In accordance with the Department of Labor and Industry's statute 326.0981, Subd. 11,

"This educational offering is recognized by the Minnesota Department of Labor and Industry as satisfying **1.5 code/energy hours** of credit toward **Building Officials and Residential Contractors** continuing education requirements."

For additional continuing education approvals, please see the continuing education credit section in the conference agenda booklet.

Welcome

Houses That Work - Module 2 about

Module Two

- Creating building enclosures that work for healthy, safe durable, efficient and sustainable homes.
  - Foundation systems
  - Above grade wall systems
  - Windows
  - Roof and attic systems

NOW THAT WE KNOW THE BUILDING SCIENCE BASICS....

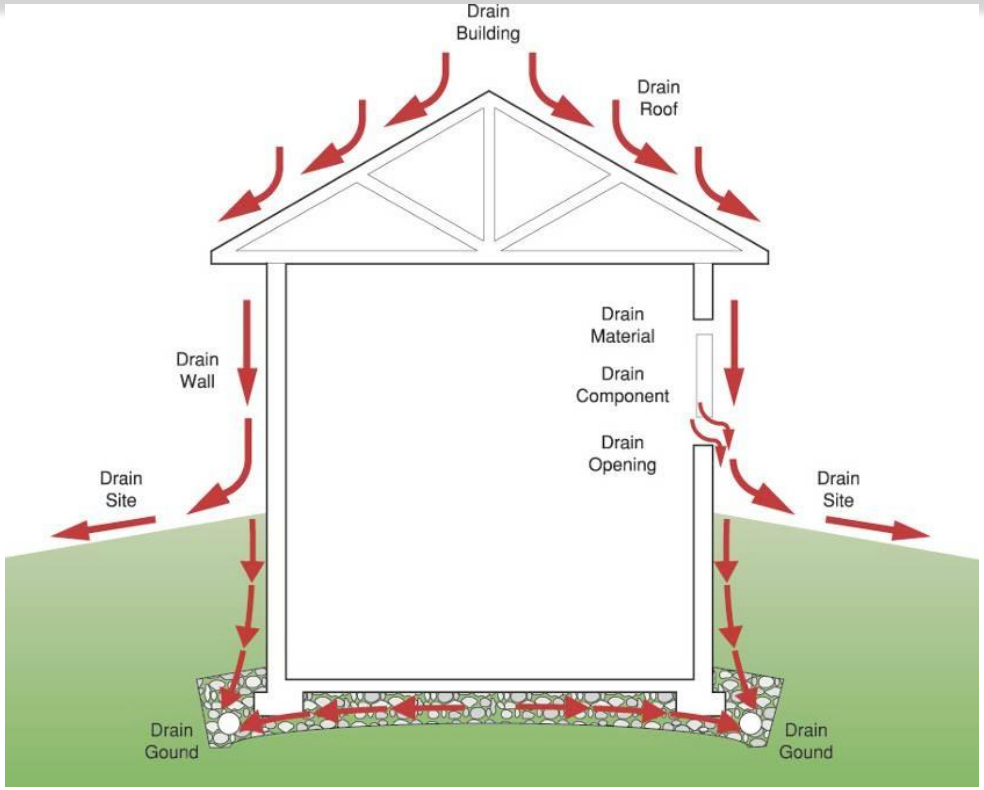
We can begin to create walls, roofs and foundation systems that work

Managing the elements

First we need to protect our building system from water

From the Ground Up

- Manage water
- Manage thermal
- Manage air



Graphics from EEBA Water Management Guide

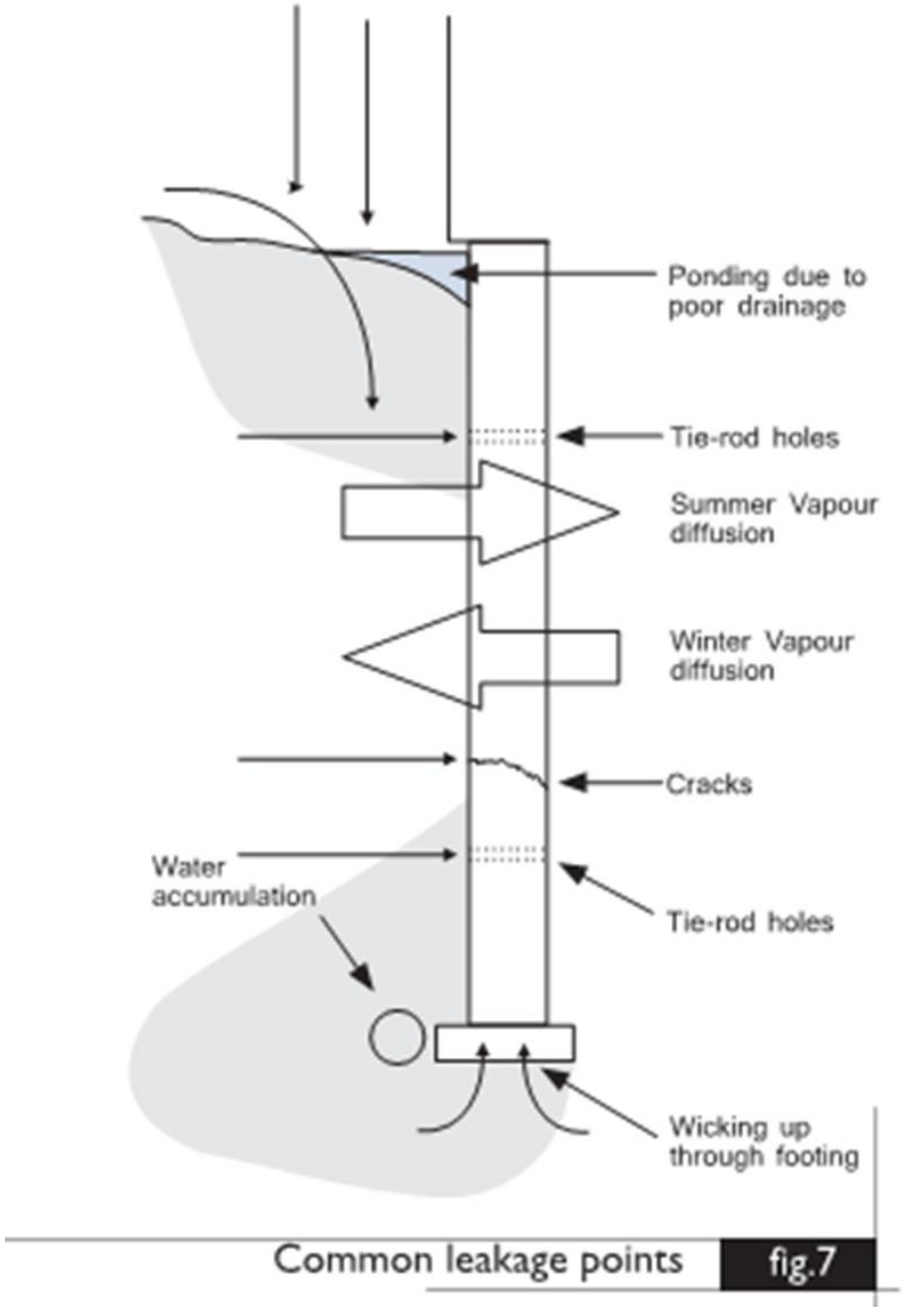
When below grade....

- Remember the rules:
  - Moisture is present
  - Insects are close by
  - Soil gas can enter
  - Surfaces can be cool
  - Concrete wicks water
  - Foundations can be very challenging

Basements: Are they meant to be lived in?

KEY NOTE: IN COLD CLIMATES….

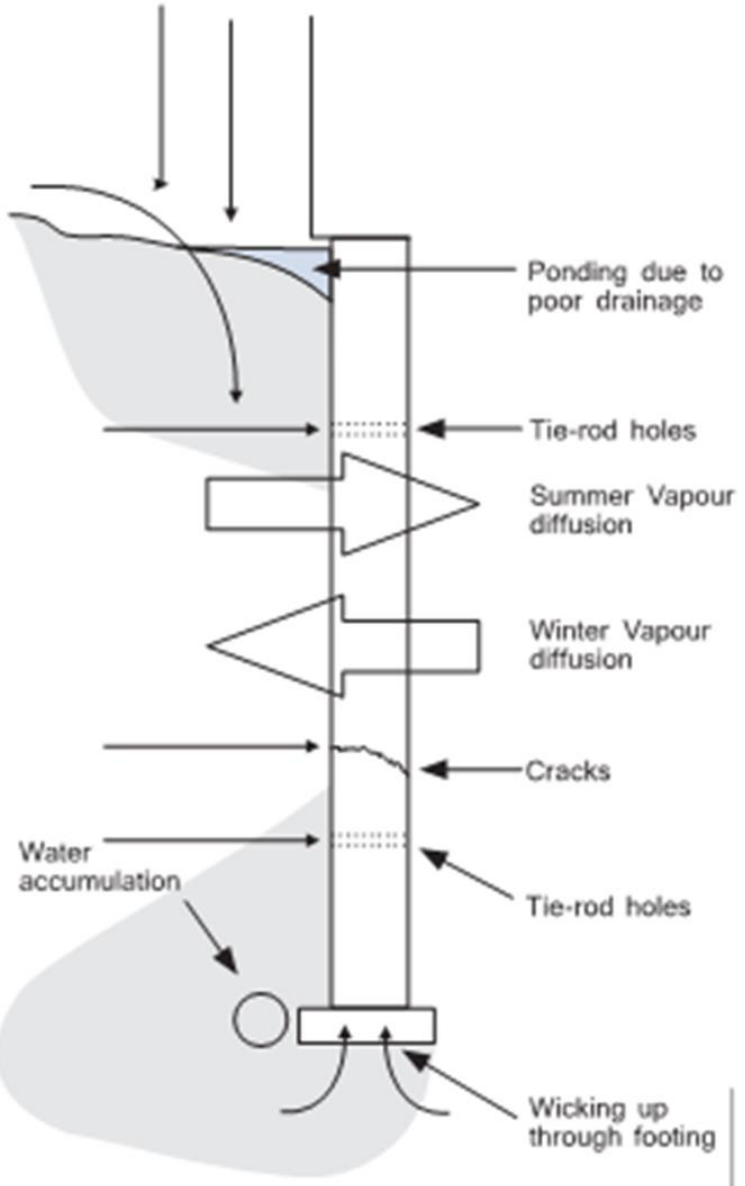
- Below Grade Walls primarily **DRY TO The INSIDE**
- Above Grade Walls primarily DRY TO The OUTSIDE



Common leakage points fig.7

Basements: The Design Priorities In New Homes

1. Liquid water-Rain or ground water
2. Soil dampness-Wet and Humid (Water vapour diffusion)
3. Construction moisture
4. Air leakage(and soil gas)
5. Cool surfaces (and surface condensation control)
6. Space Conditioning: Humidity (and temp) control



Common leakage points fig.7

Liquid water-Rain or ground water

- Drain the rain
- Drain the ground water
- Drain EVERYTHING

- During construction - Keep water away from foundations

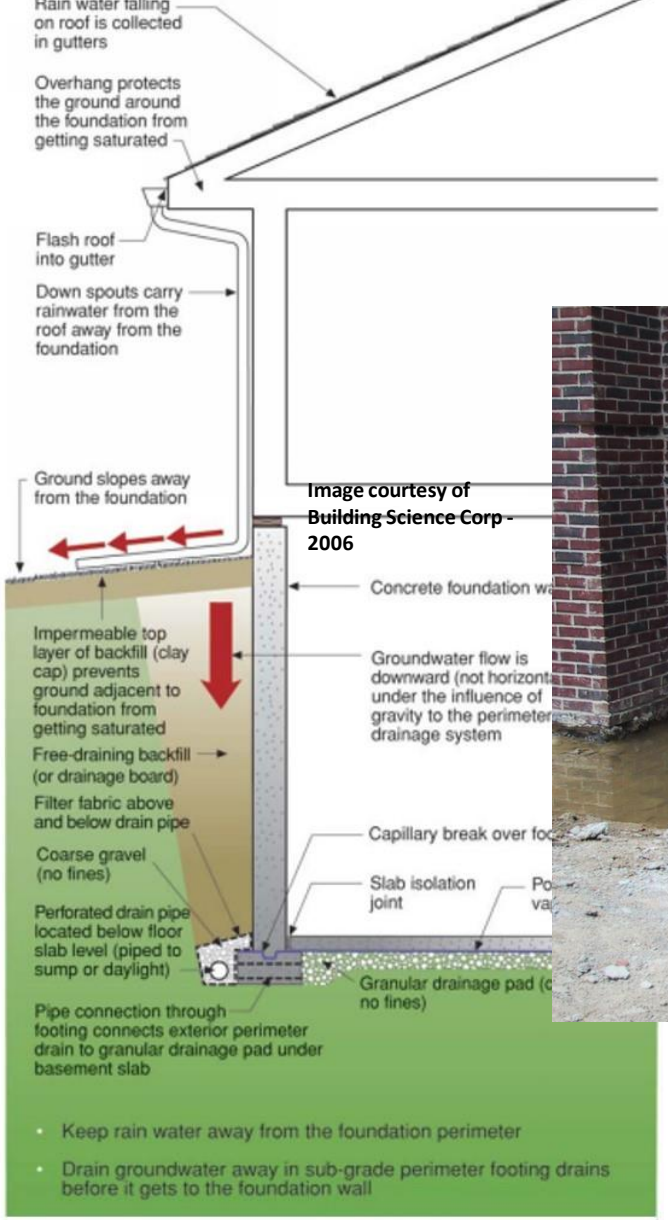


Image courtesy of Building Science Corp - 2006

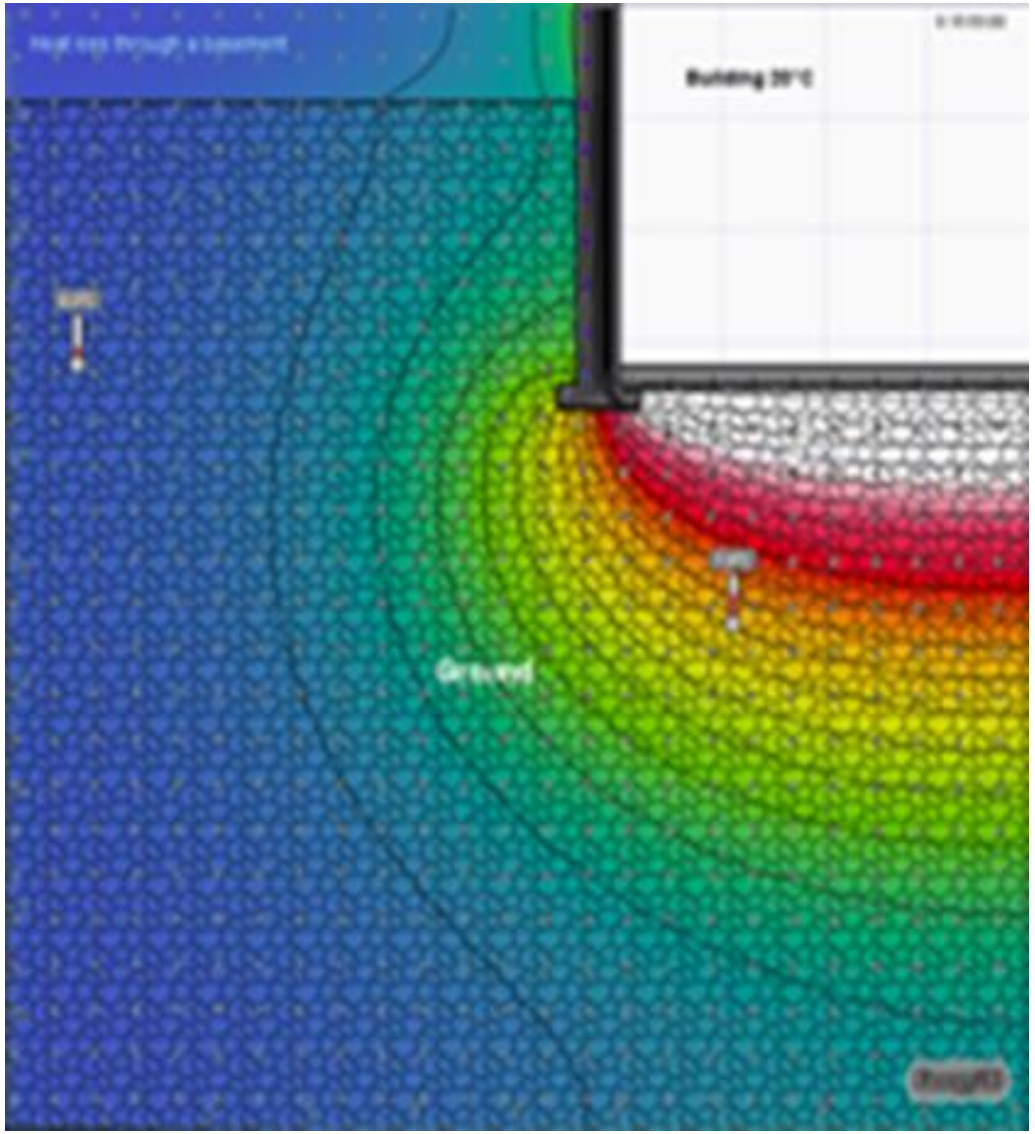
Image used with permission courtesy of building science.com
Building Science Digest 103 2006-10-26 by Joseph Lstiburek
Copywrite 2006

Below grade: Heat loss…Its weird down there.

