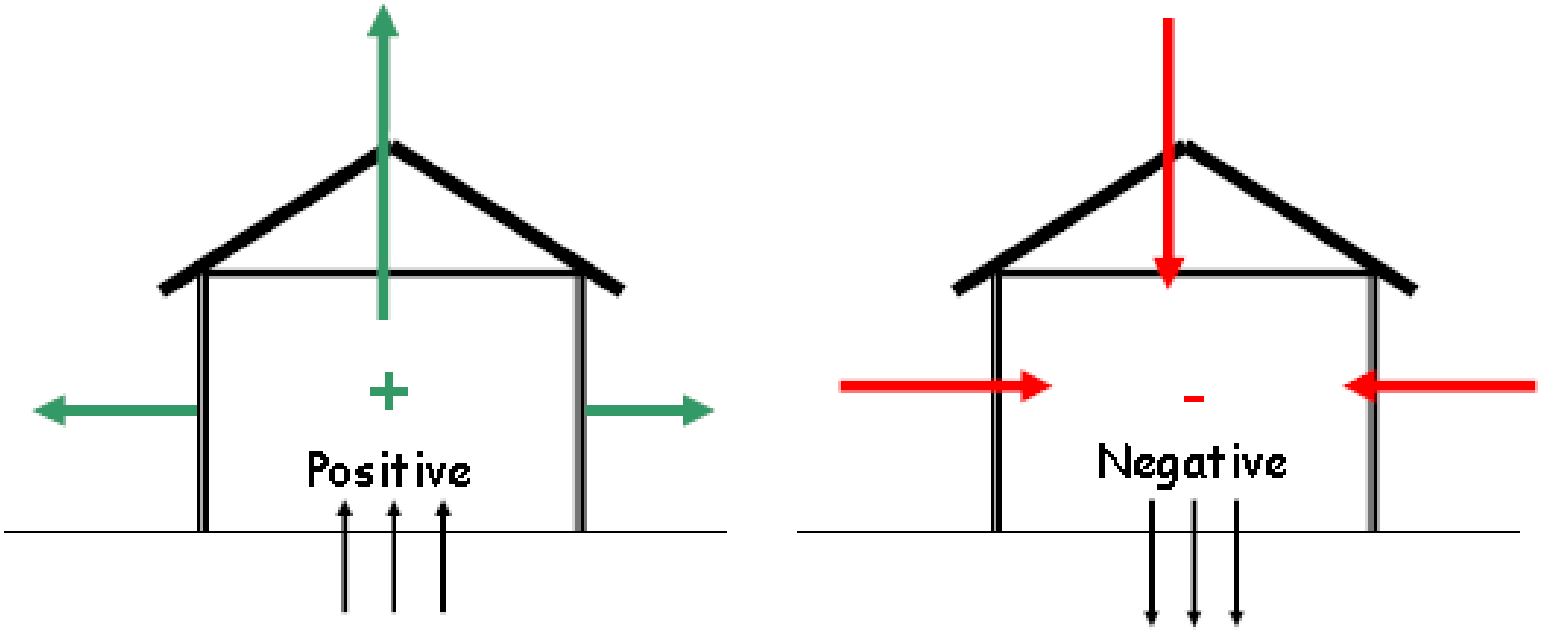
Low Dewpoint Temperature
Lower Water Vapor Density
or Concentration
(Lower Vapor Pressure)
on Cold Side of Assembly

AIR TRANSPORT

Higher Air
Pressure

Lower Air
Pressure

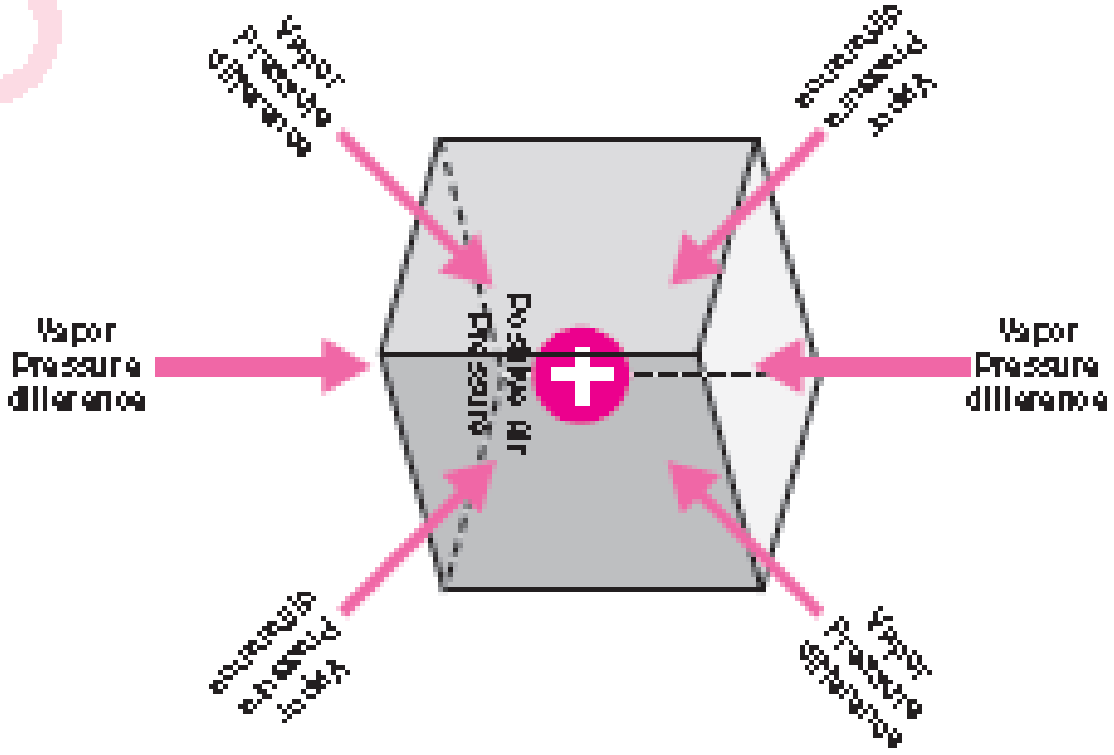
P = Pressure Difference



Flow is from + Positive (High) to - Negative (Low).

For every cfm that Exits one cfm Enters.

Flow takes path of Least resistance.


Vapor Pressure difference
Vapor Pressure difference
Positive air pressure

Vocabulary Lesson

There are too many terms, and confusion over what is to be used and not used, lets use simple terms that are easy to understand:

- Water Control Layer
- Air Control Layer
- Vapor Control Layer
- Thermal Control Layer

Layers of Control

- Water Control Layer
  - A sheet, spray or trowel-applied membrane or material layer that controls the passage of liquid water even after long or continuous exposure to moisture.
- Air Control Layer
  - Air control layers control airflow between a conditioned space and an unconditioned space or between units in multi-family and apartment construction.

Layers of Control

- Thermal Control Layer
  - The component (or components) that is (or are) designed and installed in an assembly to control the transfer of thermal energy (heat). Typically these are comprised of insulation products, radiant barriers, or trapped gaps filled with air or other gases. One quantitative measure of a thermal control layers resistance to heat flow is the R-value. R-values are limited in that they deal with conduction, one of three modes of heat flow (the other two being convection and radiation) and that their range of applicability is typically limited to materials not assemblies.