- The ground is a **heat sink**
- Predominant heat loss is at edge of slab OR at slab /foundation/footing interface

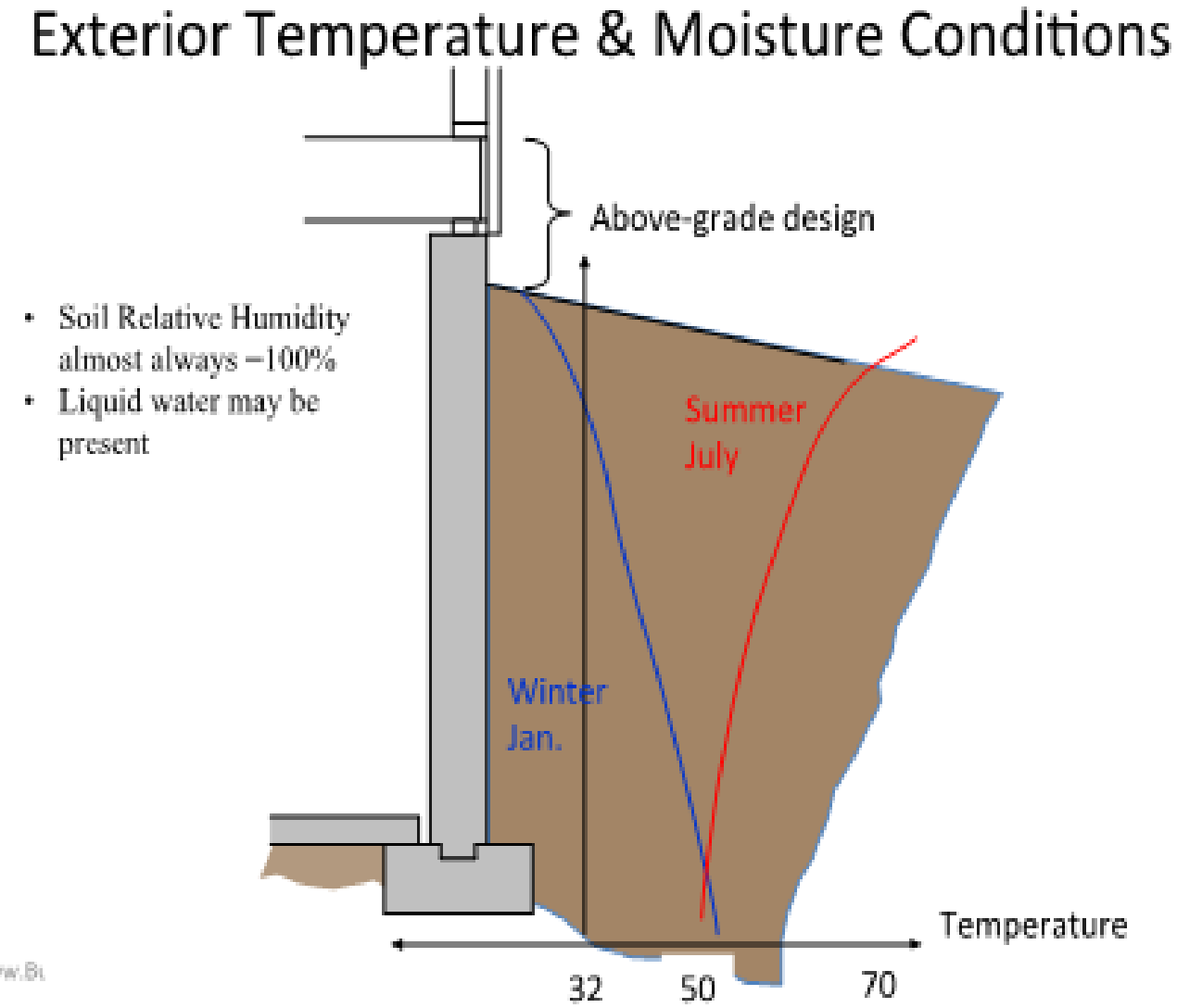
Heat loss below grade is a function of:

- Depth of the foundation
- Presence of water

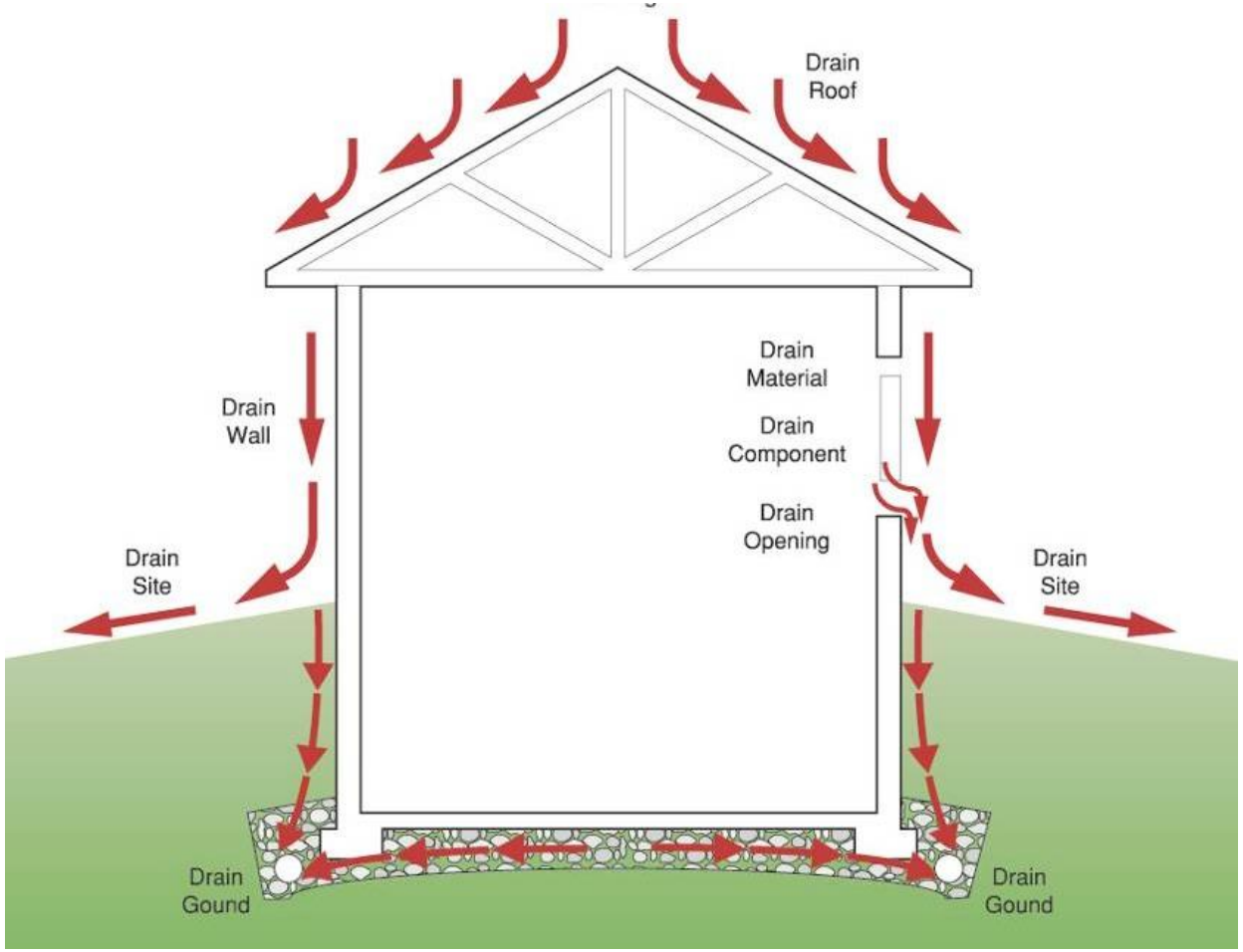


Below grade: Heat loss

- Ground temperatures (3'+) are approximately 4-5 months behind above grade temperature conditions e.g. May/June –foundation walls the coldest.



Drain the Building



Graphics from EEBA Water Management Guide

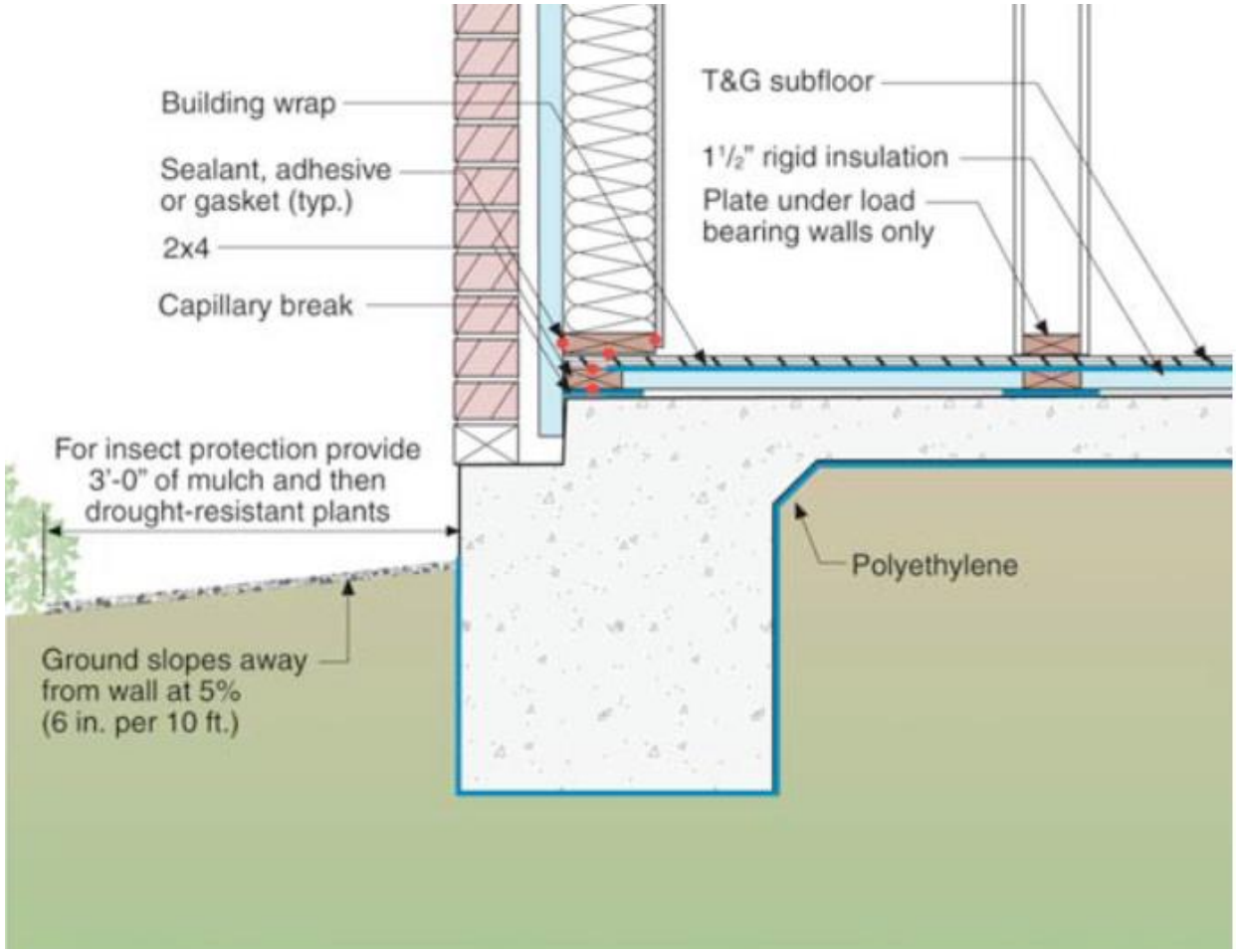
Full basement

Crawl spaces

Slab on Grade

It starts with proper grading & drainage

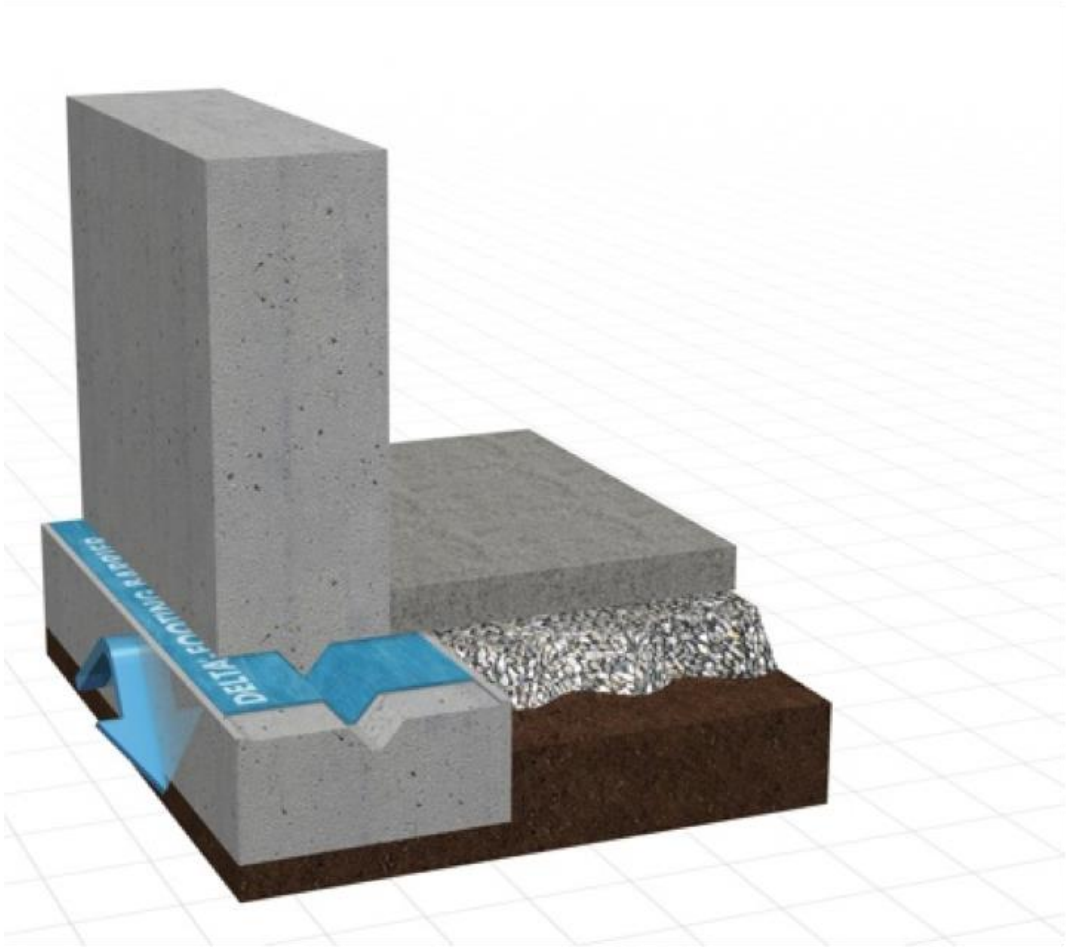
- 5% - 6” over 10’
- At least 4’ to 6’ away



Landscape too close to the foundation

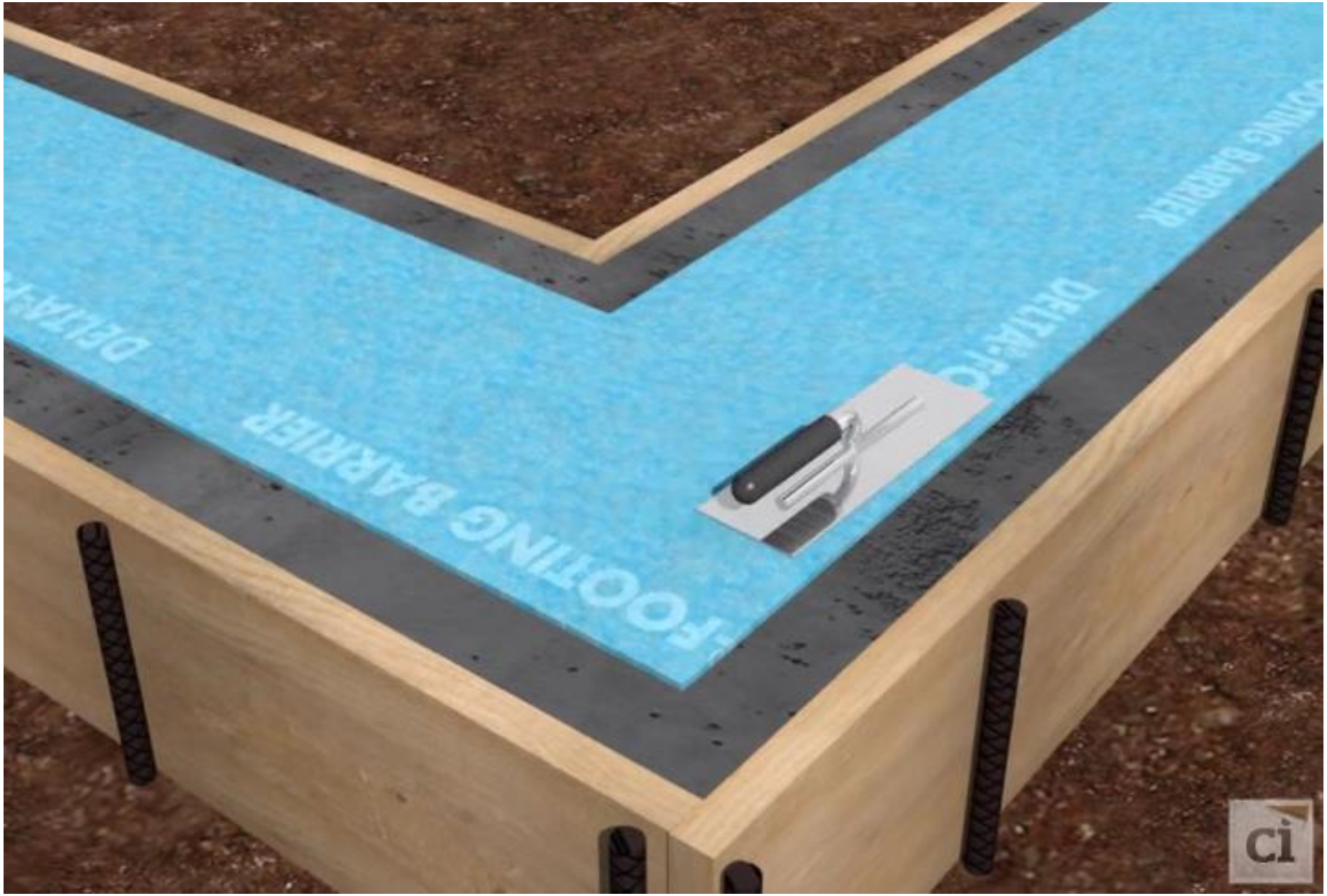
Capillary break applied between footing and foundation wall

- Required whenever one porous component meets another
  - Footing/slab to foundation wall
  - Foundation wall to framing
  - Under slabs-on grade



Footing to foundation connection


DELTA-FOOTING BARRIER
www.delta-fb.com
• Prevents Capillary Wicking
• Helps to Prevent Mold
• Ideal For Fully Insulated Basements


FOOTING BARRIER
DELTA-FD
FOOTING BARRIER
DELTA-FD
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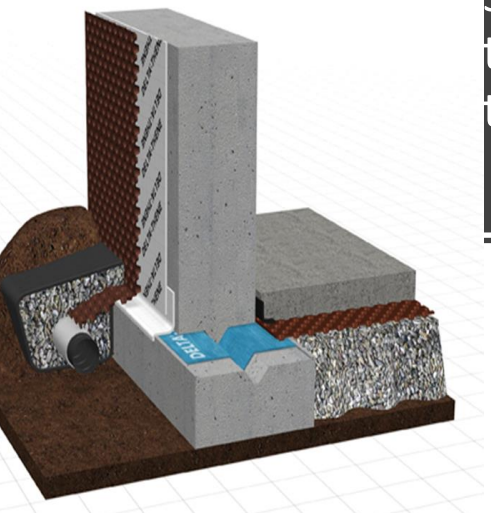
The LEAK equation

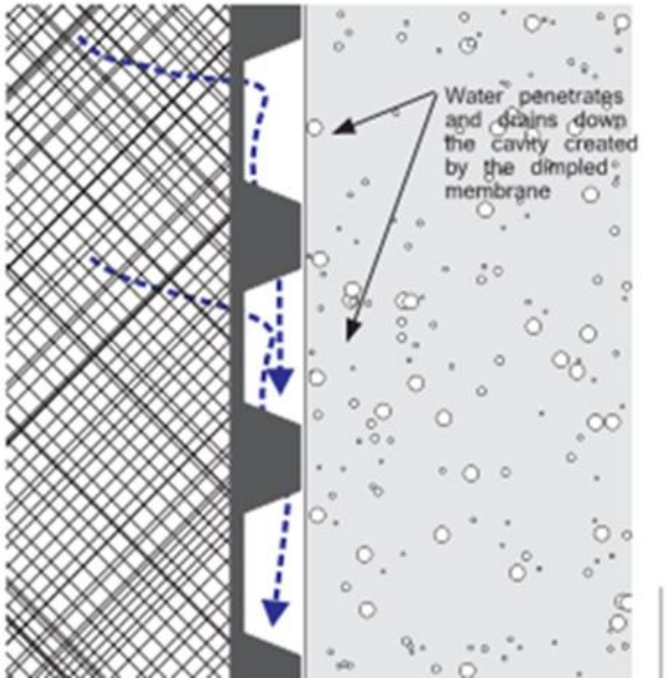
Liquid Water How does it get in?

- Hydrostatic Pressure - liquid leaks through HOLES
- Capillarity – “sponge” action ; concrete sucking up water through surface tension.



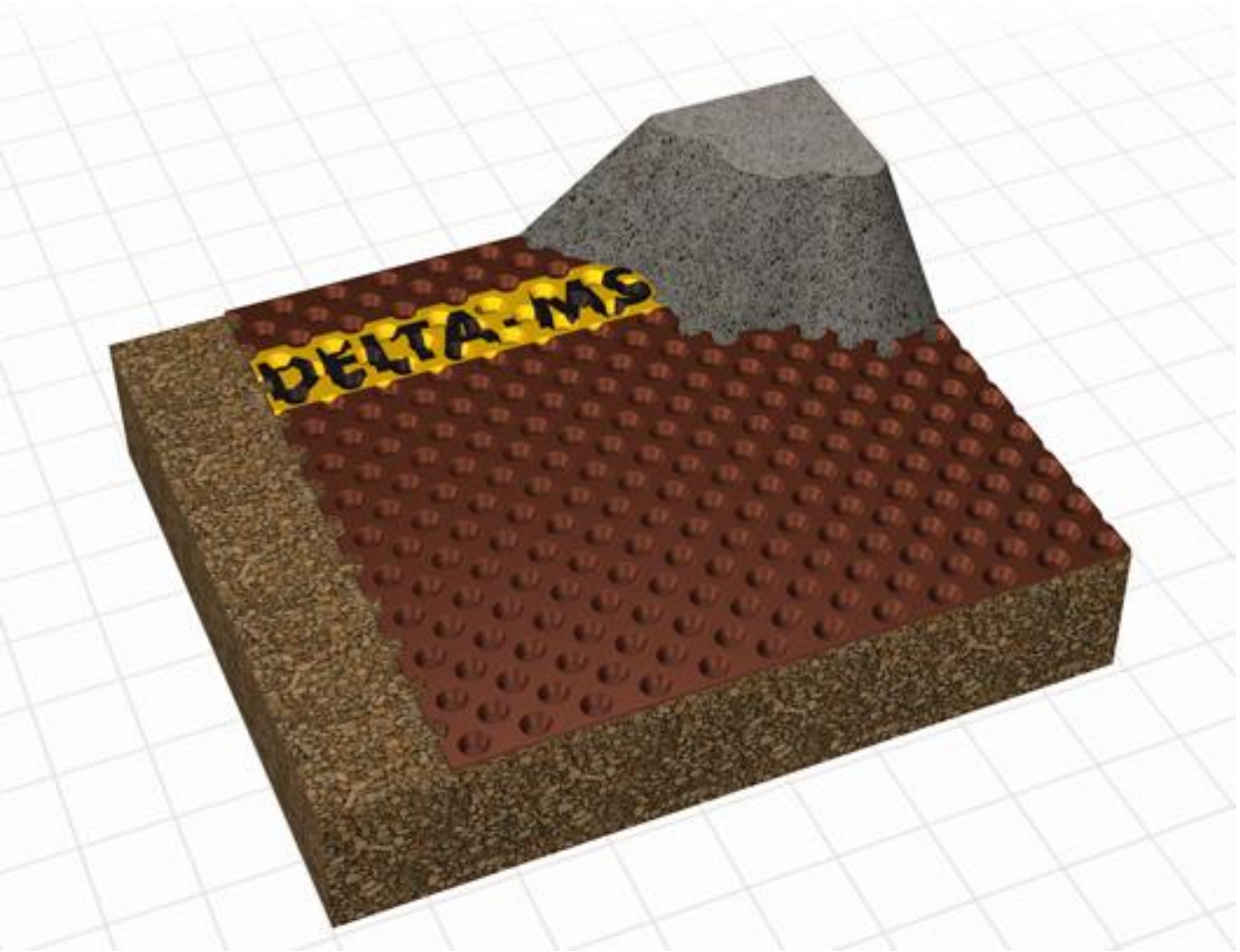
Hole + Pressure Difference + Water = Leak!

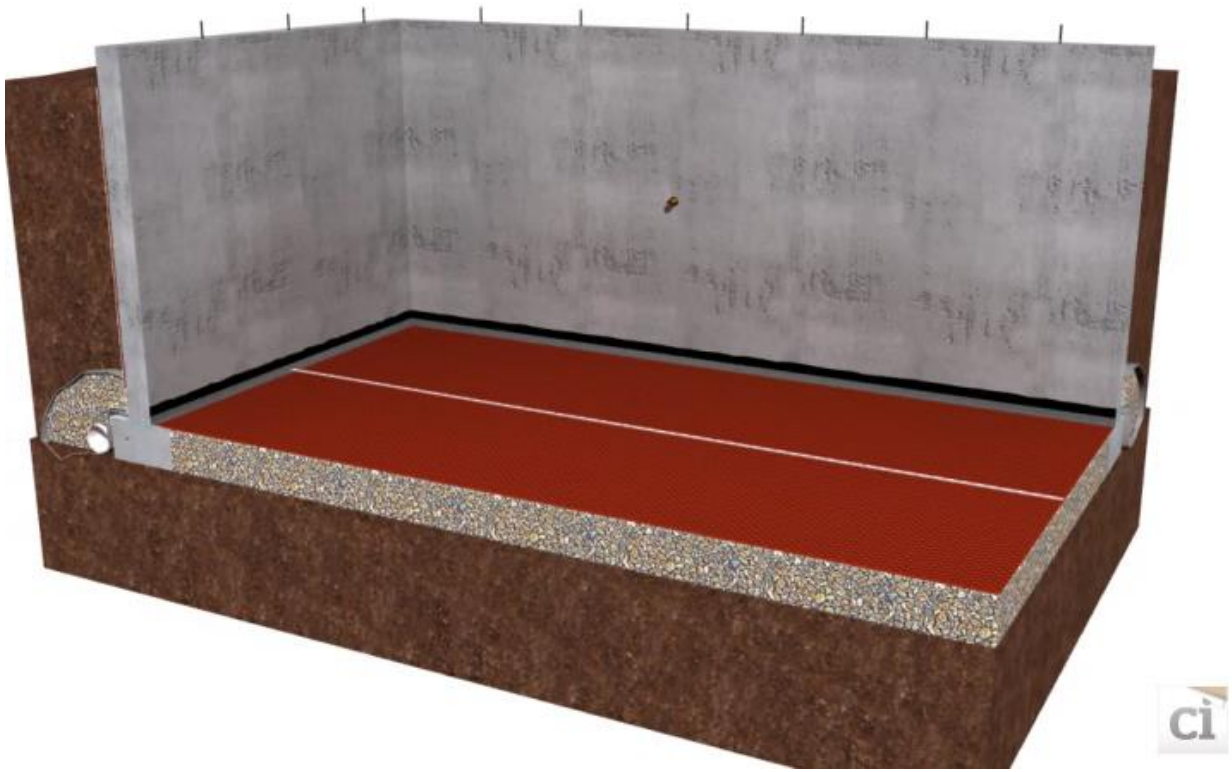
Air gap drainage membrane



Drainage is very helpful

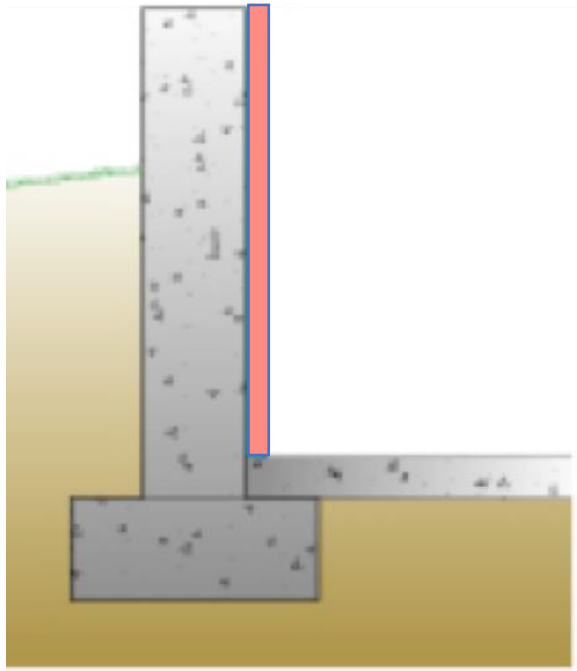
Membrane under-slab



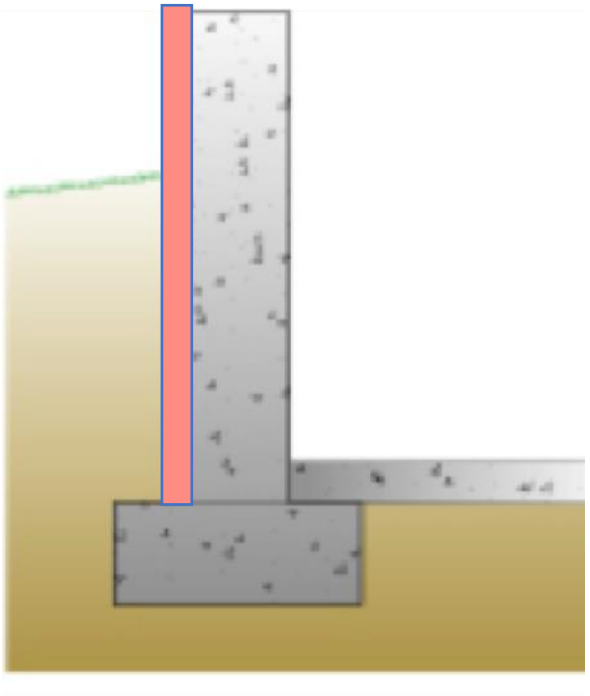


Foundation Insulation is Cost Effective

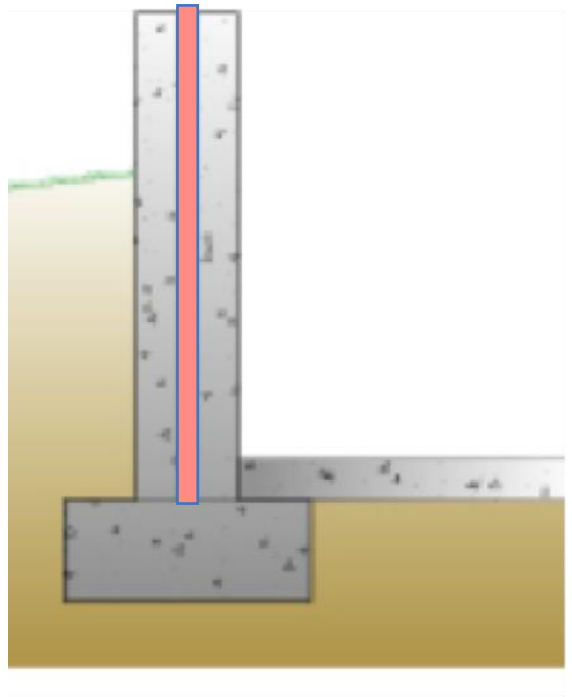
Foundation type, climate and soil conditions all affect performance