Layers of Control

- Vapor Control Layer
  - The component (or components) that is (or are) designed and installed in an assembly to control the movement of water by vapor diffusion.

Layers of Control

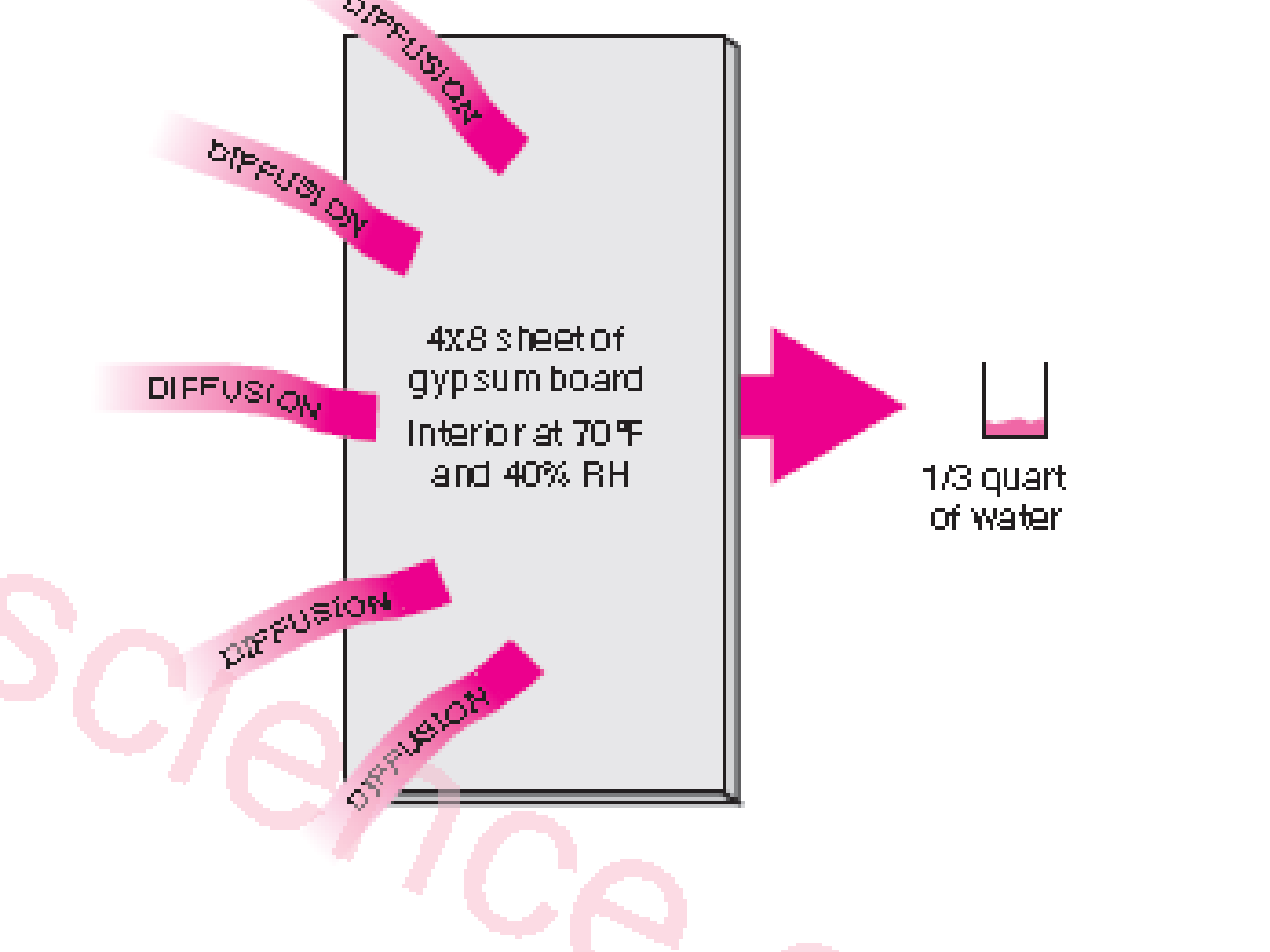
- **Vapor control layer classes**
- The measure of a material or assembly's ability to limit the amount of water that passes through the material or assembly by vapor diffusion. The test procedure for determining vapor control layer class is ASTM E-96 Test Method A (the desiccant or dry cup method).
- Class I: permanence of 0.1 perm or less
  - VAPOR IMPERMEABLE: Rubber Membranes, polyethylene film, glass, aluminum foil, sheet metal, foil-faced insulating sheathings
- Class II: permanence of 1.0 perm or less and greater than 0.1 perm
  - VAPOR SEMI IMPERMEABLE: oil-based points, most vinyl wall coverings, unfaced extruded polystyrene 1-inch