Internally Insulated

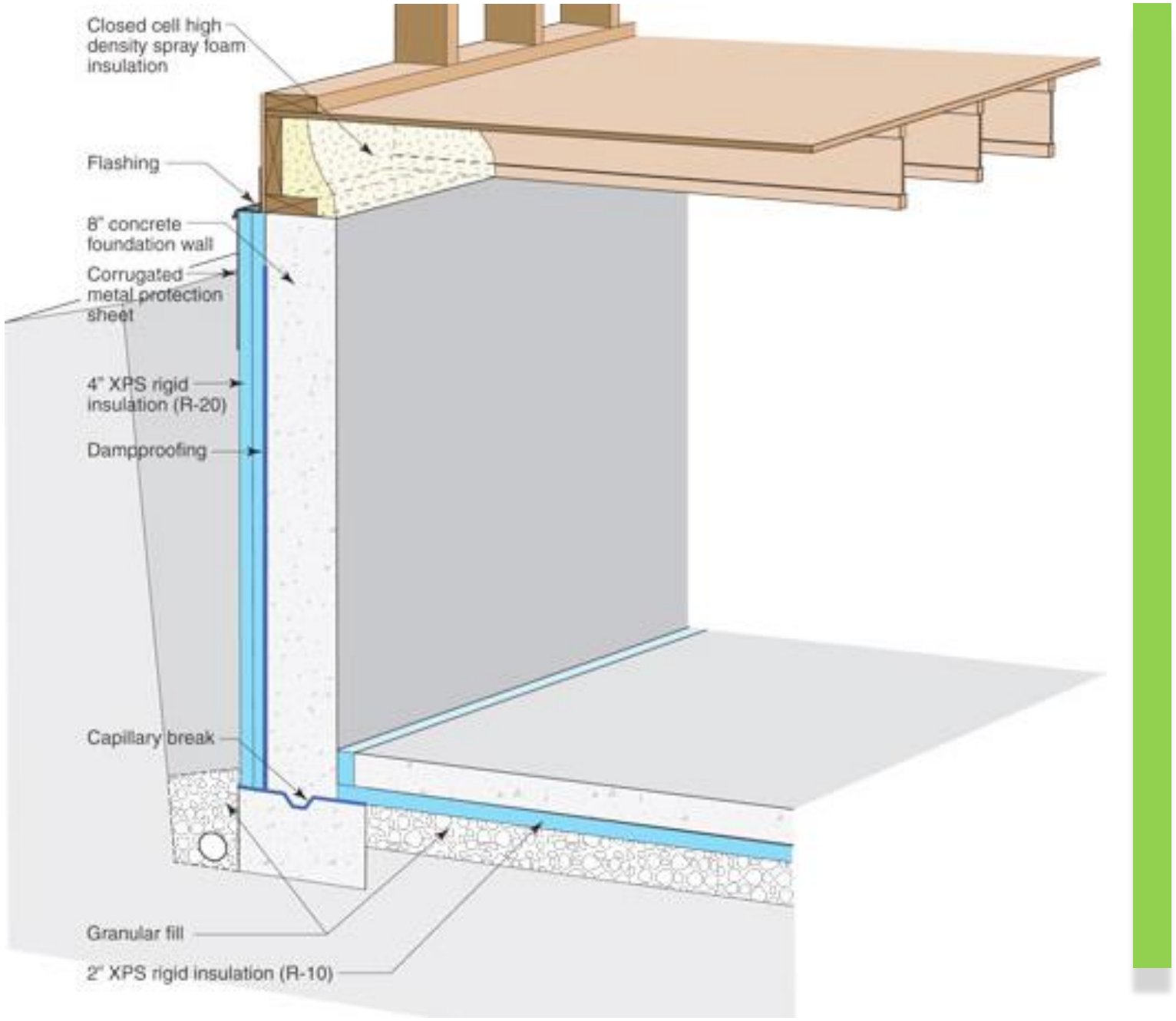


Externally Insulated

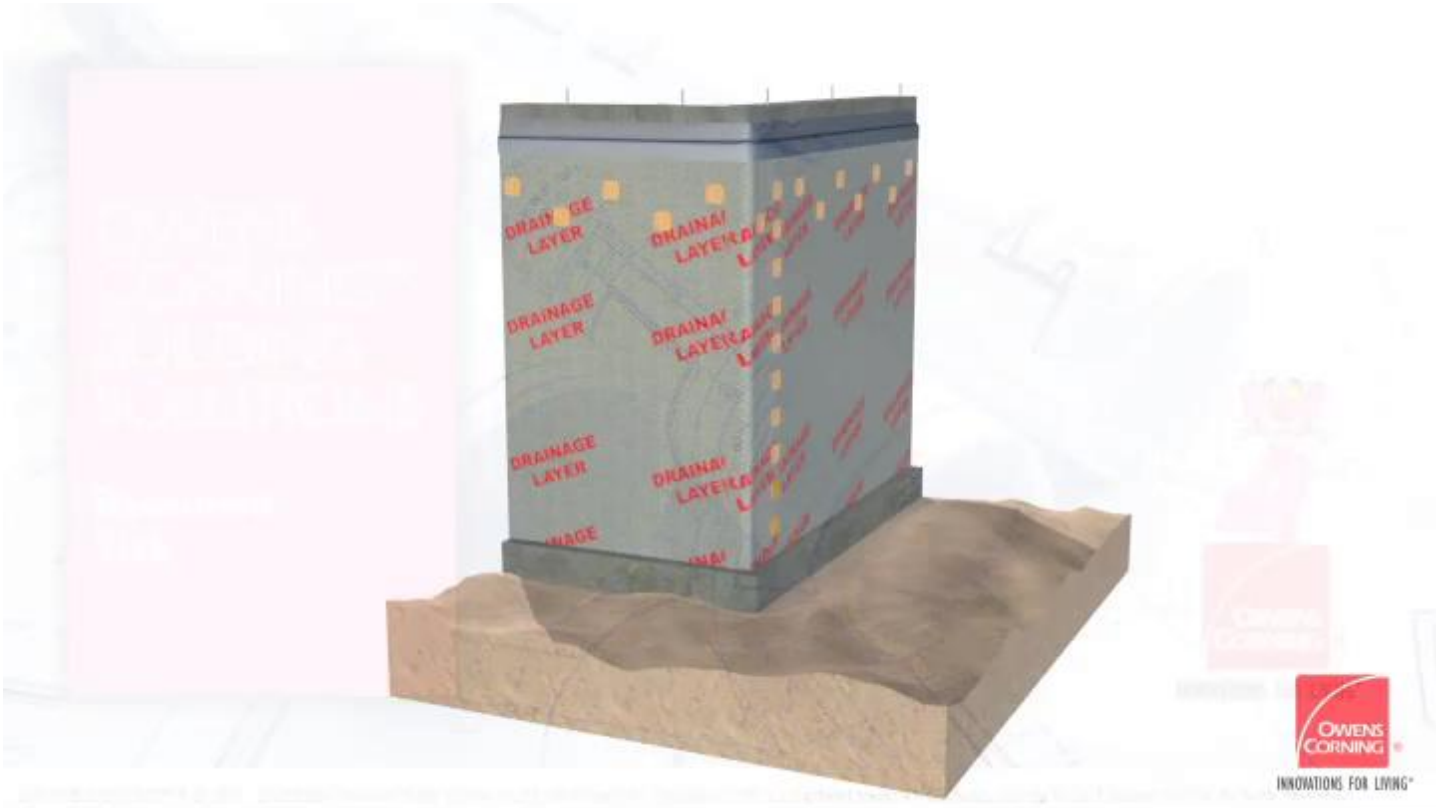


Insulated inside the wall

Exterior Insulation is the best option

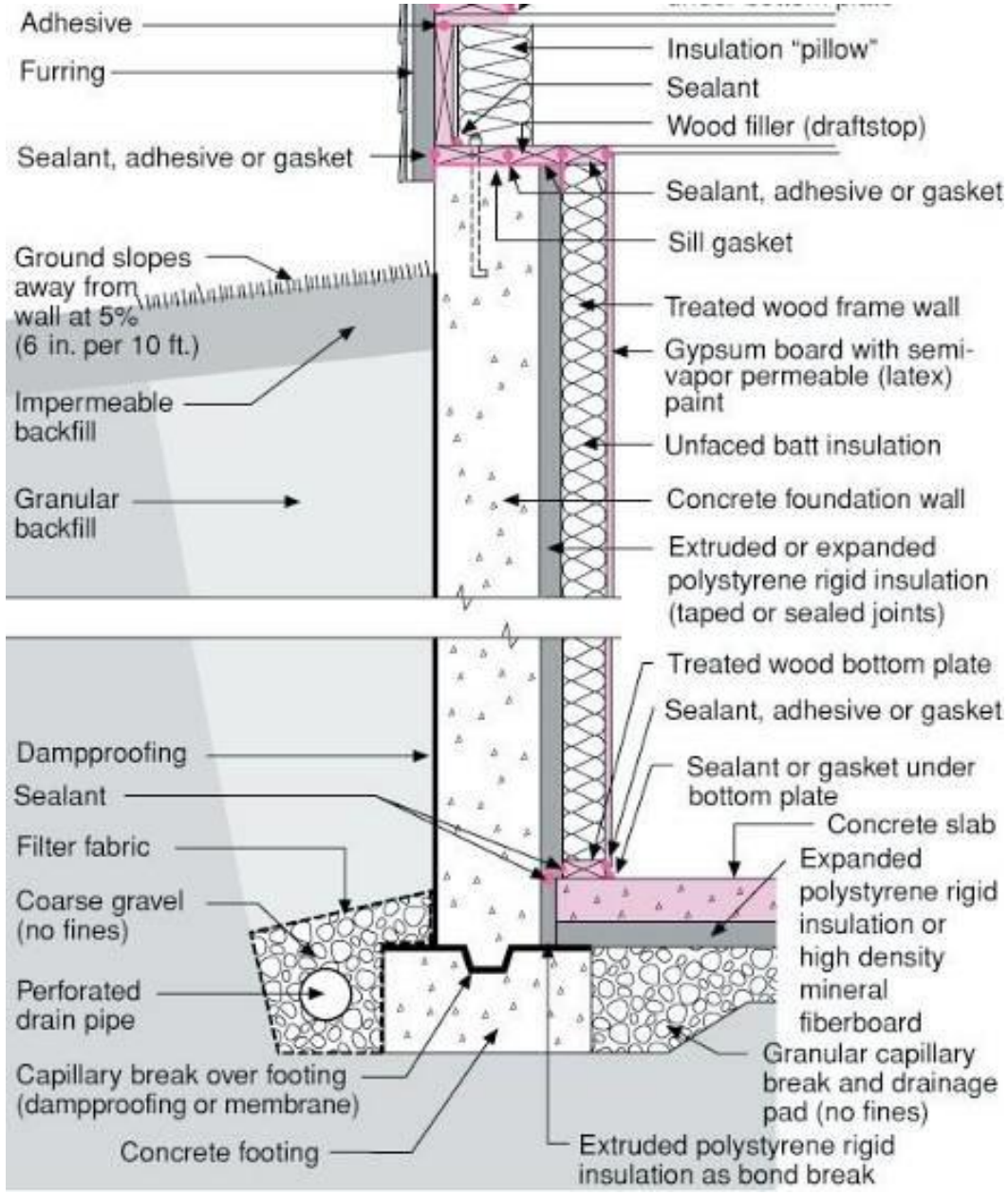


Basement Slab Insulation



Interior insulation is possible

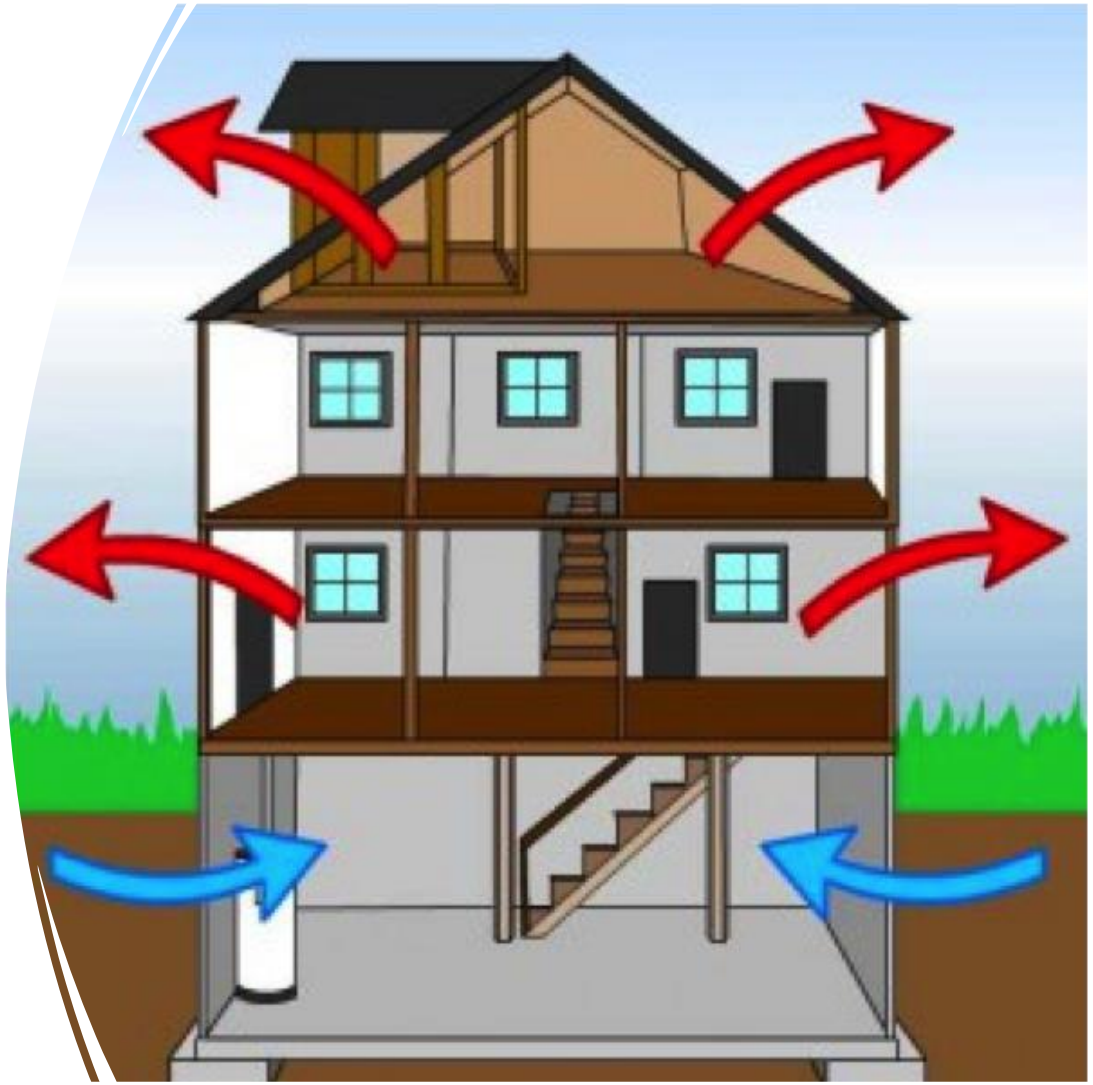
- Foam based solutions are best



Air leakage(and soil gas)

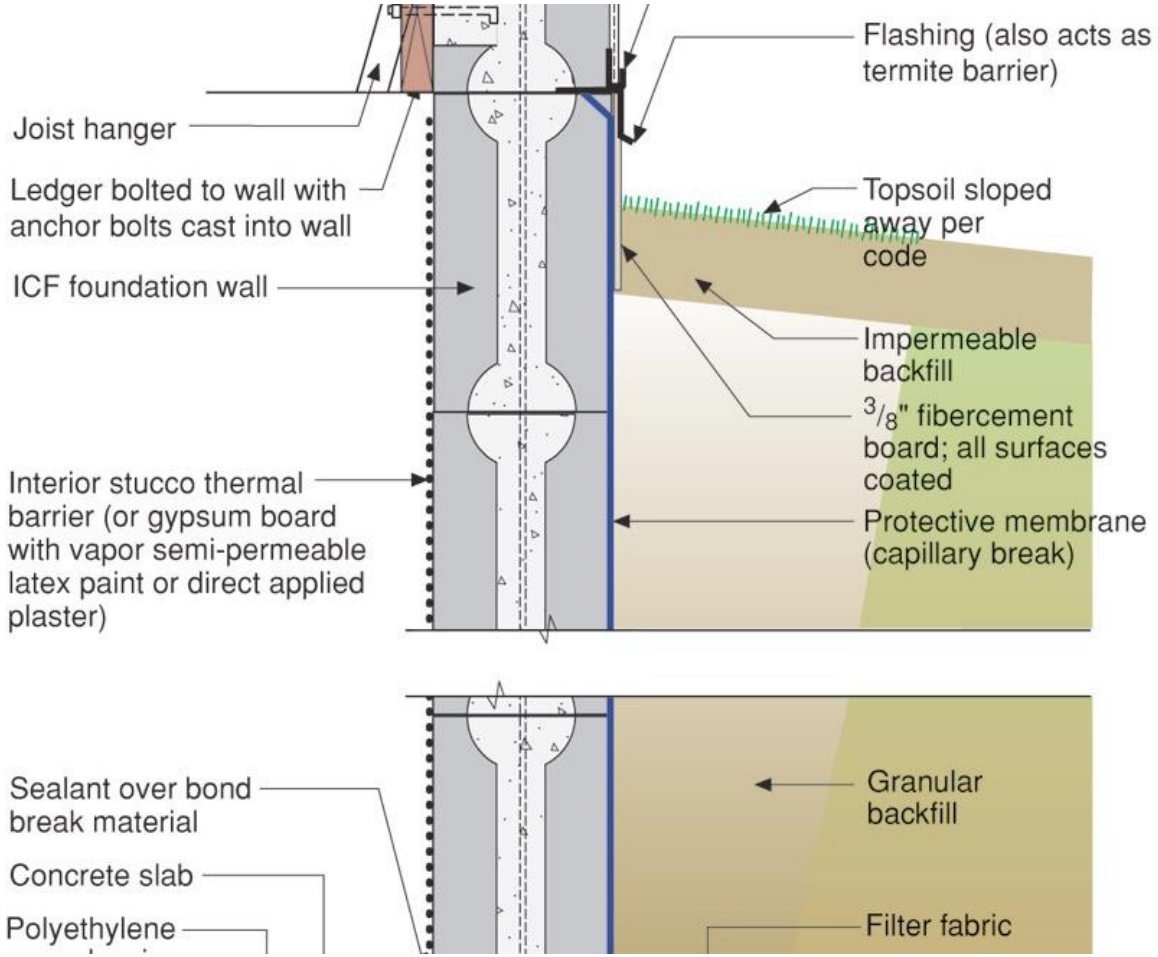
Building Science Rule: Air OUT = Air IN

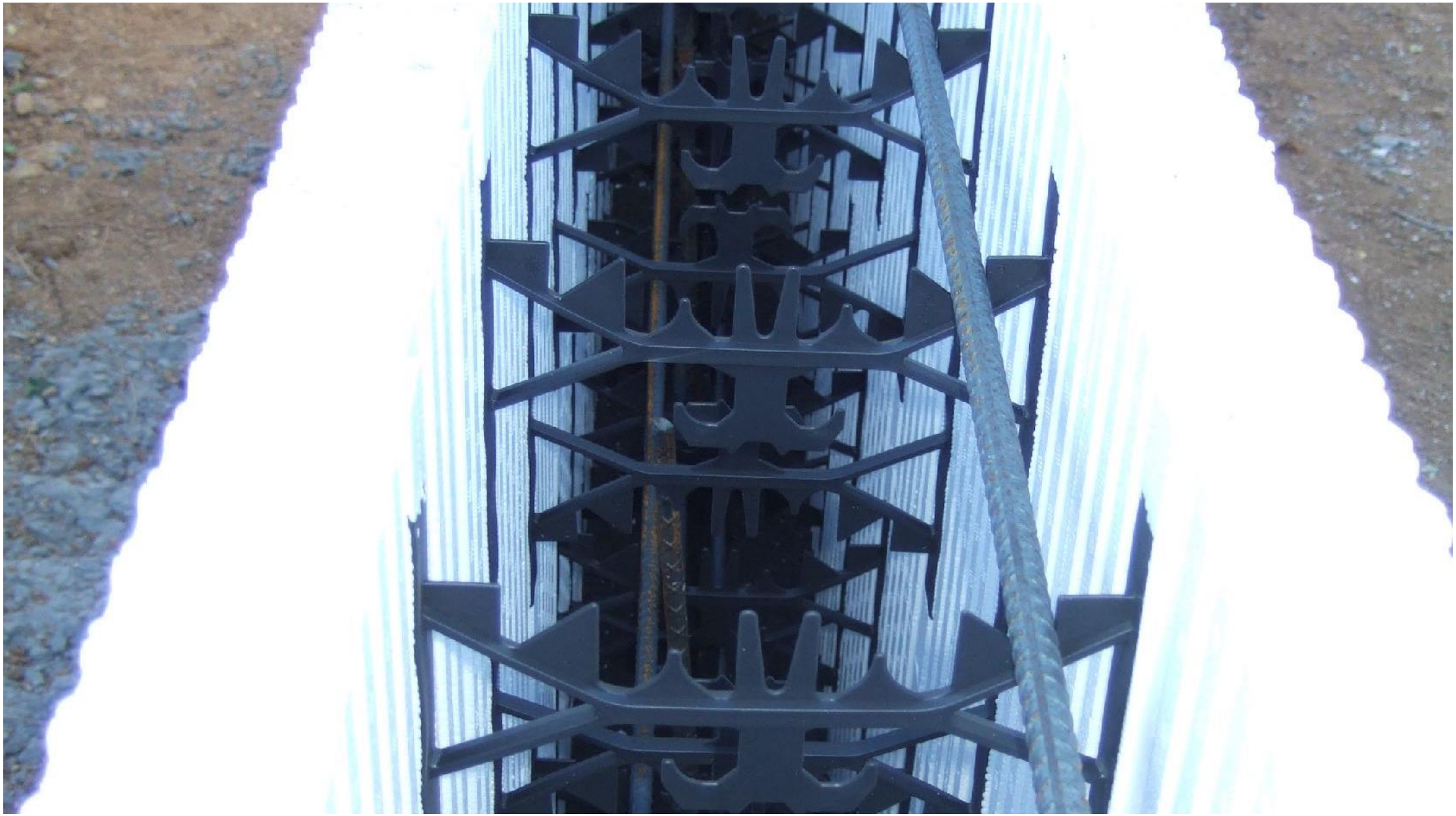
- Leaky house = cold, drafty basement
- Leaky House = humid basement(humid soil and water vapor)
- Leaky house = soil gas concerns.



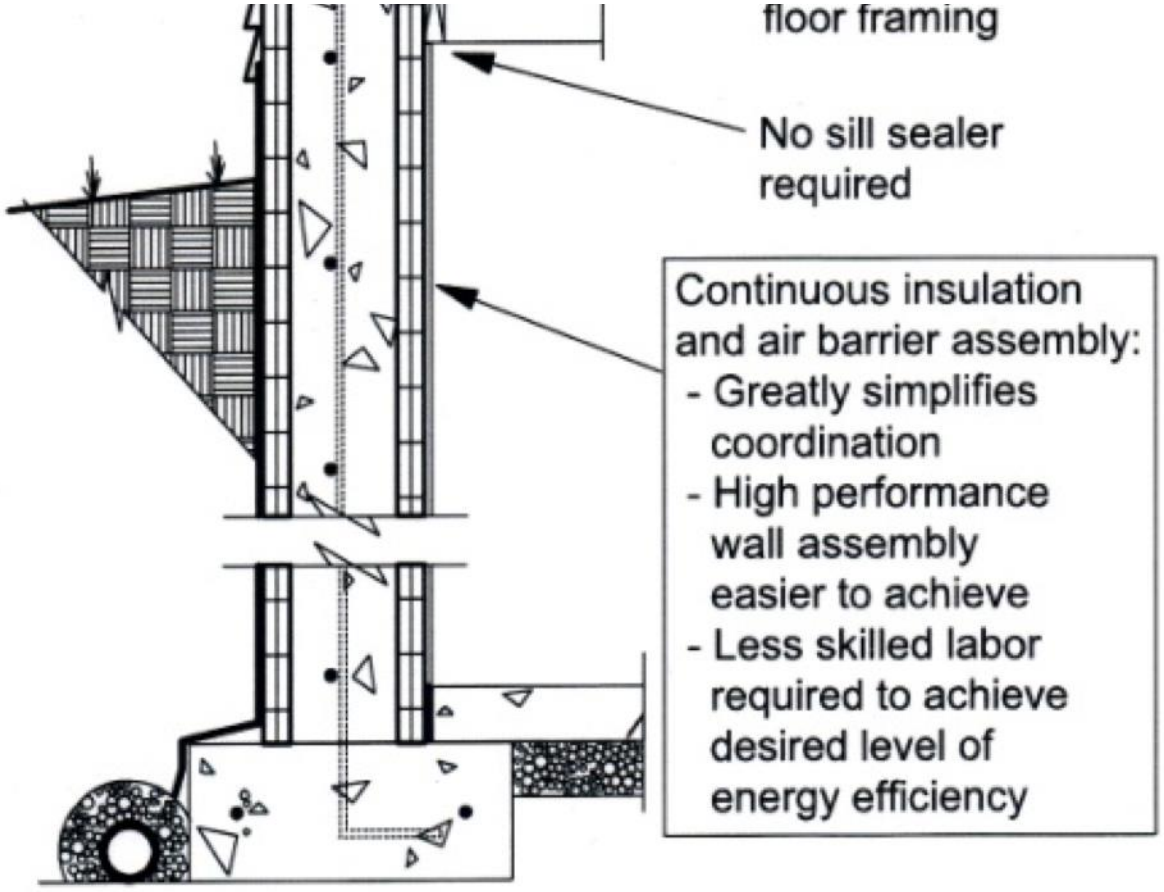
Insulated Concrete Forms

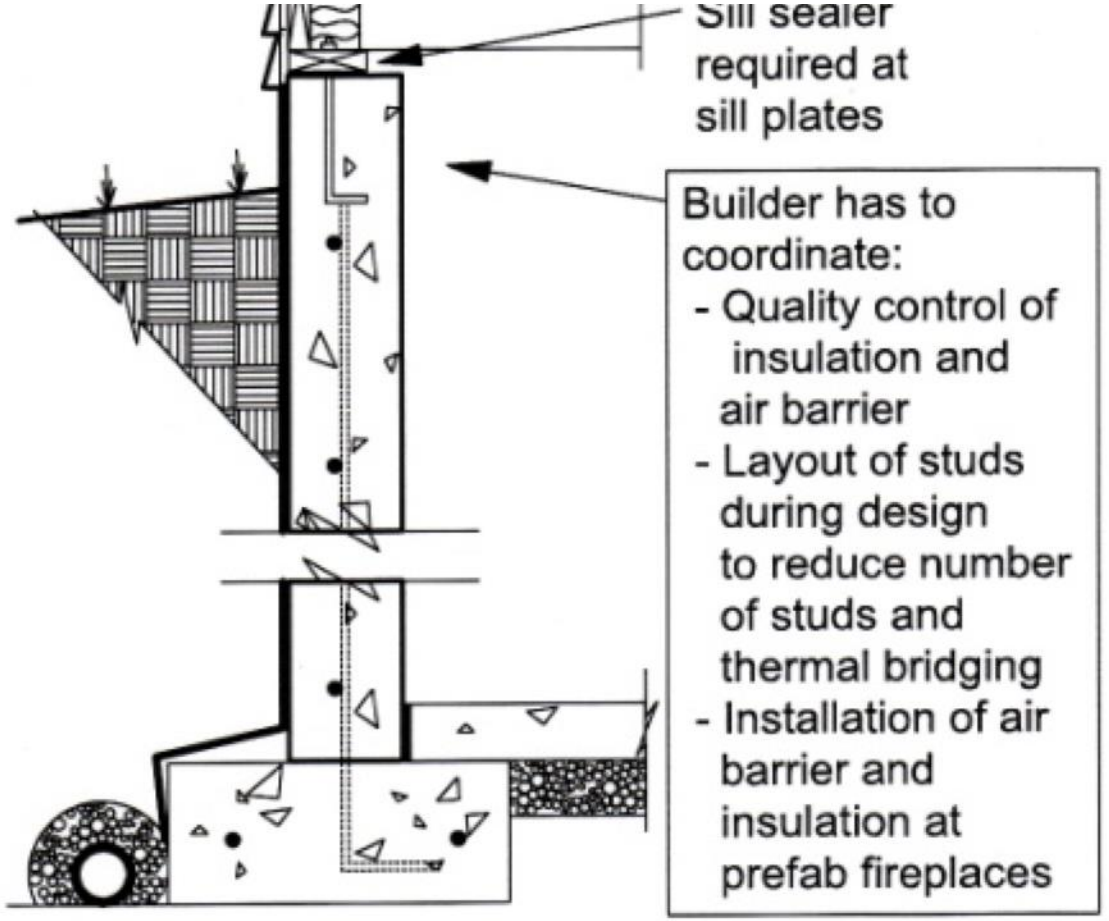
- Allows for controlled drying towards the interior
- Insulation and foundations in one system
- Interior finished can be directly applied
- Remember the capillary break