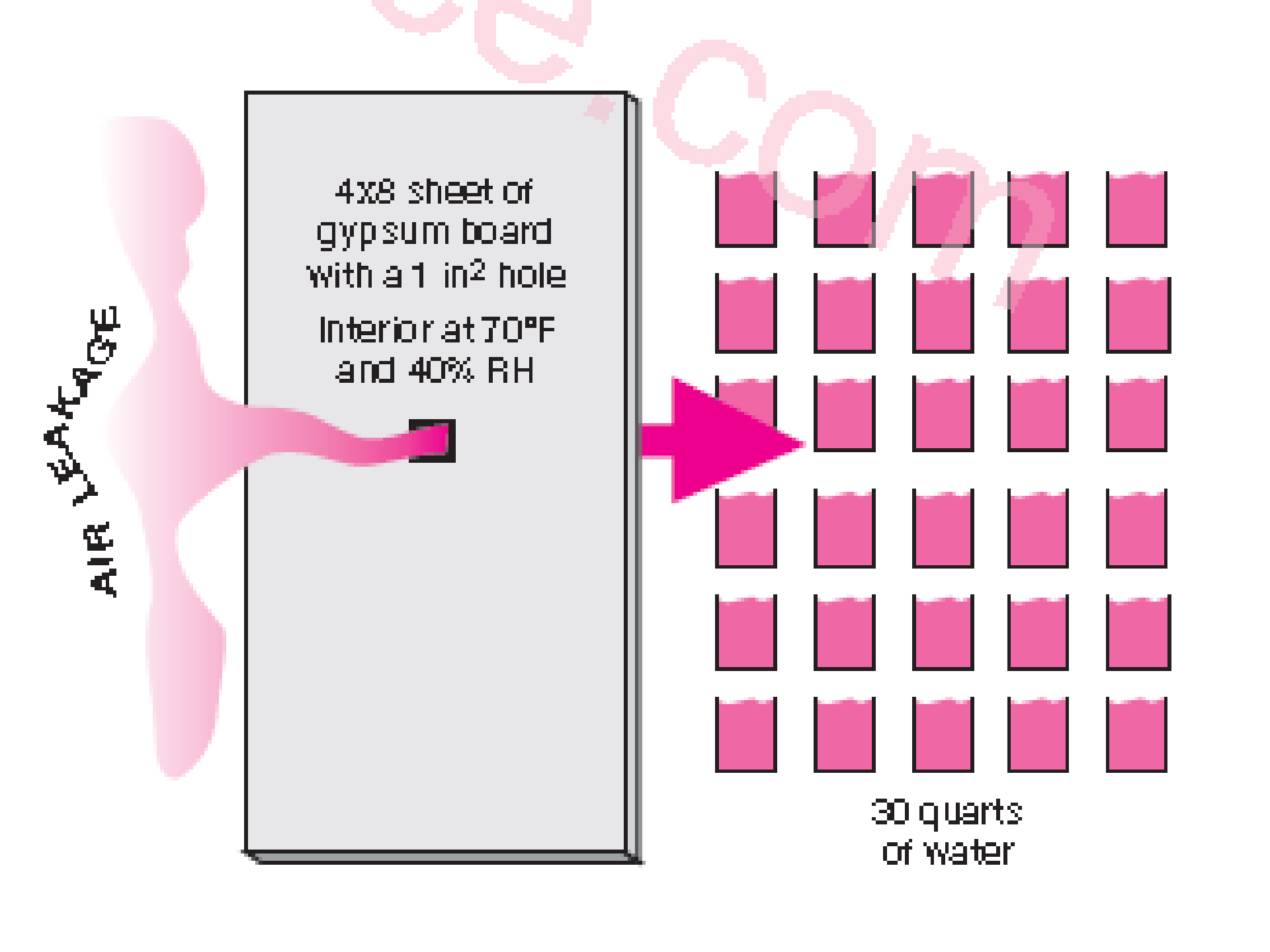
Layers of Control

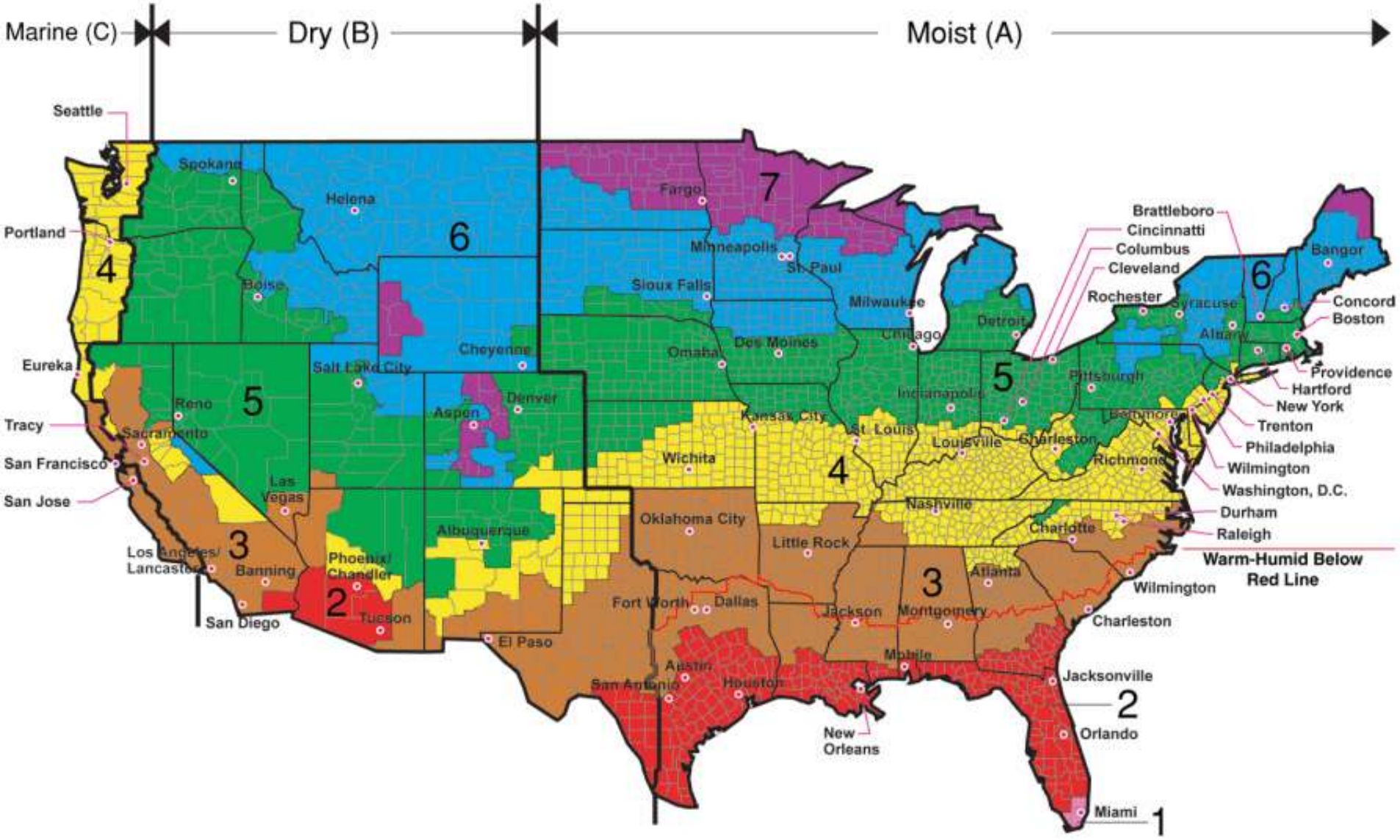
- **Vapor control layer classes**
- Class III: permanence of 10 perms or less and greater than 1.0 perm
  - VAPOR SEMI-PERMEABLE: Plywood, bitumen impregnated Kraft Paper, OSB, un-faced expanded & extruded polystyrene (EPS & XPS), fiber faced isocyanurate, asphalt impregnated building papers (#30 building paper), most latex-based paints
- Class IV: permanence greater than 10 perms
  - VAPOR PERMEABLE: unpainted gypsum board & plaster, unfaced fiberglass insulation, cellulose insulation, synthetic stucco, some latex paints, #15 asphalt impregnated building paper, asphalt impregnated fiberboard sheathing, “house wraps”

Air Control Layer

- Key characteristics of air barrier
  - Continuity (holes, penetrations, openings)
  - Ability to resist air pressure differences
    - Wind
    - Stack effect
    - Mechanical
- Rigid materials like interior gypsum board, exterior sheathing and rigid draft stopping materials are good air barriers due to their ability to resist air pressure differences.

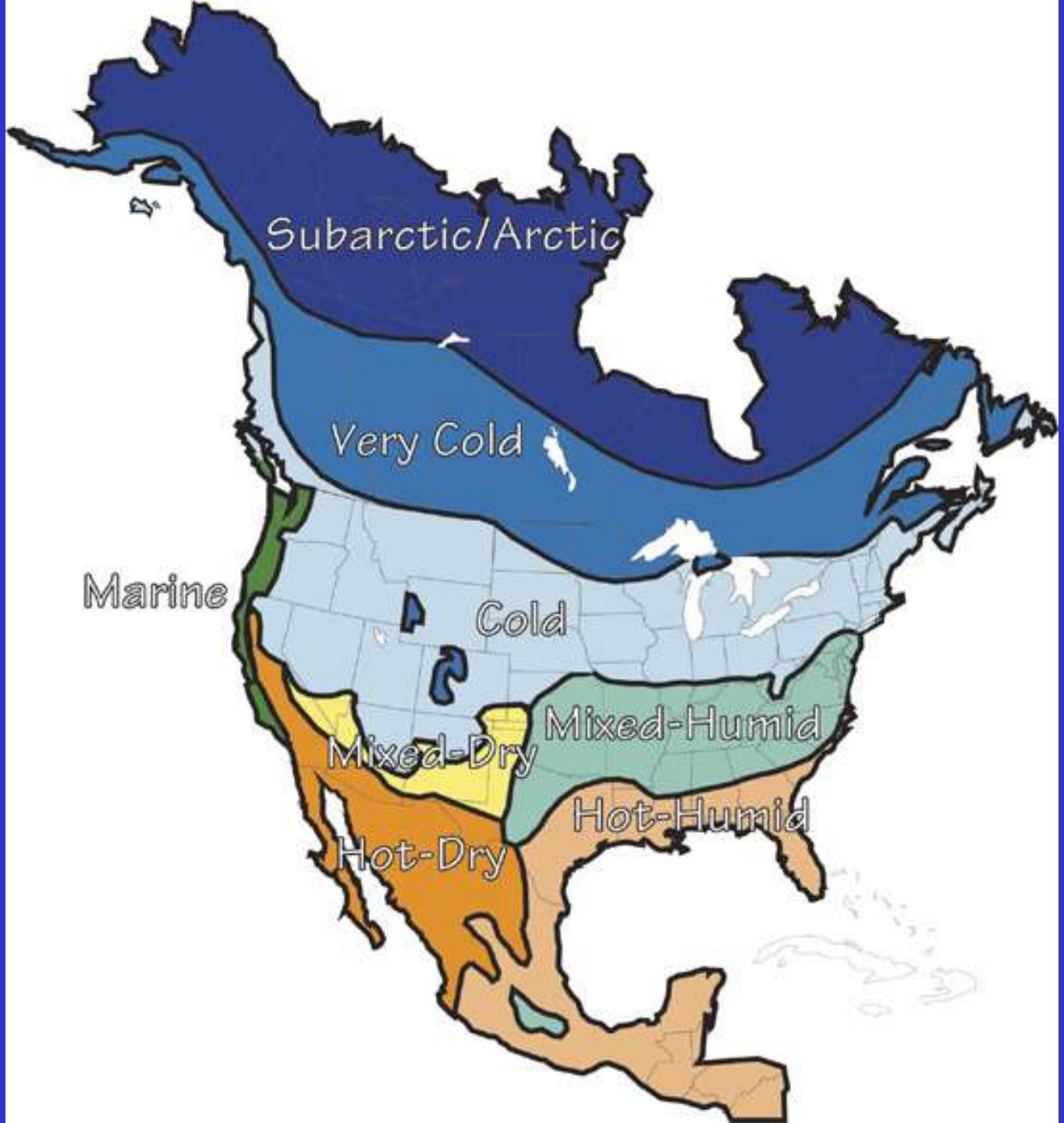

DIFFUSION
DIFFUSION
DIFFUSION
DIFFUSION
DIFFUSION
4x8 sheet of
gypsum board
Interior at 70°F
and 40% RH
1/3 quart
of water


4x8 sheet of
gypsum board
with a 1 in² hole
Interior at 70°F
and 40% RH
AIR LEAKAGE
30 quarts
of water



All of Alaska in Zone 7 except for the following Boroughs in Zone 8: Bethel, Dellingham, Fairbanks, N. Star, Nome North Slope, Northwest Arctic, Southeast Fairbanks, Wade Hampton, and Yukon-Koyukuk

Zone 1 includes: Hawaii, Guam, Puerto Rico, and the Virgin Islands


Subarctic/Arctic
Very Cold
Marine
Cold
Mixed-Humid
Mixed-Dry
Hot-Humid
Hot-Dry

Enclosure Components Requirements

- Zone 2
- No Interior Vapor Barrier

Component Assembly

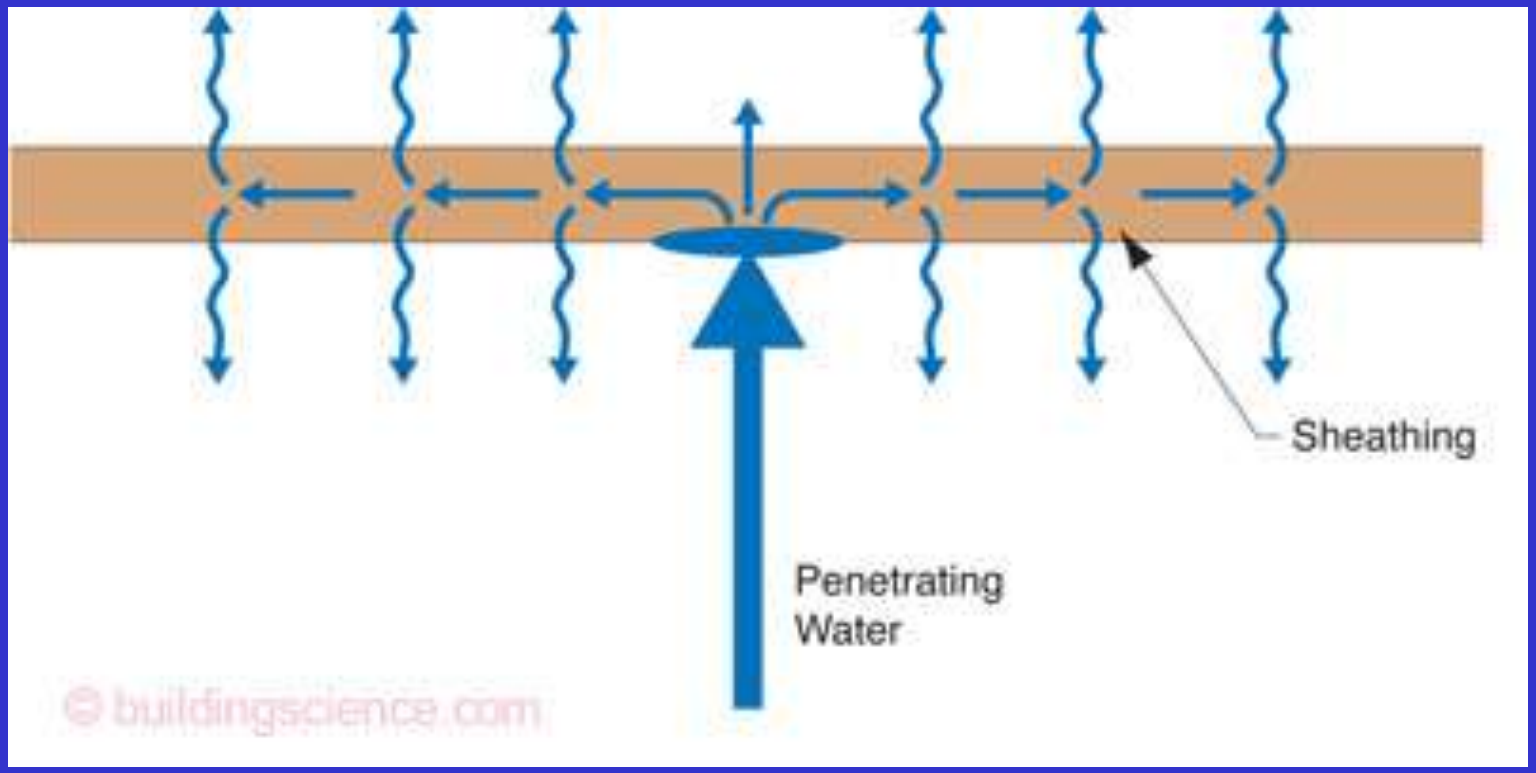
- Structure
- Air & Moisture Control
- Thermal Break (Insulation)
- Exterior Cladding
- Interior Finishes
- Windows & Doors and other Big Holes in the enclosure
- Penetrations, Flashing, Caulking, and other things to fill gaps, cracks & hide undesirable situations