ICF versus conventional

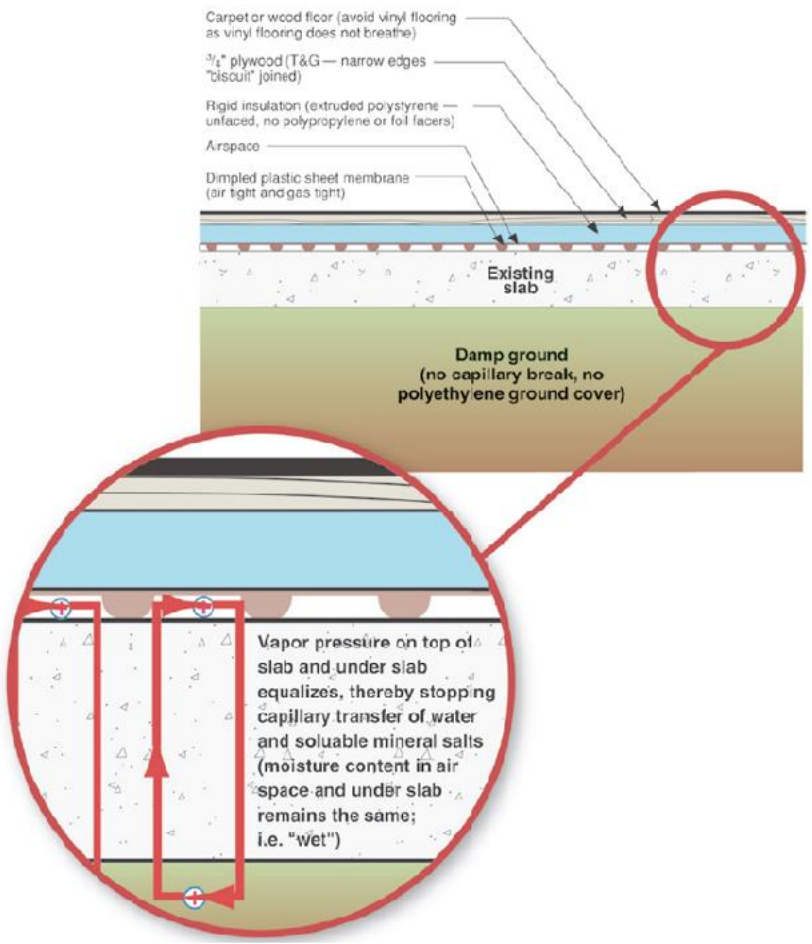





DELTA-MS
DELTA-MS
DELTA-MS

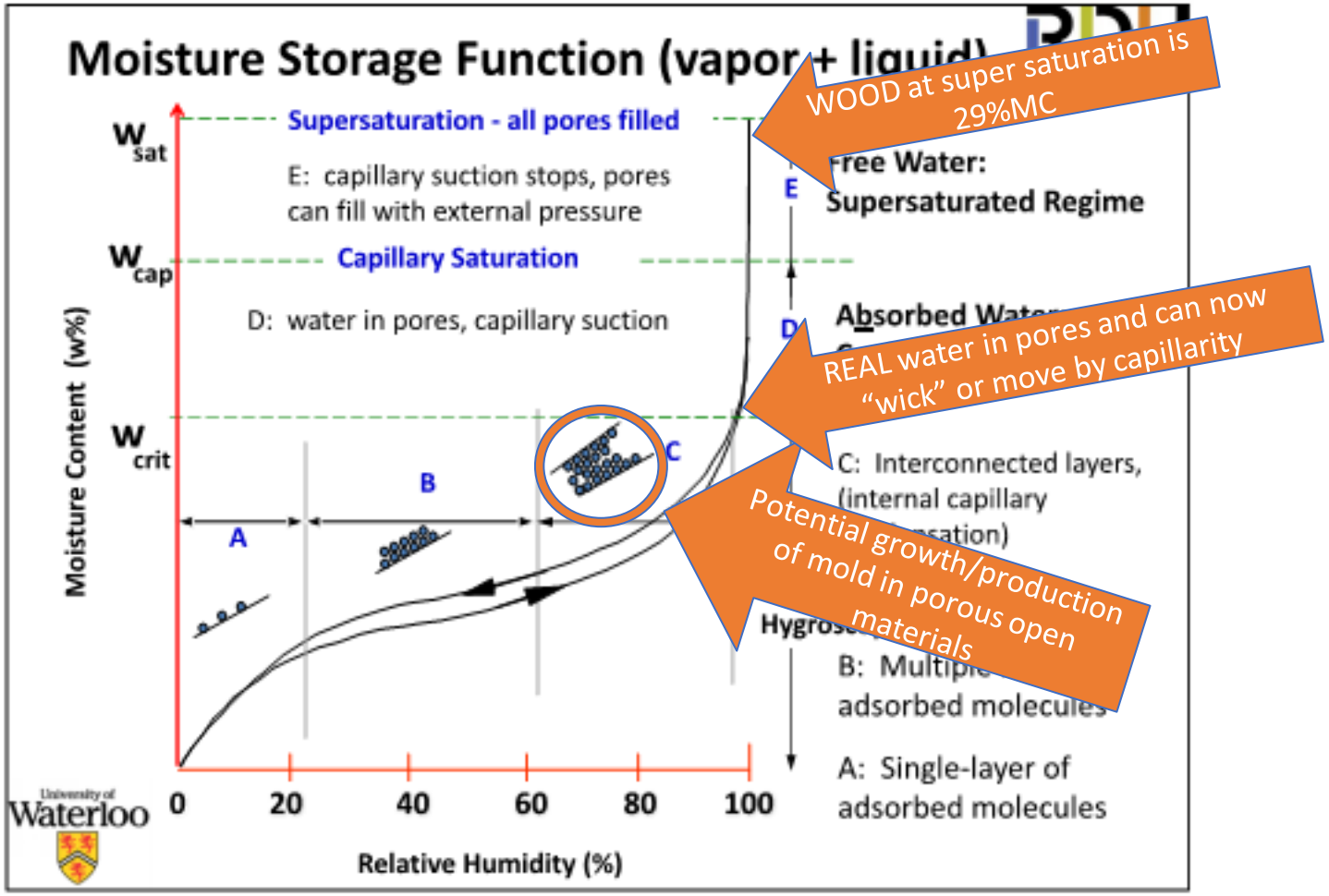
What do you do with an existing basement floor?

Membrane over slab



WHY BASMENT MATERIALS & FURNISHINGS GET "DAMP" AND SMELL

The 4th "phase of water": Adsorbed



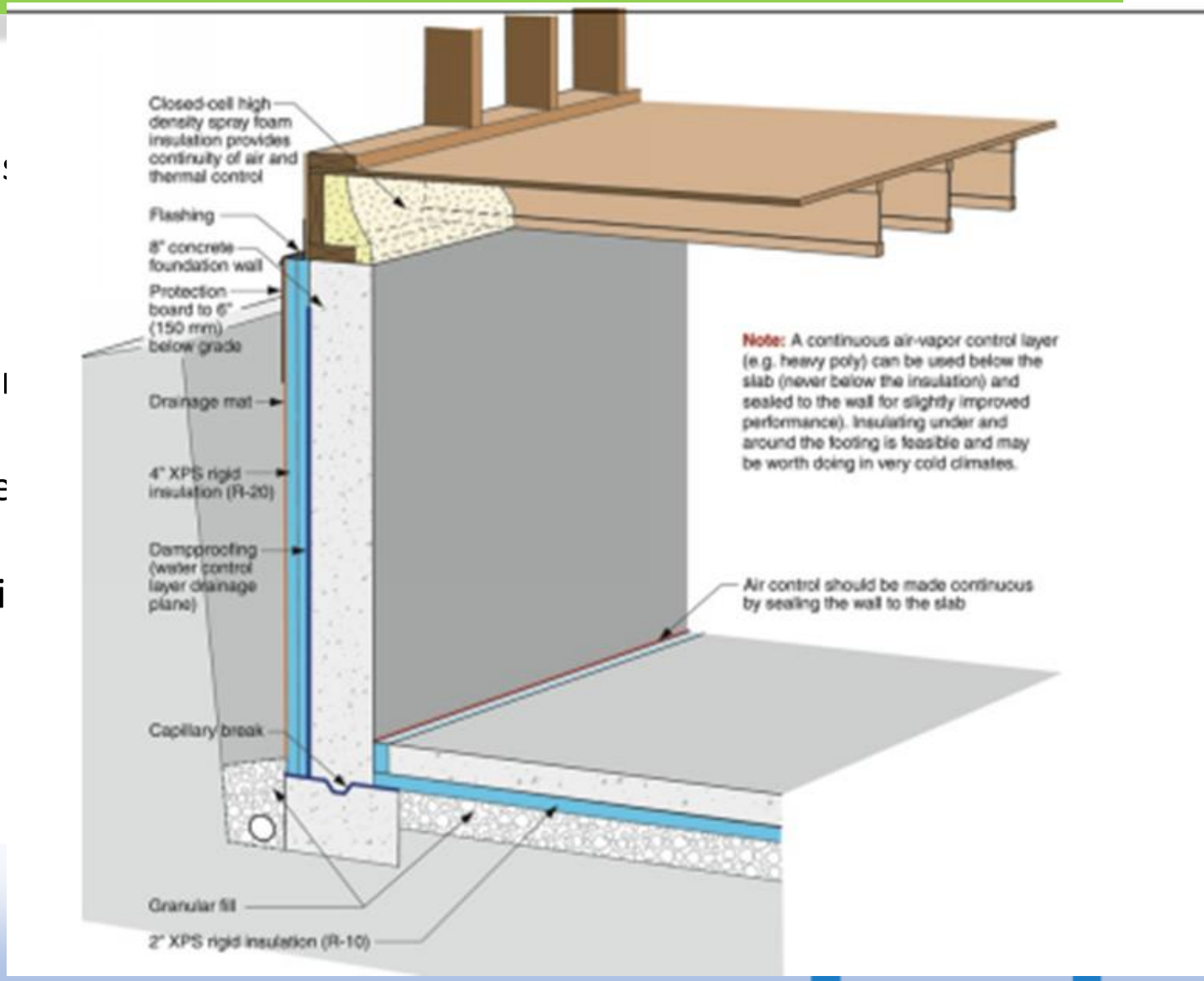
Below grade insulation options: EXTERIOR CONTINUOUS INSULATION

EXTERIOR insulation is the “ideal” solution

- Thermal Control/Limits thermal bridging
- Can act as drainage and hydrostatic control(s manuf specifications)
- Can act as a Air Barrier (see manuf specifications)
- Can act as a vapor control/ throttle, mitigati rate of inward vapor drive.
- Limits freeze-thaw cycle damage to concrete pore structure and durability.
- Warms first condensing surface –condensati control
- Can act as part of Radon barrier when continuous with under slab(see manuf specifications)

Remember :

- Edge of slab thermal break



Space Conditioning: Humidity (and temp) control in basement

- Proper Load Calculations (Man J)
- Right Size Equipment selection-Air conditoonong NOT too big-Just right to enable DEHUMIDIFICATION. (Man S)
- Consider 2 stage OR Modulating AC to enable optimal humidity control (latent load)
- Sealing of supply side duct work AND RETURN DUCTS in basement, Leaky duct work can turn the basements into a :meat locker" in the spring/summer. (Man D)
- Consider ERV in lieu of HRV for better removal of humidity in during AC , spring and summer use.

Every below grade space in N. America needs auxiliary dehumidification

- Every BELOW GRADE space needs one
- VERY Important FOR FIRST 5+YEARS of new home occupation as basement concrete releases un-bund water during curing process.
- Give as a “gift” to owner
- Cost to run for a year: $75 -$100
- DRY basement = better smelling basment

NOTE: Some basements/crawl spaces will ALWAYS need dehumidification e.g. lack of capillary breaks, high/active water levels under slab , poor drainage conditions, etc

Let’s move up and look at above grade walls

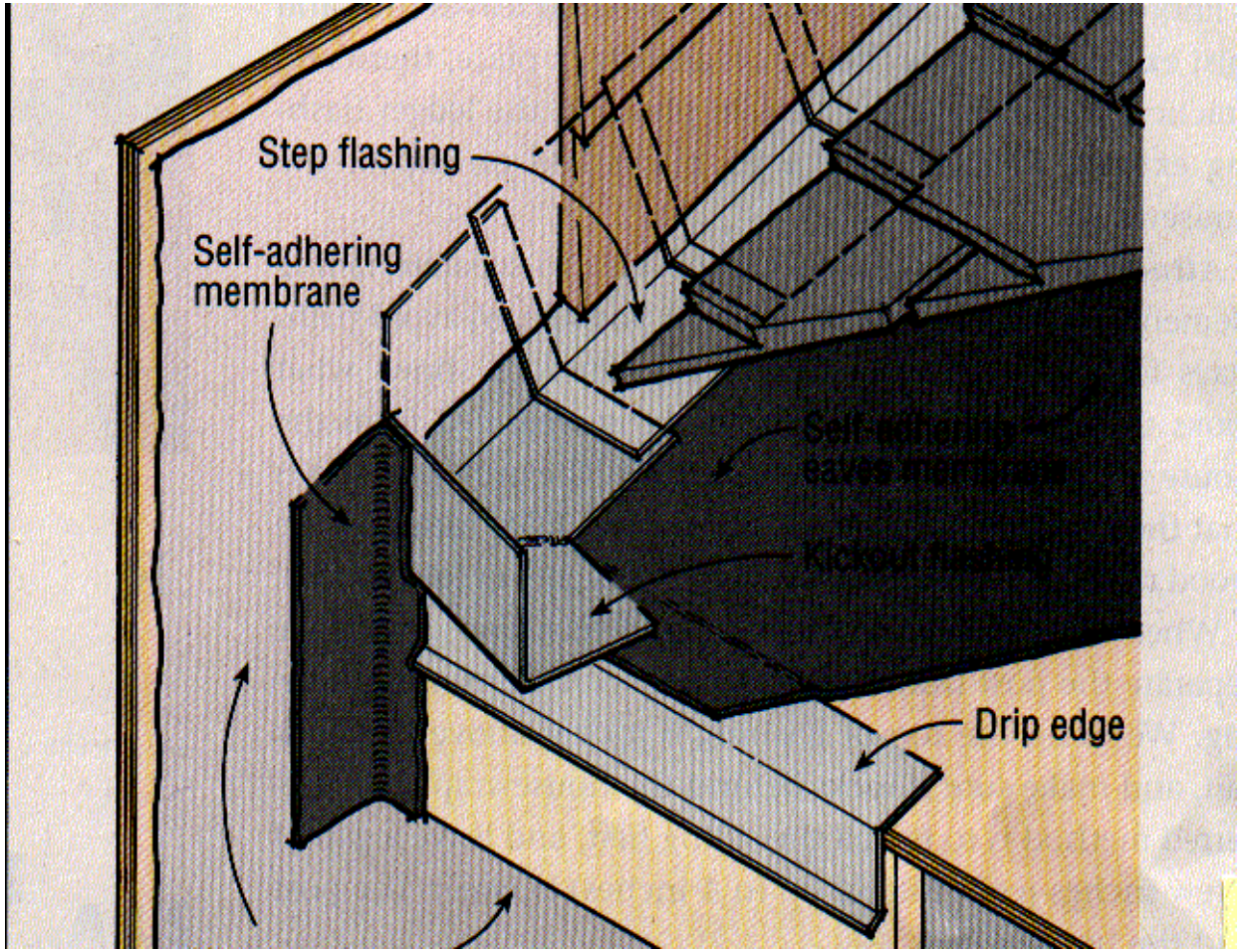
A wall system needs to perform

- Provide strength & rigidity
- Be durable
- Control light & solar gain
- Control noise
- Control rain penetration
- Control air flow
- Control heat flow
- Control water & vapor flow

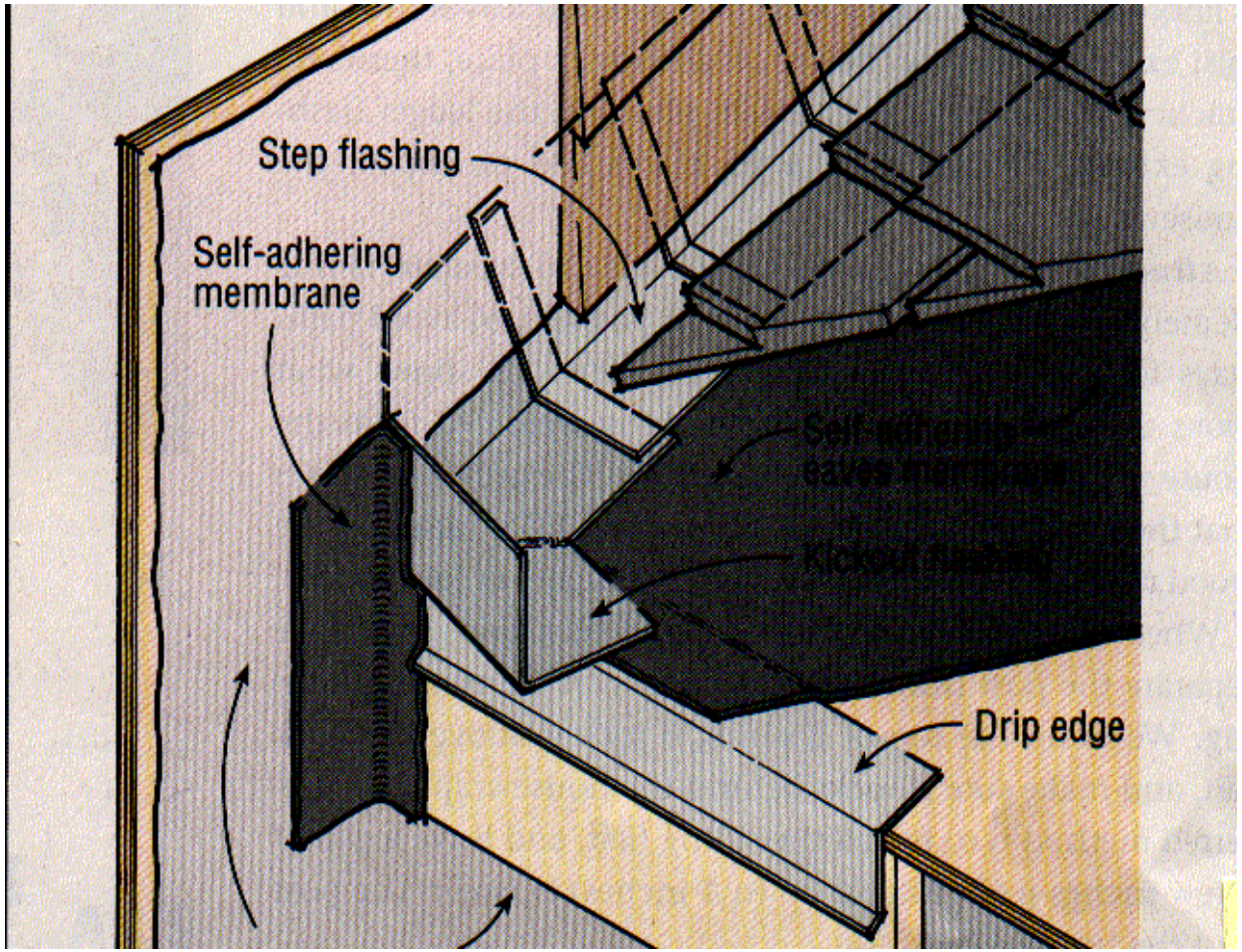
Flashing & Gutters must effectively redirect water