Sheathing & Decking

- Sheathing
  - Keeps he house from racking
  - Keeps the wind out
  - Keeps the rain out
  - Wrapped with paper, wrap etc
- Plywood & OSB
  - There are others however in the wind zones we have down here the alternatives do not hold up structurally.

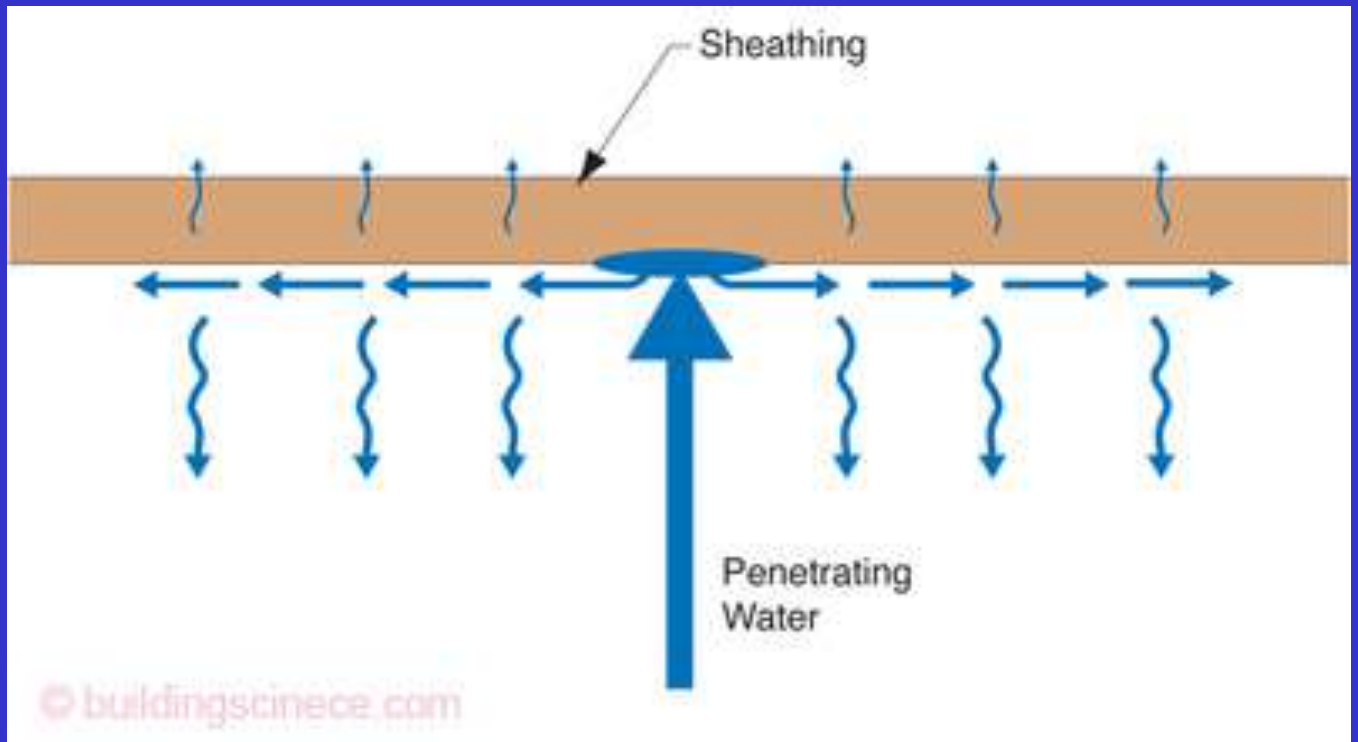
Plywood

- Replaced board sheathing
- Strong
- Great moisture distribution properties



OSB

- Stronger & cheaper than plywood
- Improved sensitivity to water
- Less moisture distribution properties
- Needs small air gap (ie crinkled wrap)

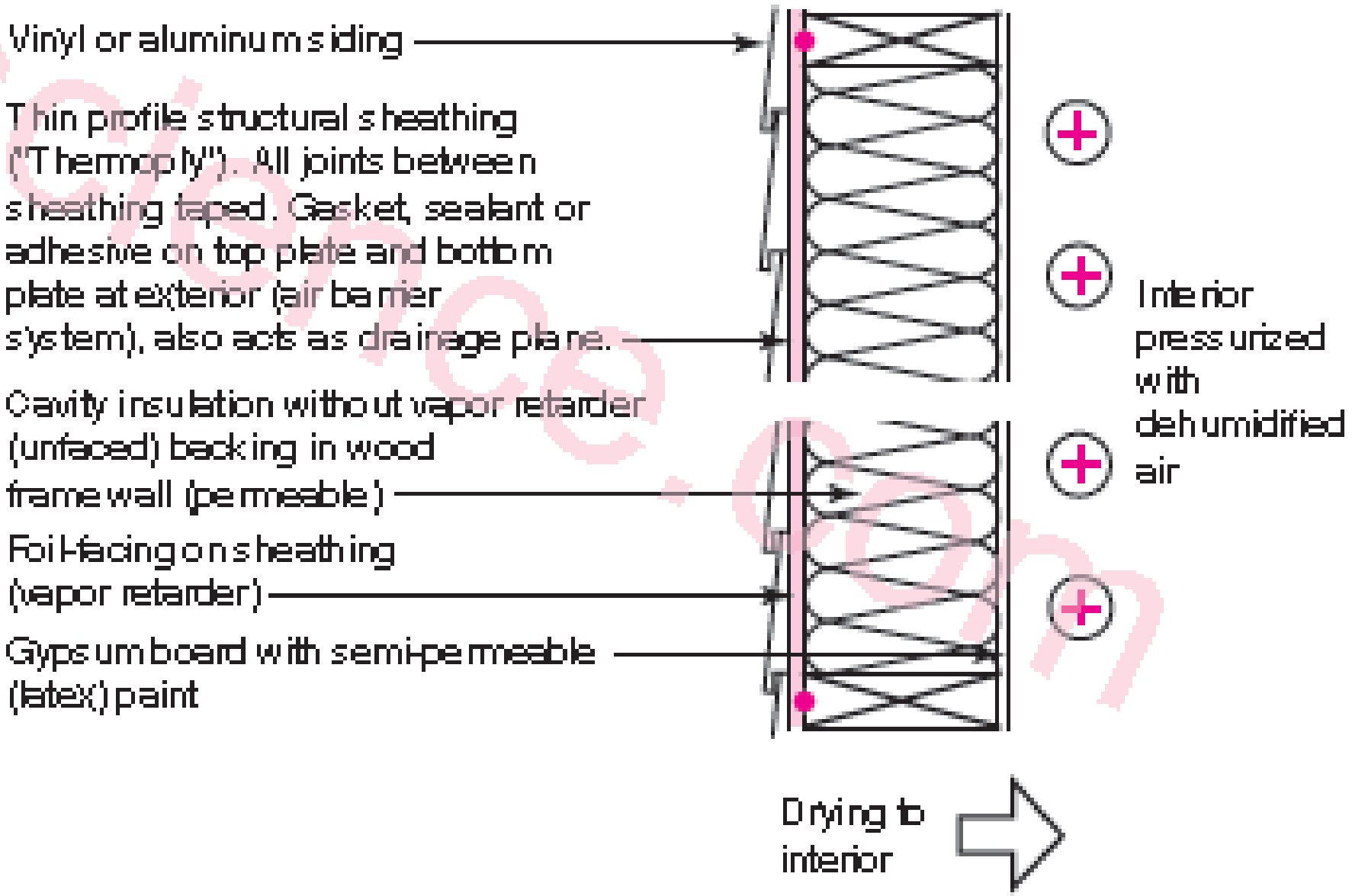


Building Strategy

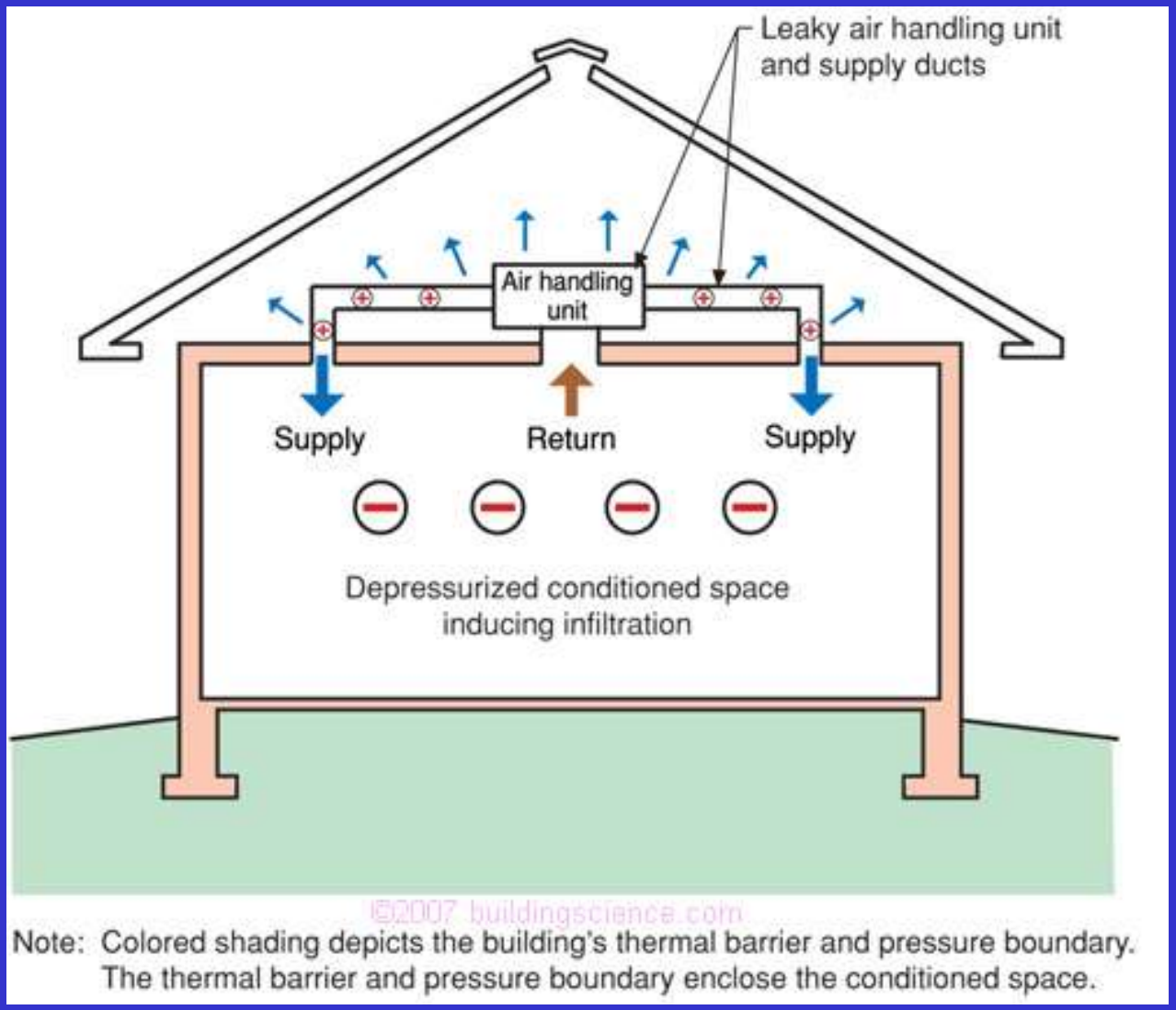
- Protect from wetting by air transport and vapor diffusion
- Proper location of vapor, air, water & thermal control layers depends on climate location and season