The interface between walls & roofs

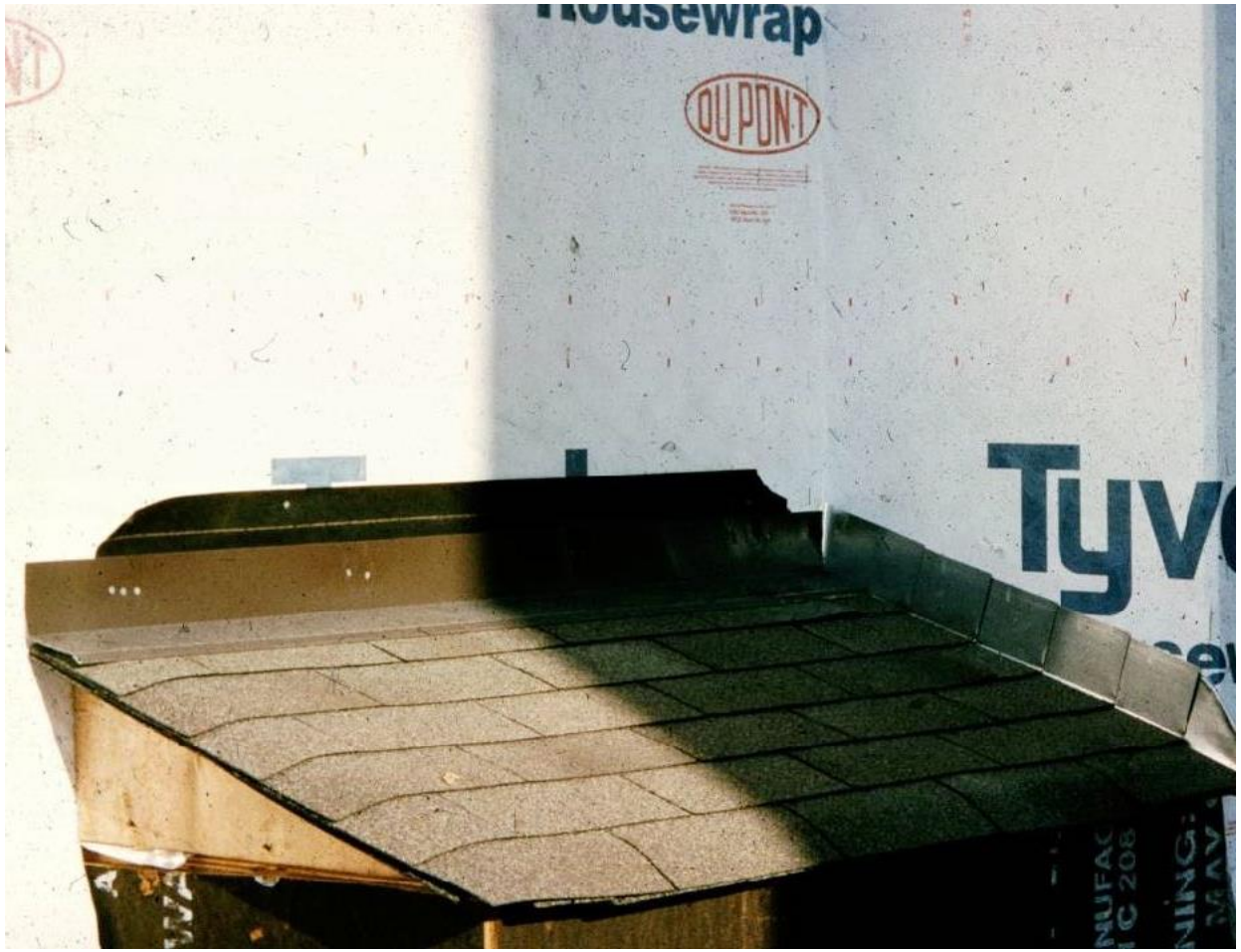
Concentrate on the path of flow…



Kick-out Flashing - Simple and effective



Flashing must be integrated with the drainage plane



Drain the Assembly

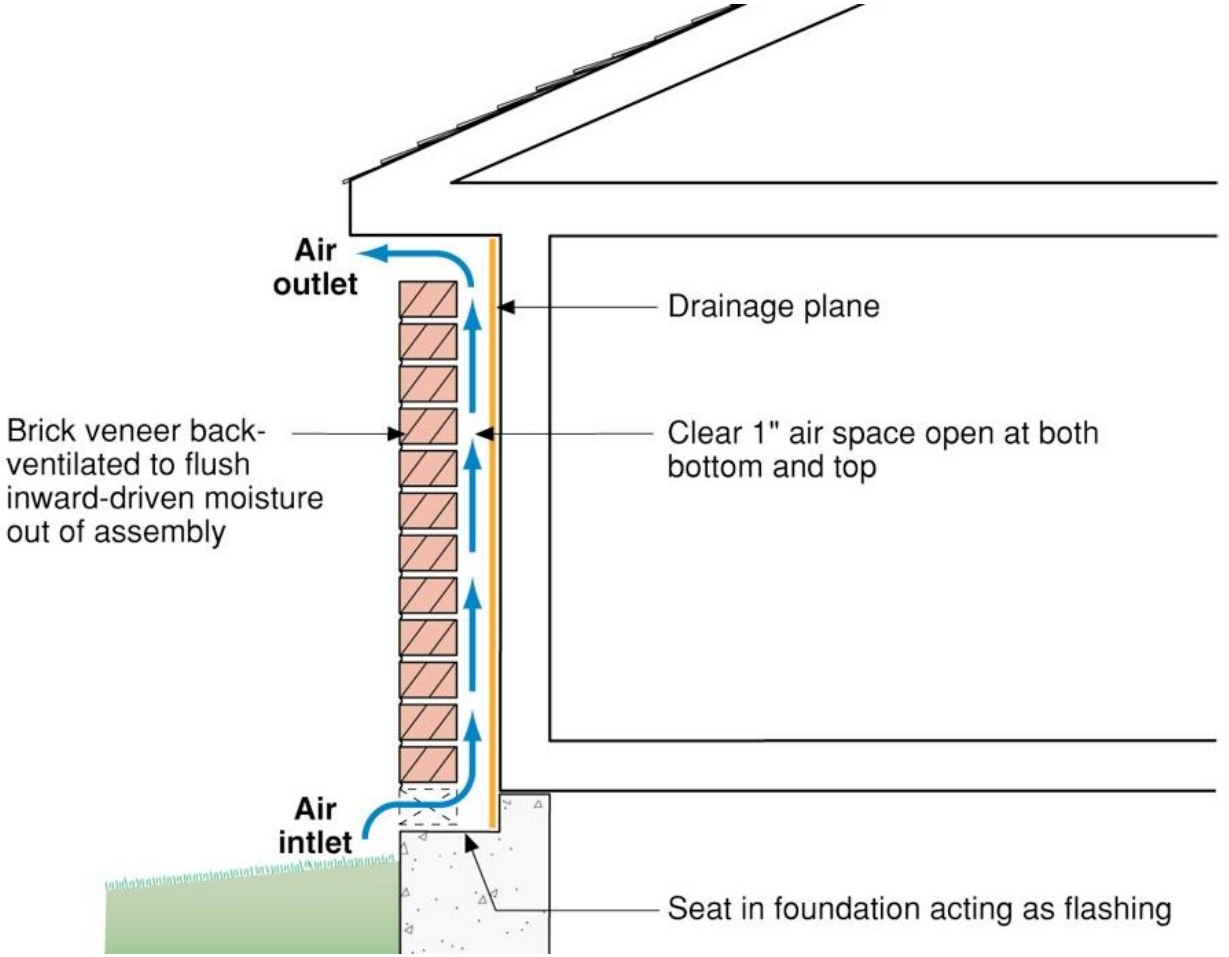
Drainage is pretty simple

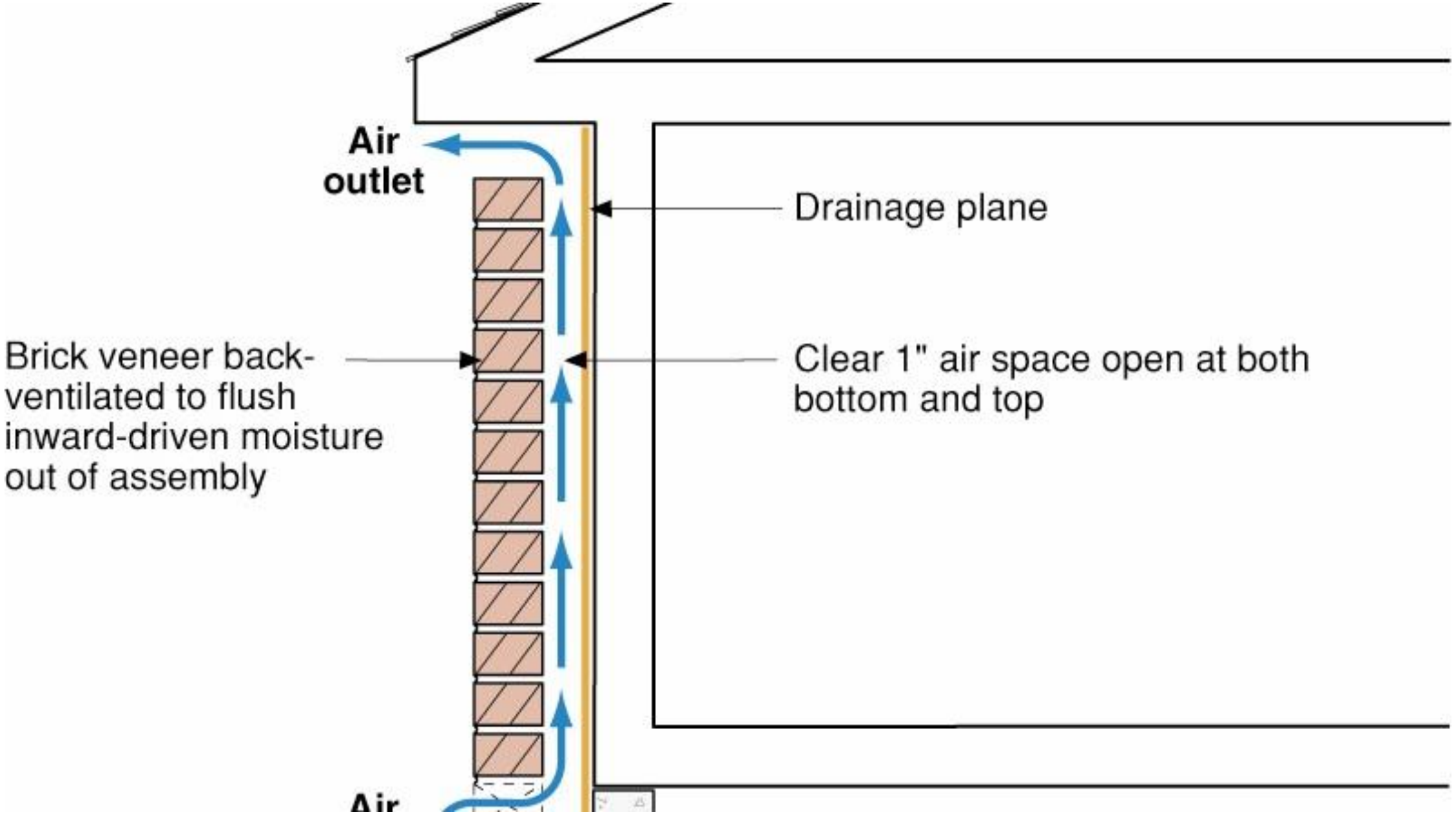

See installation instructi
VEK.COM
T12042

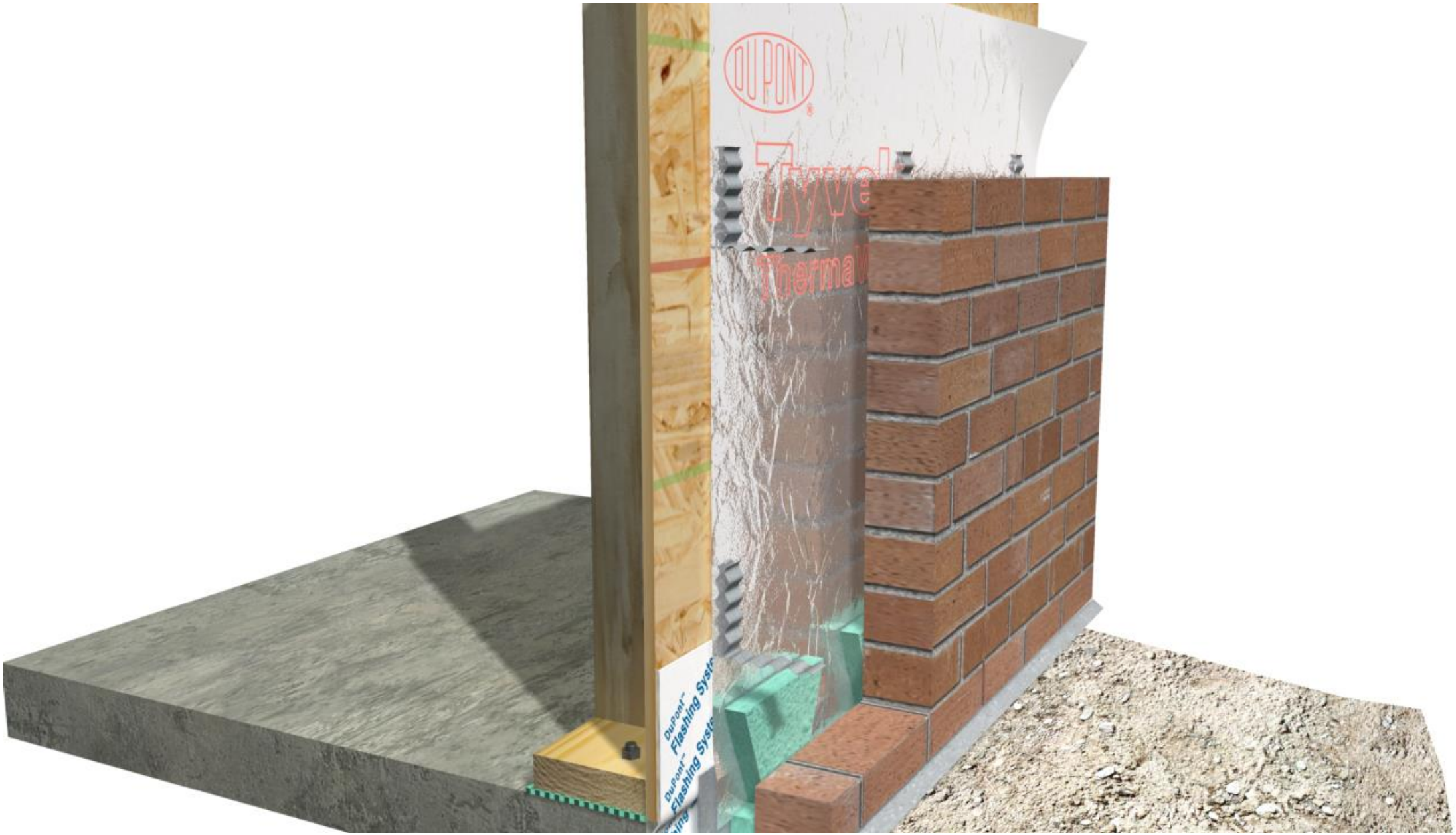
Venting our Cladding

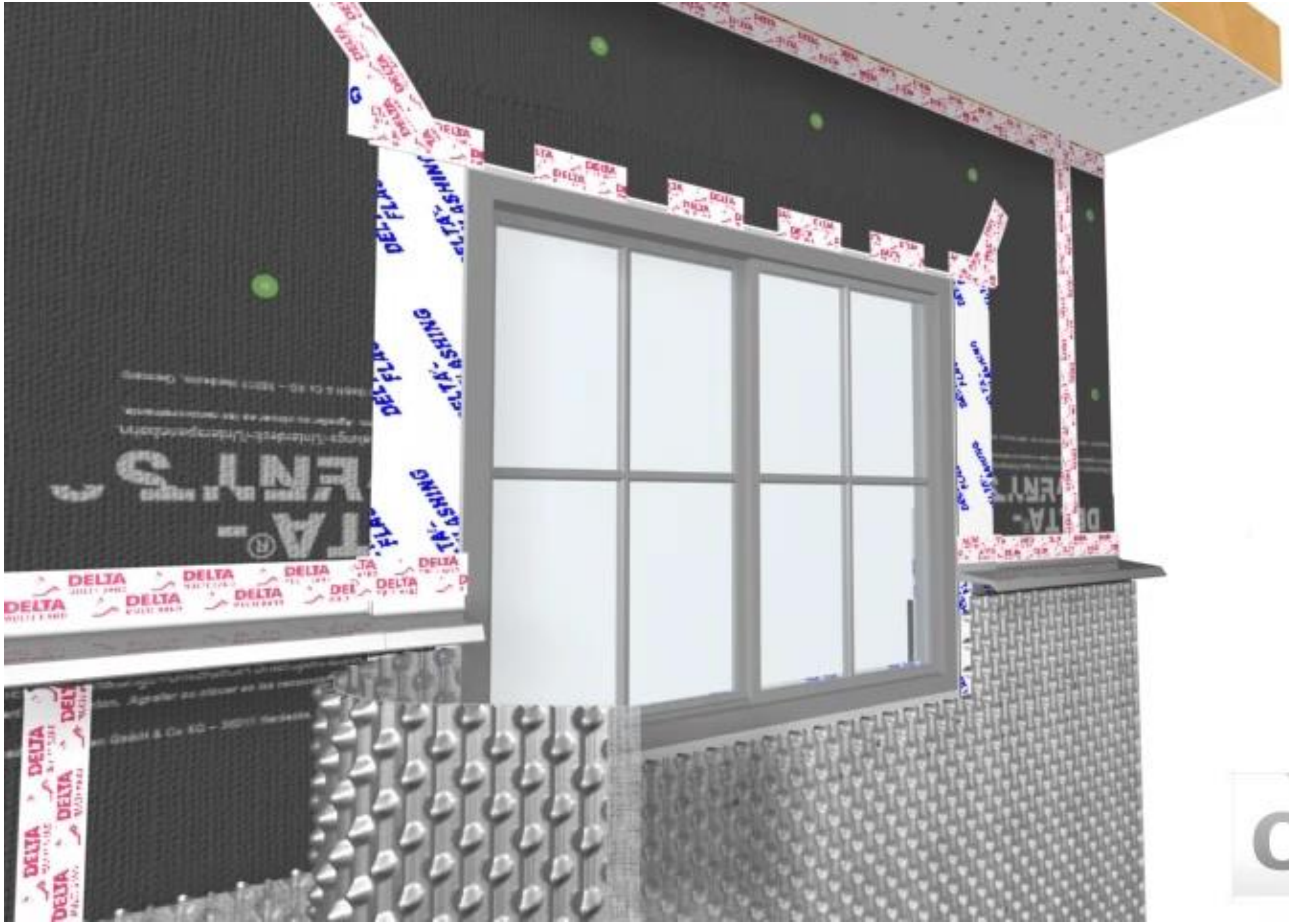
Air Flow assists drying

Create intentional airflow
When using brick
& stone & siding in:
Humid summer climates
Rainy climates
Wood sheathing applications




Air
outlet
Drainage plane
Brick veneer back-
ventilated to flush
inward-driven moisture
out of assembly
Clear 1" air space open at both
bottom and top
Air