Building Strategy: Hot Humid Climate

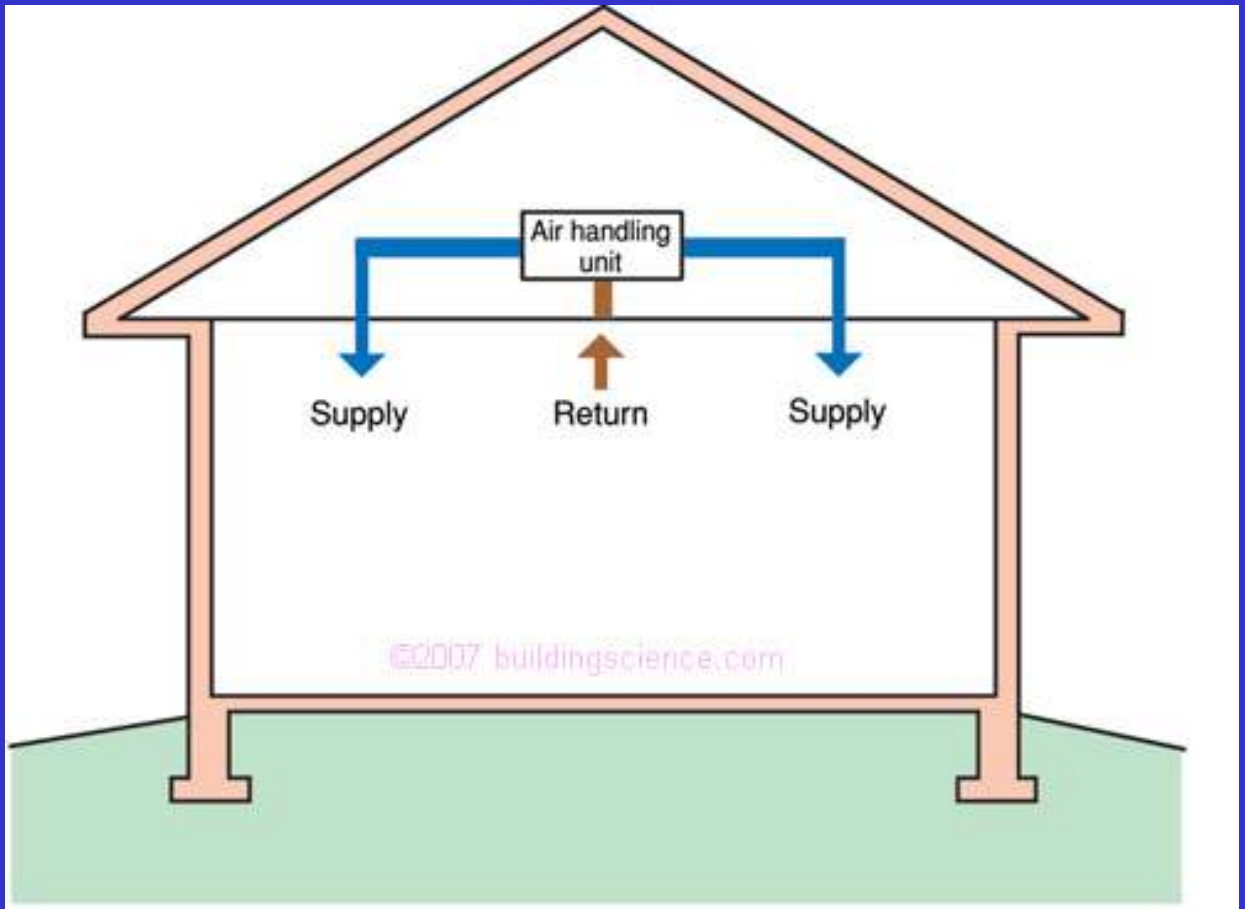
- Must be protected from wetting from exterior and allowed to dry from inside
- Air Control and Vapor Control on exterior of assembly
- Permeable materials on the inside and cavity
- Maintain a slightly positive air pressure with conditioned air.


Vinyl or aluminum siding
Thin profile structural sheathing ("Thermoply"). All joints between sheathing taped. Gasket, sealant or adhesive on top plate and bottom plate at exterior (air barrier system), also acts as drainage plane.
Cavity insulation without vapor retarder (unfaced) backing in wood frame wall (permeable)
Foil-facing on sheathing (vapor retarder)
Gypsum board with semi-permeable (latex) paint
Interior pressurized with dehumidified air
Drying to interior
Air pressure acts to the exterior
Vapor pressure acts to the interior

Attic Venting or Not?



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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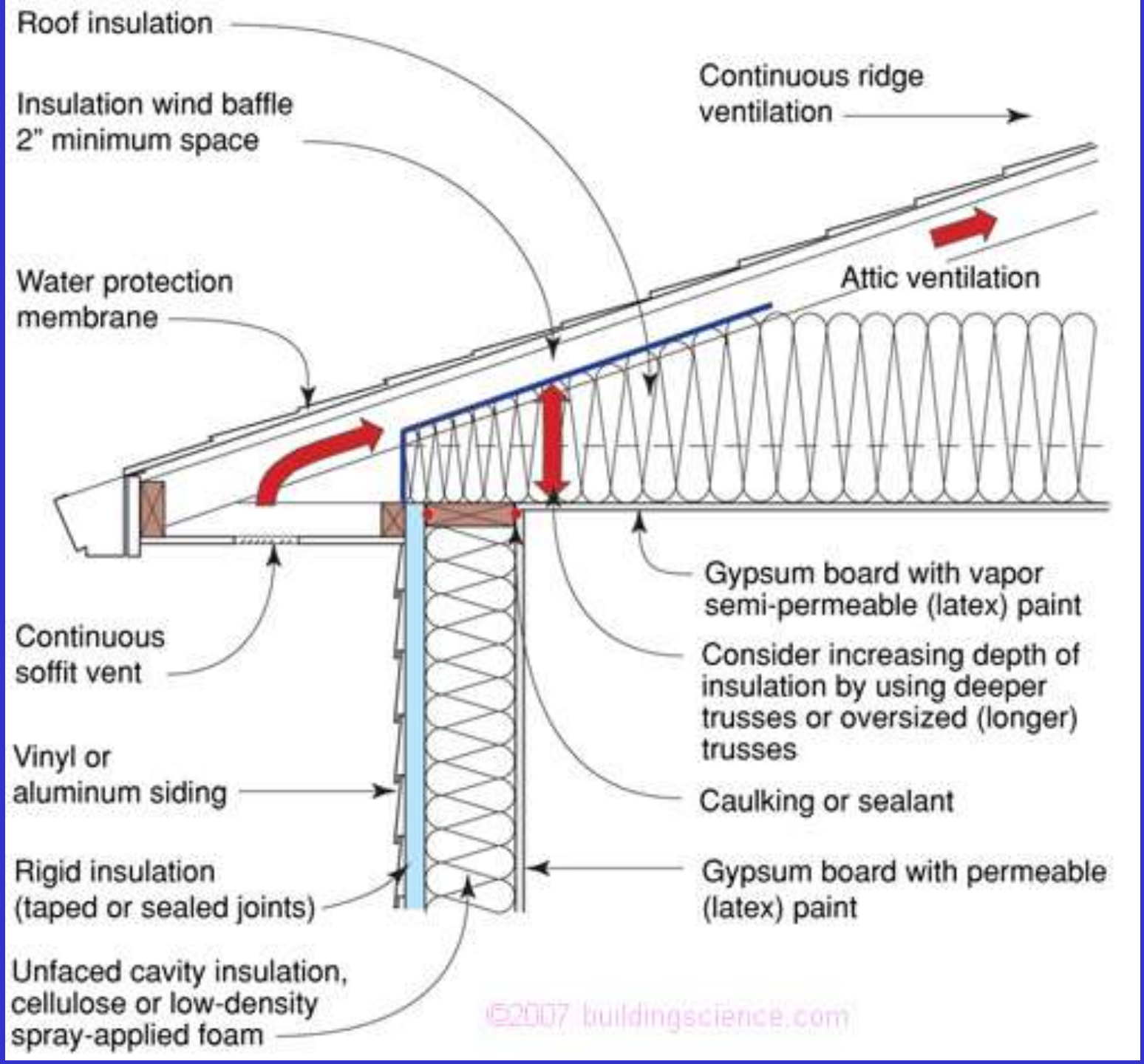
Roof insulation
Insulation wind baffle
2" minimum space
Continuous ridge
ventilation
Water protection
membrane
Attic ventilation
Gypsum board with vapor
semi-permeable (latex) paint
Continuous
soffit vent
Consider increasing depth of
insulation by using deeper
trusses or oversized (longer)
trusses
Vinyl or
aluminum siding
Caulking or sealant
Rigid insulation
(taped or sealed joints)
Gypsum board with permeable
(latex) paint
Unfaced cavity insulation,
cellulose or low-density
spray-applied foam
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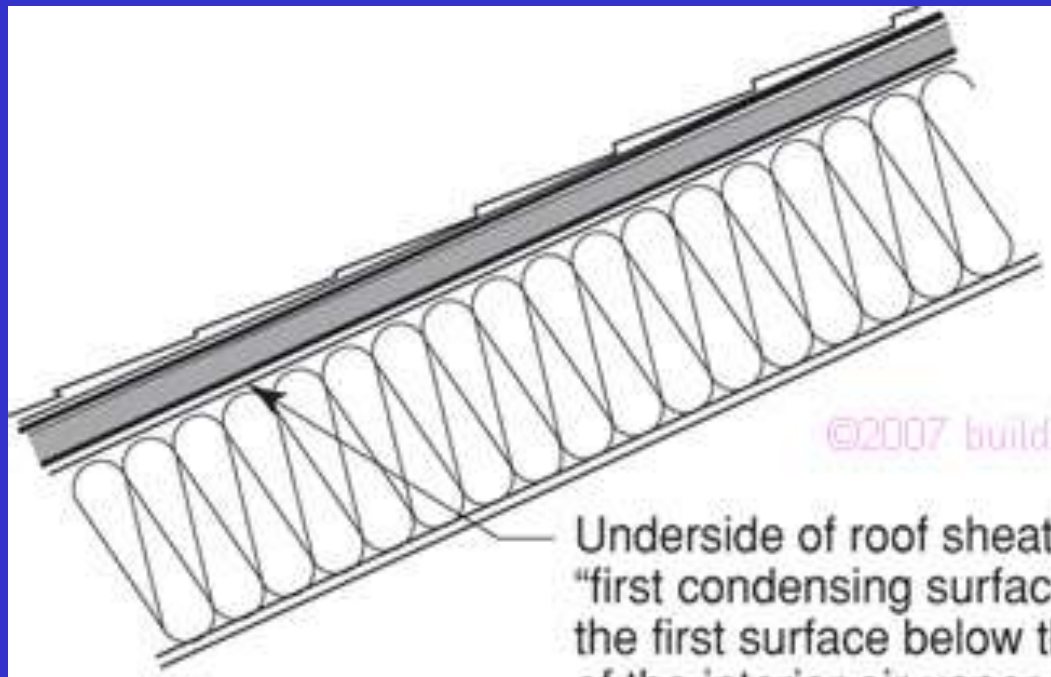
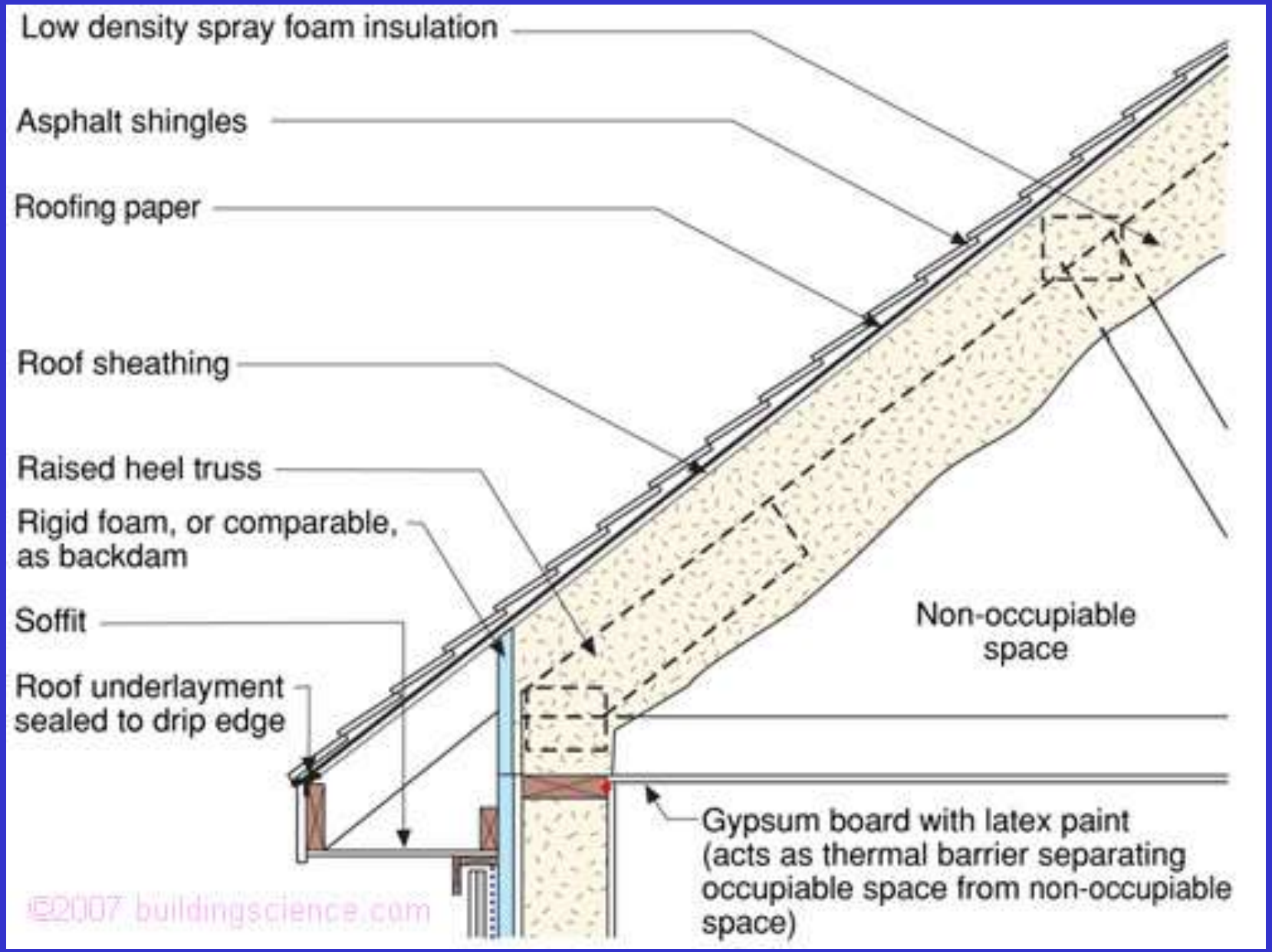


Underside of roof sheathing is typically the "first condensing surface" as it tends to be the first surface below the dewpoint temperature of the interior air-vapor mixture with sufficient thermal mass to support condensation during cold weather. Additionally, it also tends to be the first surface below the dewpoint temperature of the interior air-vapor mixture that is also relatively impermeable compared to the insulation layer beneath it.


Low density spray foam insulation
Asphalt shingles
Roofing paper
Roof sheathing
Raised heel truss
Rigid foam, or comparable, as backdam
Soffit
Roof underlayment sealed to drip edge
Non-occupiable space
Gypsum board with latex paint (acts as thermal barrier separating occupiable space from non-occupiable space)
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Old Dogs New Materials

Images and Resources

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