DUPONT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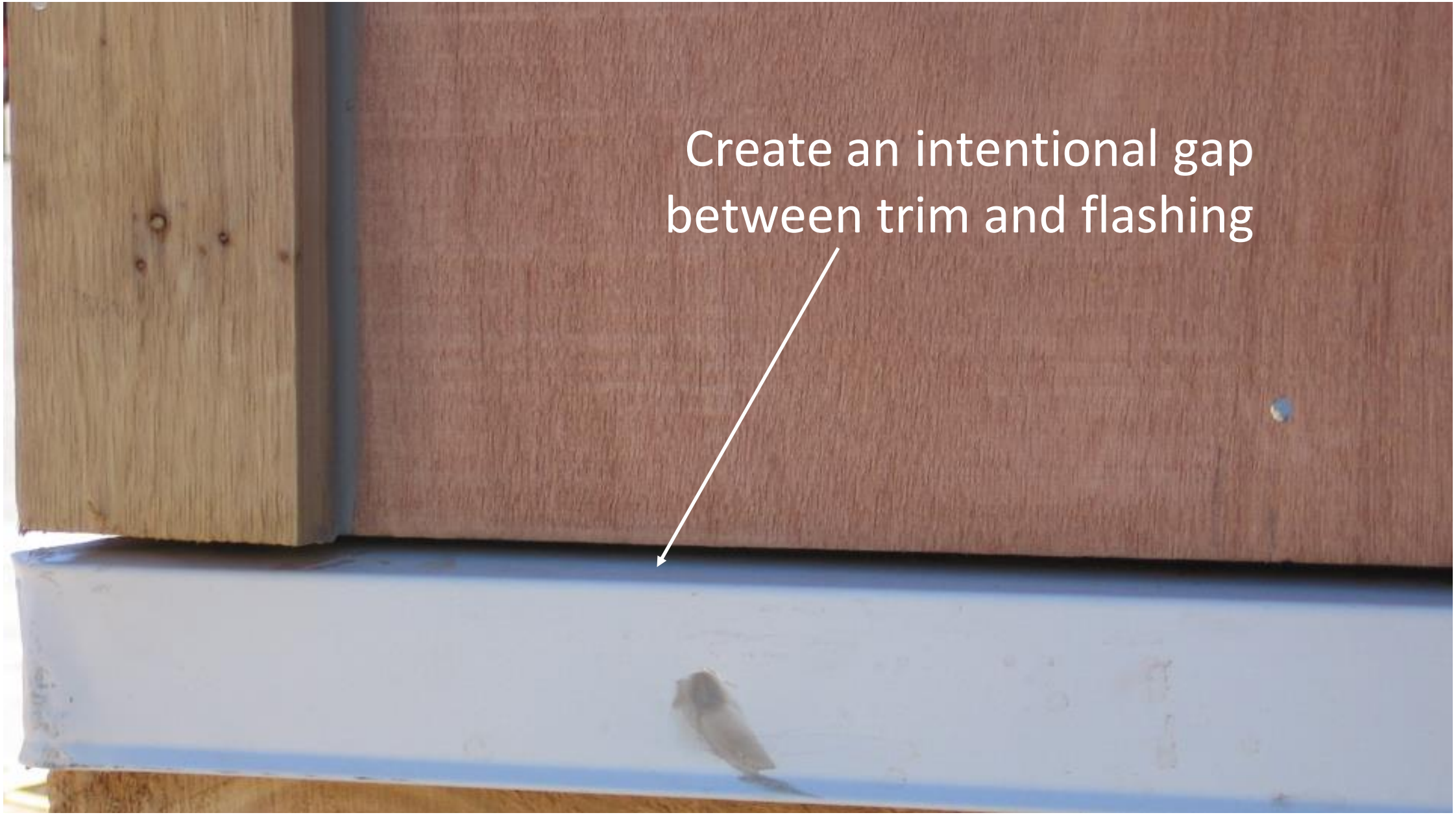
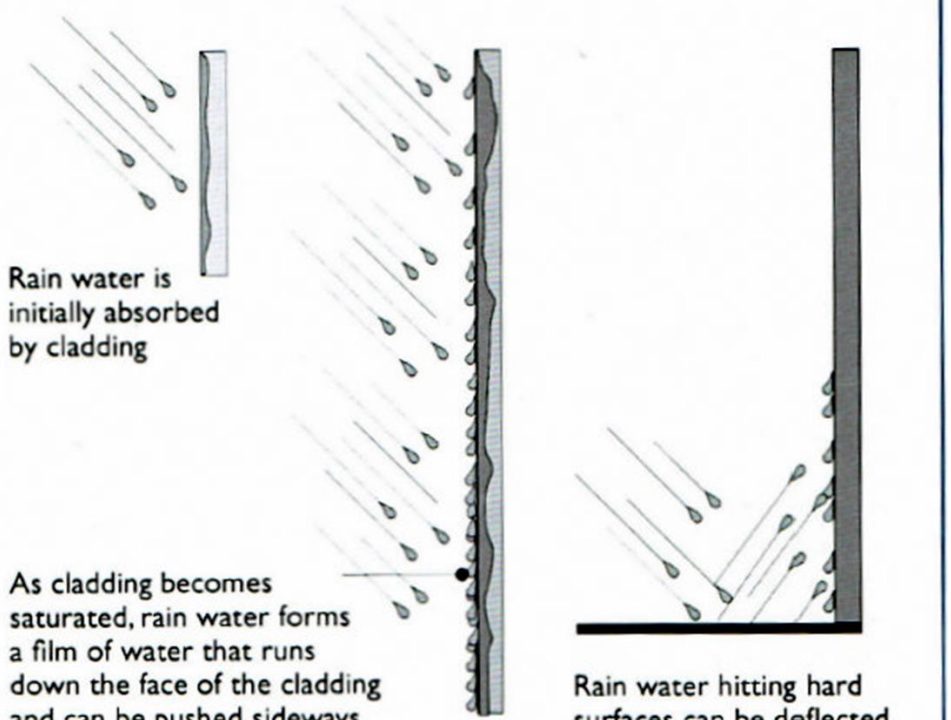

Create an intentional gap
between trim and flashing

Its all about the details

Inadequate pan flashing

Rainwater accumulation on cladding



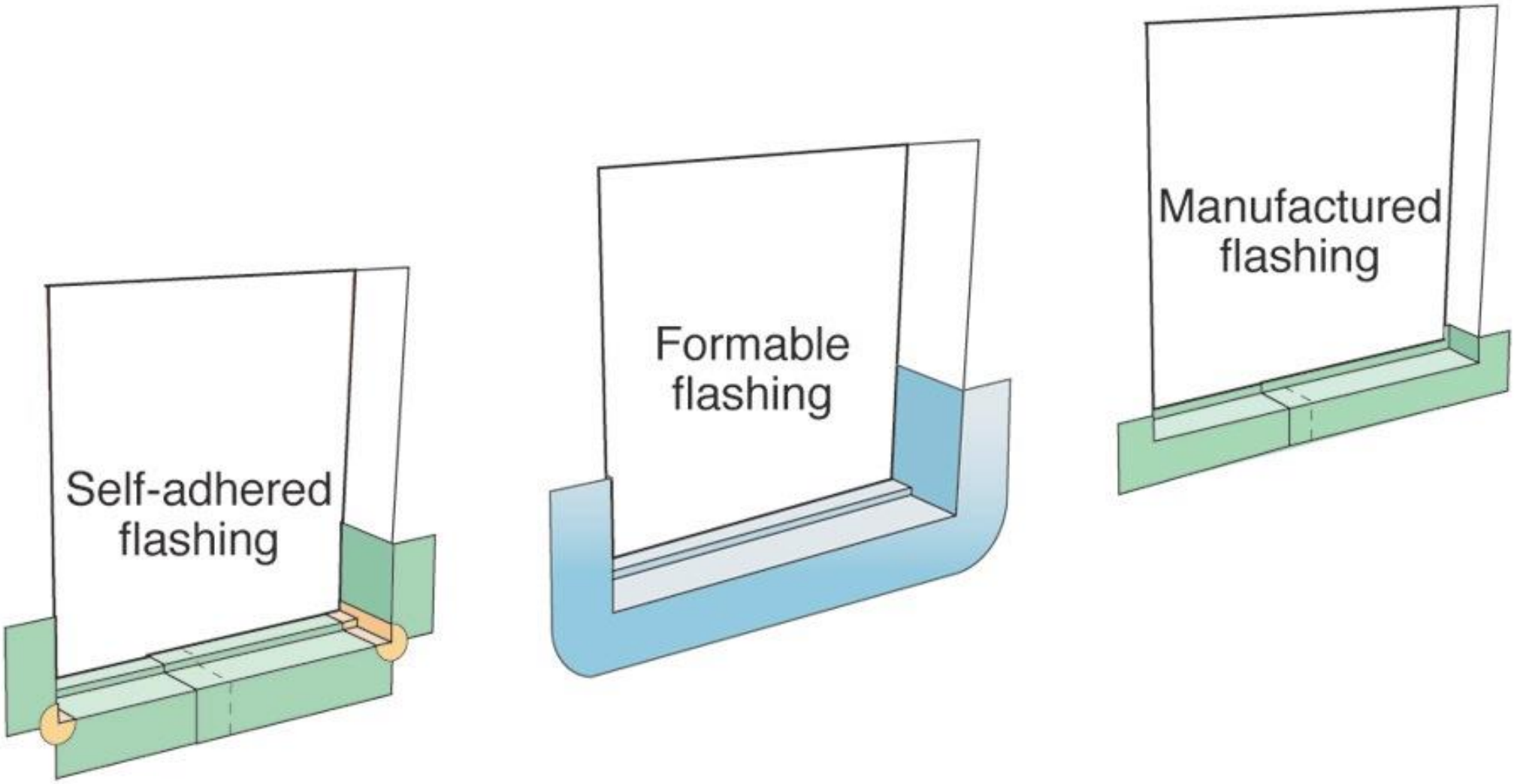
2.23

Protecting door openings

The Details Demonstrating a method


StraightFlash
StraightFlash
StraightFlash
StraightFlash
StraightFlash
StraightFlash
StraightFlash
StraightFlash
Tyvek
HomeWrap
Tyvek

Site-Constructed or manufactured pan flashings for window and door openings in frame walls

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Allow for drainage at the base of windows

Managing moisture: Material issues

A typical scenario in 2021 (are we brave enough to look "under-the-hood" of the homes we have built in past?)

- "tuck-tape" is NOT FLASHING TAPE
- NEVER, EVER, EVER,EVER, EVER tape off the bottom of openings (think back dam!)

Zone 5, single detached, built 2005

Use low pressure, low expanding foam around openings to complete the air barrier

Window Installation-Great Job!

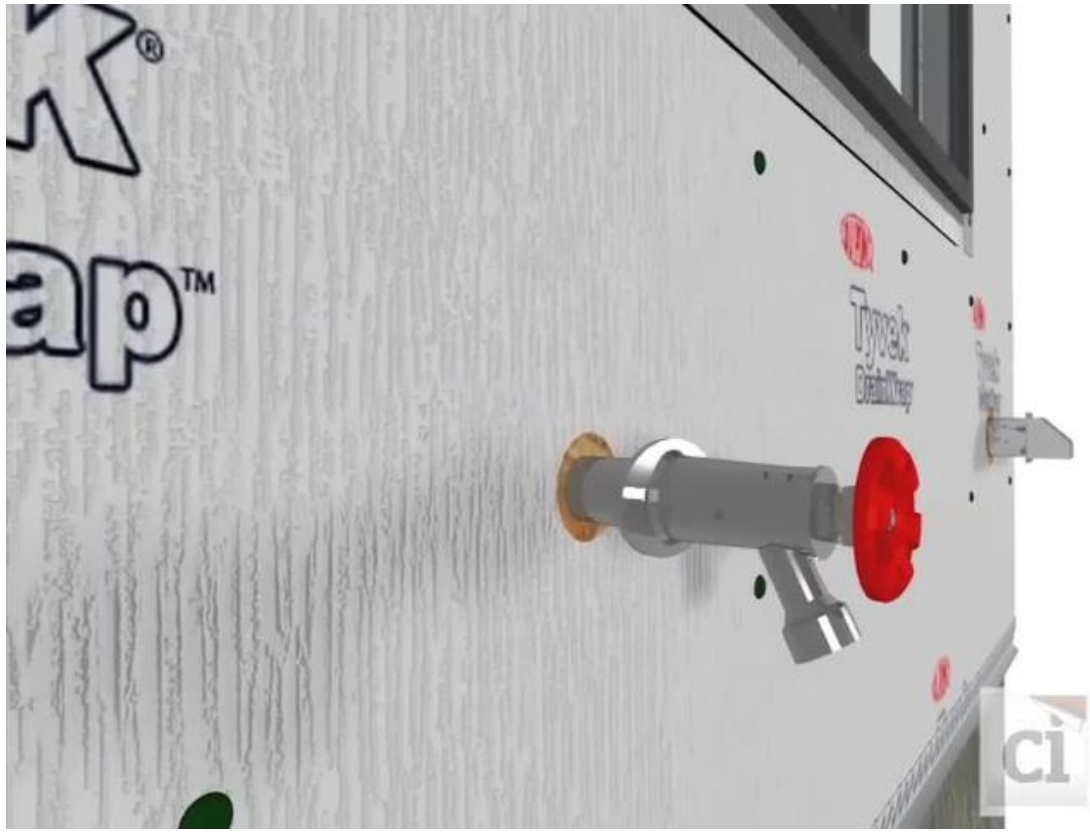
Permeability is useful for drying

Holes Add Up

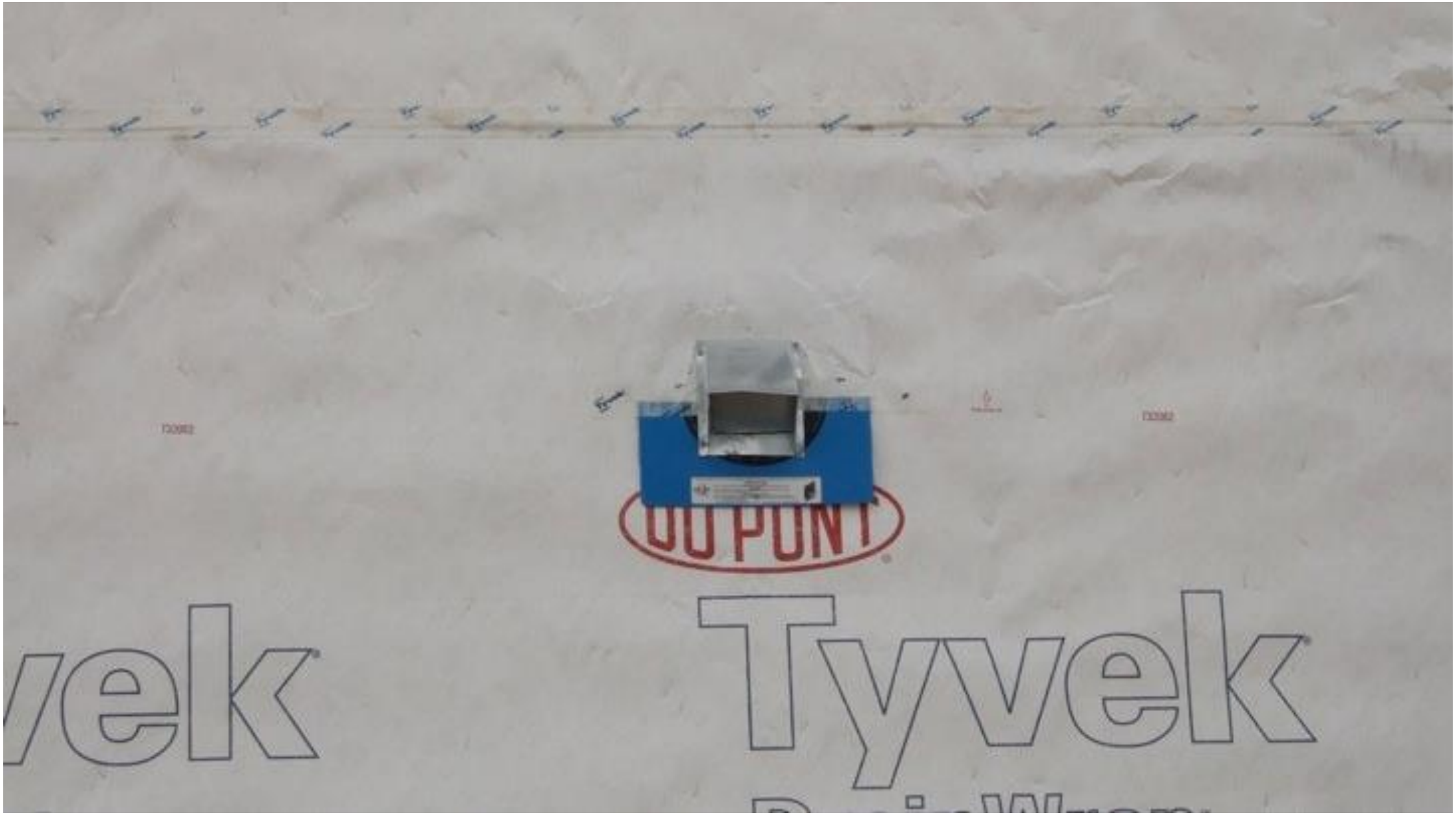
Some Holes will need special attention

It takes commitment

Even small holes matter


ap™


WEATHER RESISTIVE BARRIER
WEATHER RESISTIVE BARRIER
WEATHER RESISTIVE BARRIER
WEATHER RESISTIVE BARRIER
WEATHER RESISTIVE BARRIER
WEATHER RESISTIVE BARRIER


DUPONT
Tyvek

Air Barriers

- Air Barriers are systems of materials
- Designed and constructed to control air flow between a conditioned space and an unconditioned space
- Air barrier system is the primary air enclosure boundary that separates indoor (conditioned) air and outdoor (unconditioned) air

Reasons we want houses to be tight

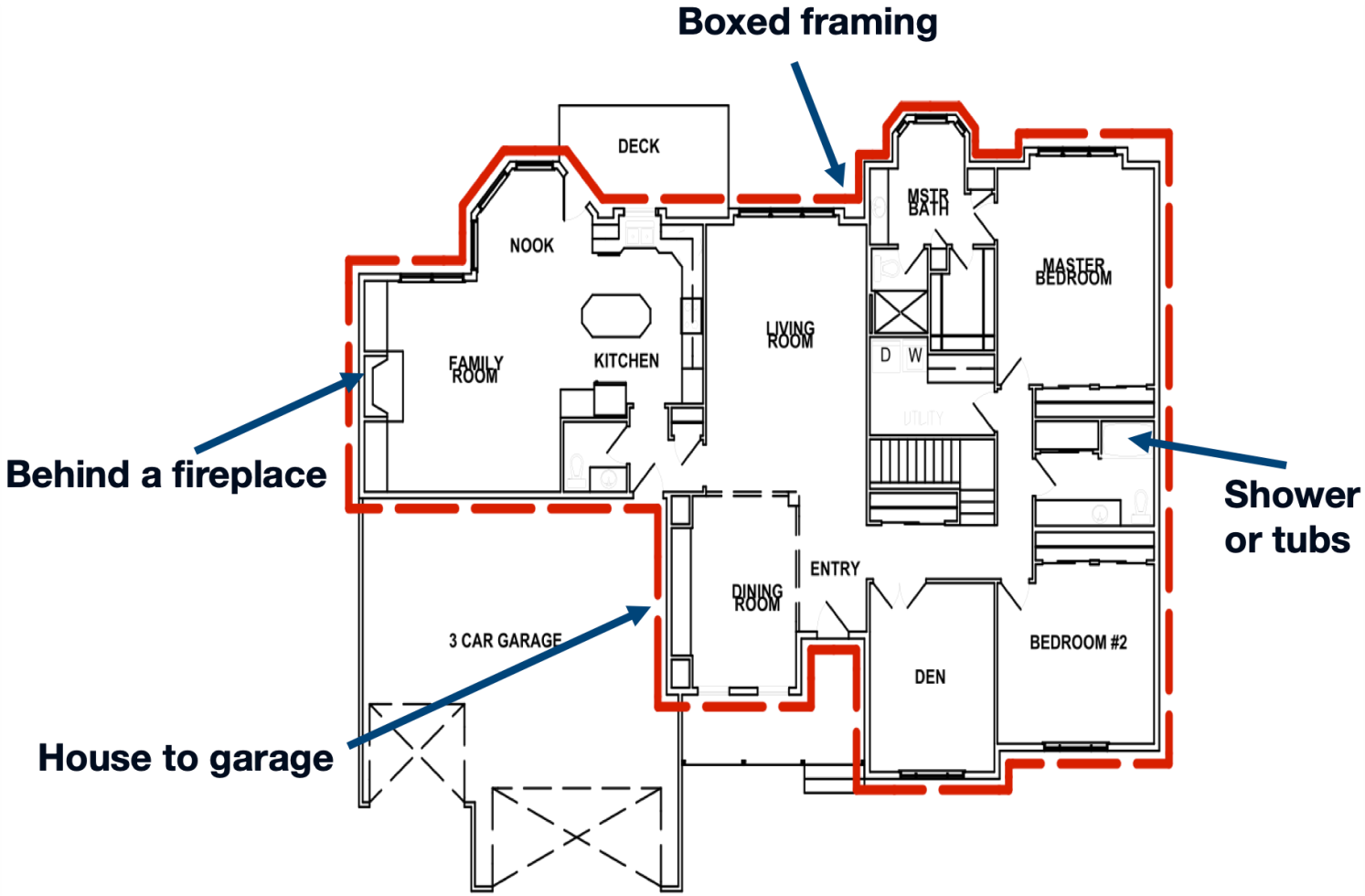
- Keeps walls Dry (limits interstitial condensation)
- Most cost effective energy saving measure
  - 20% - 30% savings
- Makes homes quieter and cleaner
- Makes homes more “comfortable”
- Reduces water entry - homes last longer
- Makes homes healthier - controlled air quality
- Environmental benefits because we are not wasting energy

Concerns about houses being “too tight”

- Indoor air quality
  - Moisture problems
  - Chemical pollutants
- Combustion appliance and venting safety
- “The walls have to breathe”
- Negative air pressure – poten for soil and gas infiltration

Moisture laden air flow can create problems

Define breaks and create a plan to manage them



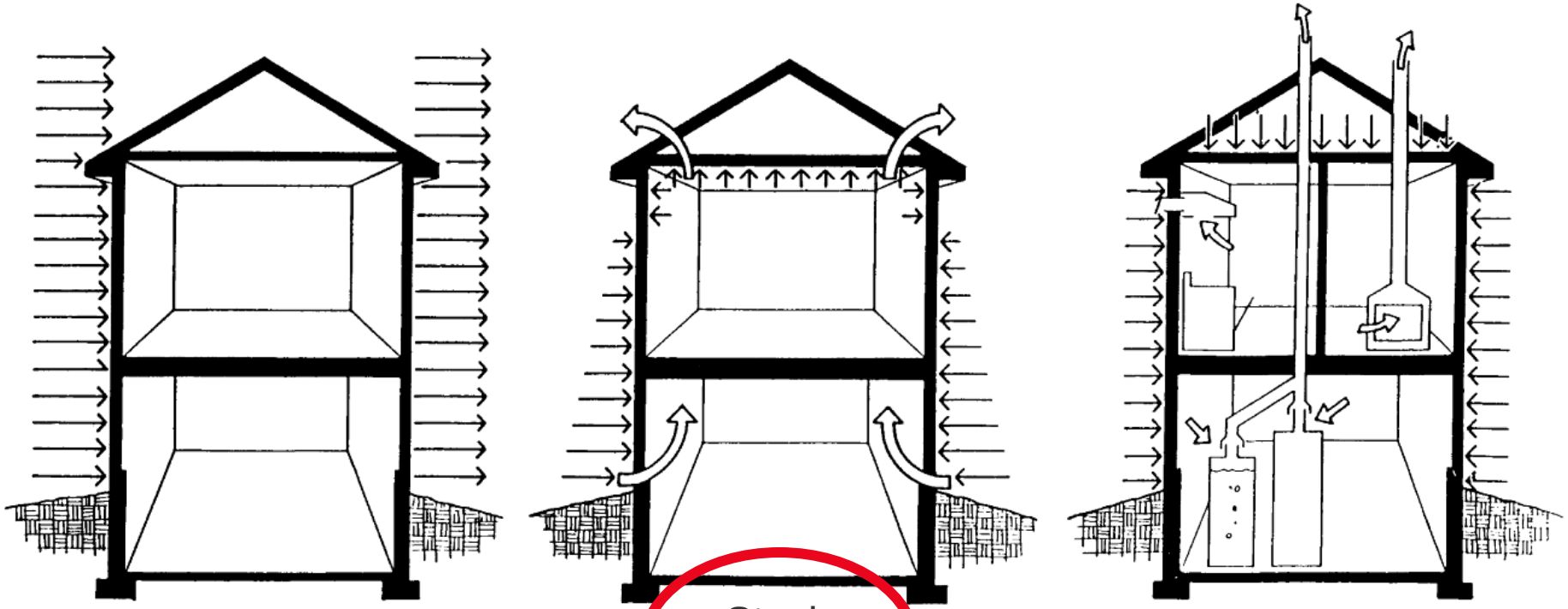
Common Holes We Miss

Plumbing
HVAC
Electrical
Framing Holes
Soffits
Behind Tubs
Chimney Shafts
Cantilevers

Air Sealing Bang-For-Your-Buck Ranking

JOINT/OPENING	CFM50*	ACH50†
top plate-to attic	0.29 to 0.68 per foot	0.29 to 1.6
duct boot	7.7 per boot	0.13 to 0.26
recessed light	9.1 per light	0.15 to 0.31
band joist (top & bottom)	0.86 per foot	0.37 to 0.42
garage-house common wall	0.60 per foot	0.14 to 0.26
sheathing-to-plate (top & bottom)	0.074 to 0.62 per foot	0.040 to 0.38
window/door framing-to-sheathing	0.031 to 0.11 per foot	0.020 to 0.10
between exterior top plates	0.10 to 0.11 per foot	0.033 to 0.046
corners (interior pointing)	0.024 to 0.21 per foot	0.0021 to 0.032
corners (exterior pointing)	0.054 to 0.45 per foot	0.0069 to 0.11
bottom plate-to-subfloor	0 to 0.11 per foot	0 to 0.11
vertical sheathing joints	0.010 to 0.090 per foot	0.011 to 0.11
sill plate-to-foundation†	0 to 0.030 per foot	0 to 0.025

A very helpful OC research project

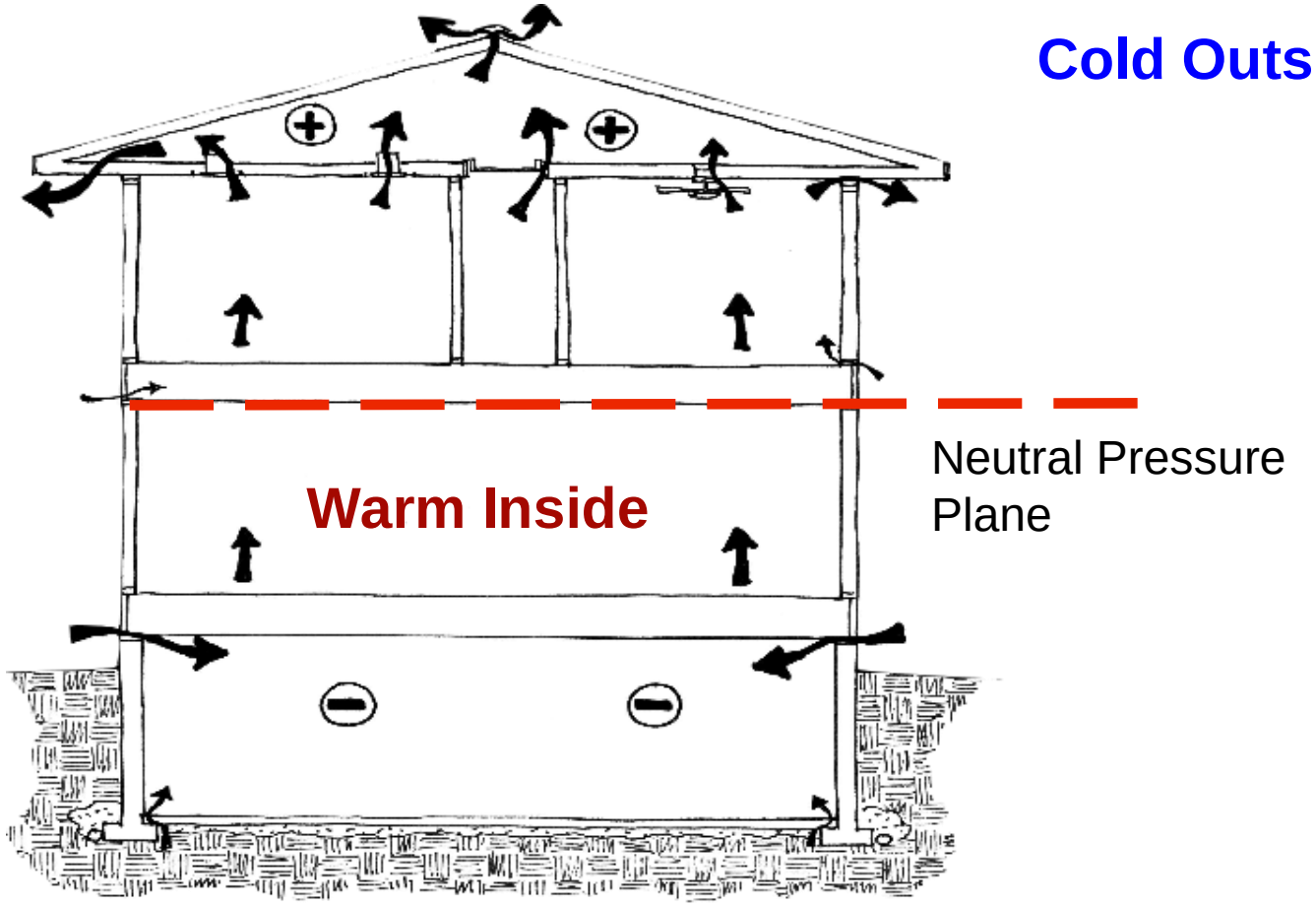


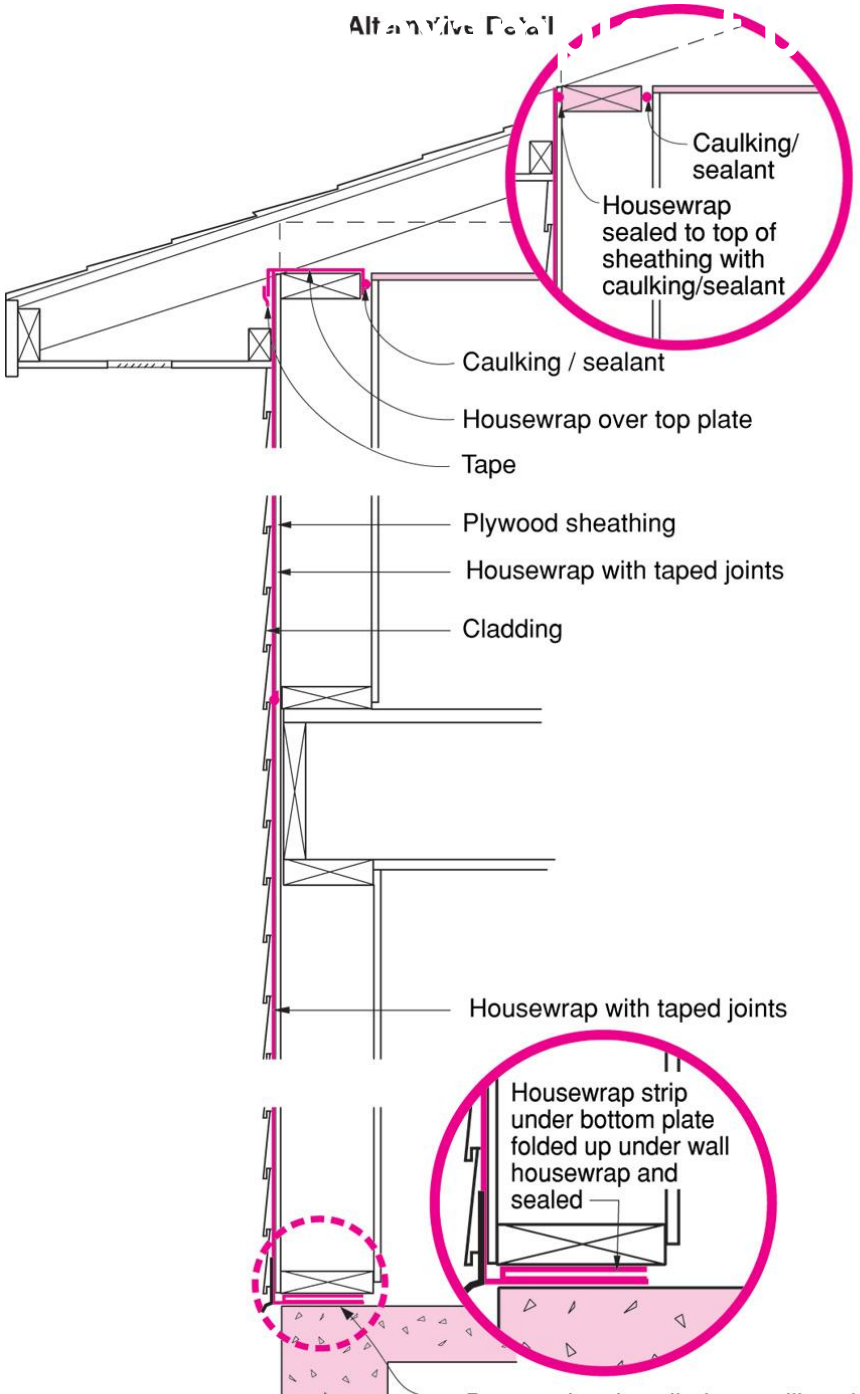
Wind Pressure

Stack Effect

Mechanical Pressure

30-50% of winter heat

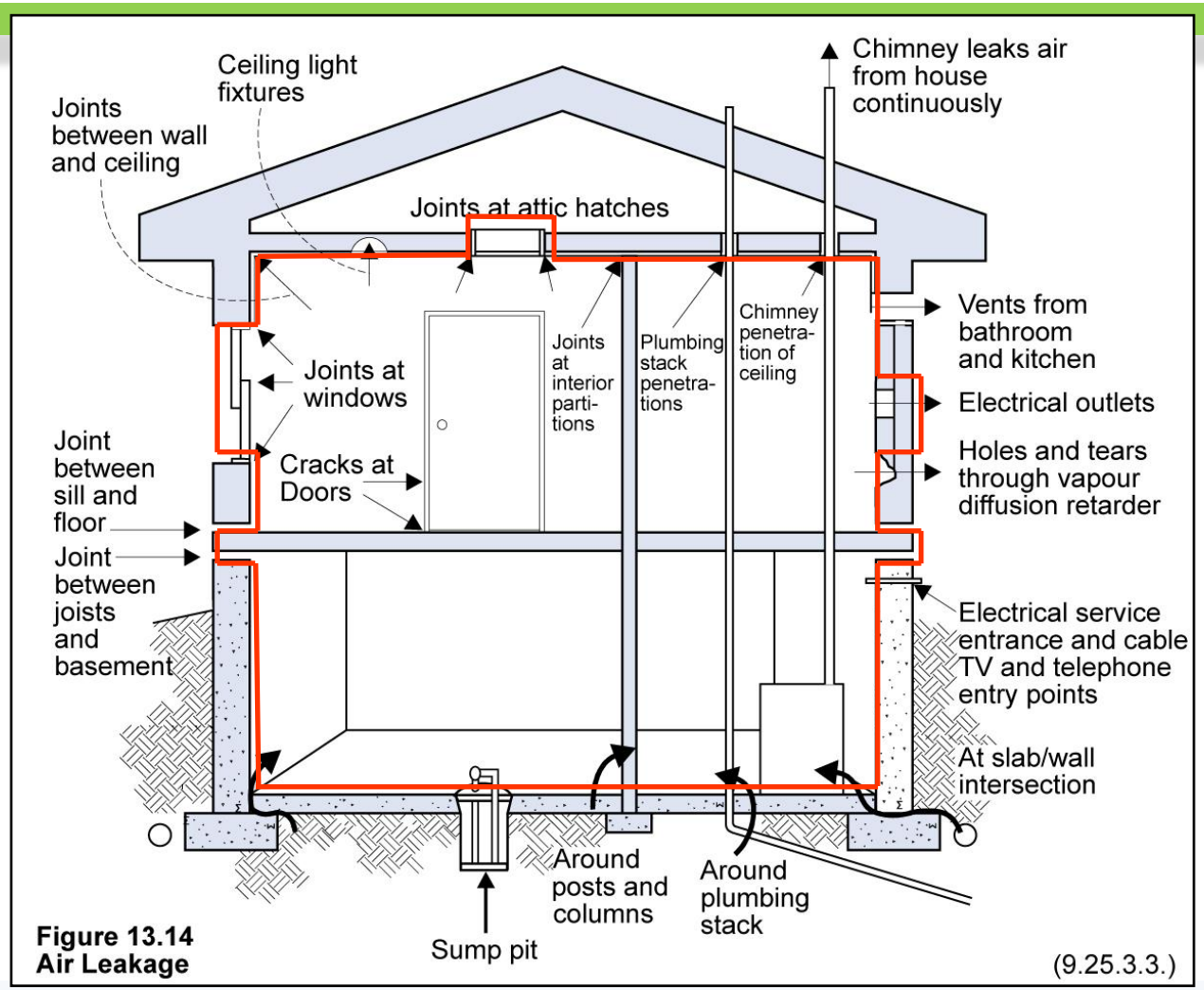

Cold Outside
Warm Inside
Neutral Pressure Plane



Exterior Air Barrier

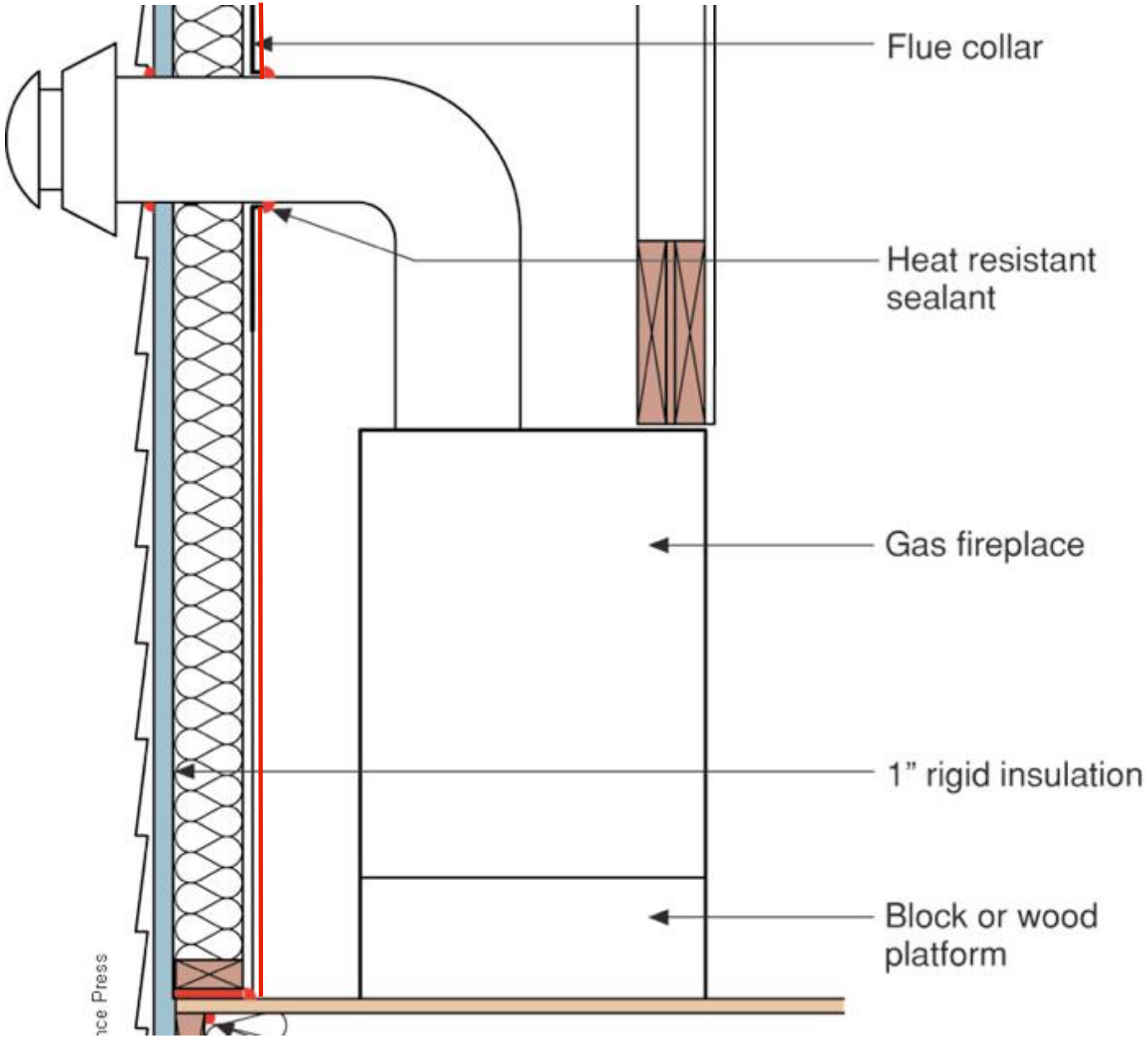
- A well detailed weather barrier or sheathing can also be an effective air barrier
  - It must be continuously connected
  - Simple tapes & caulking applied by one trade
- You get multiple functions from one material & trade

Continuous air barrier system



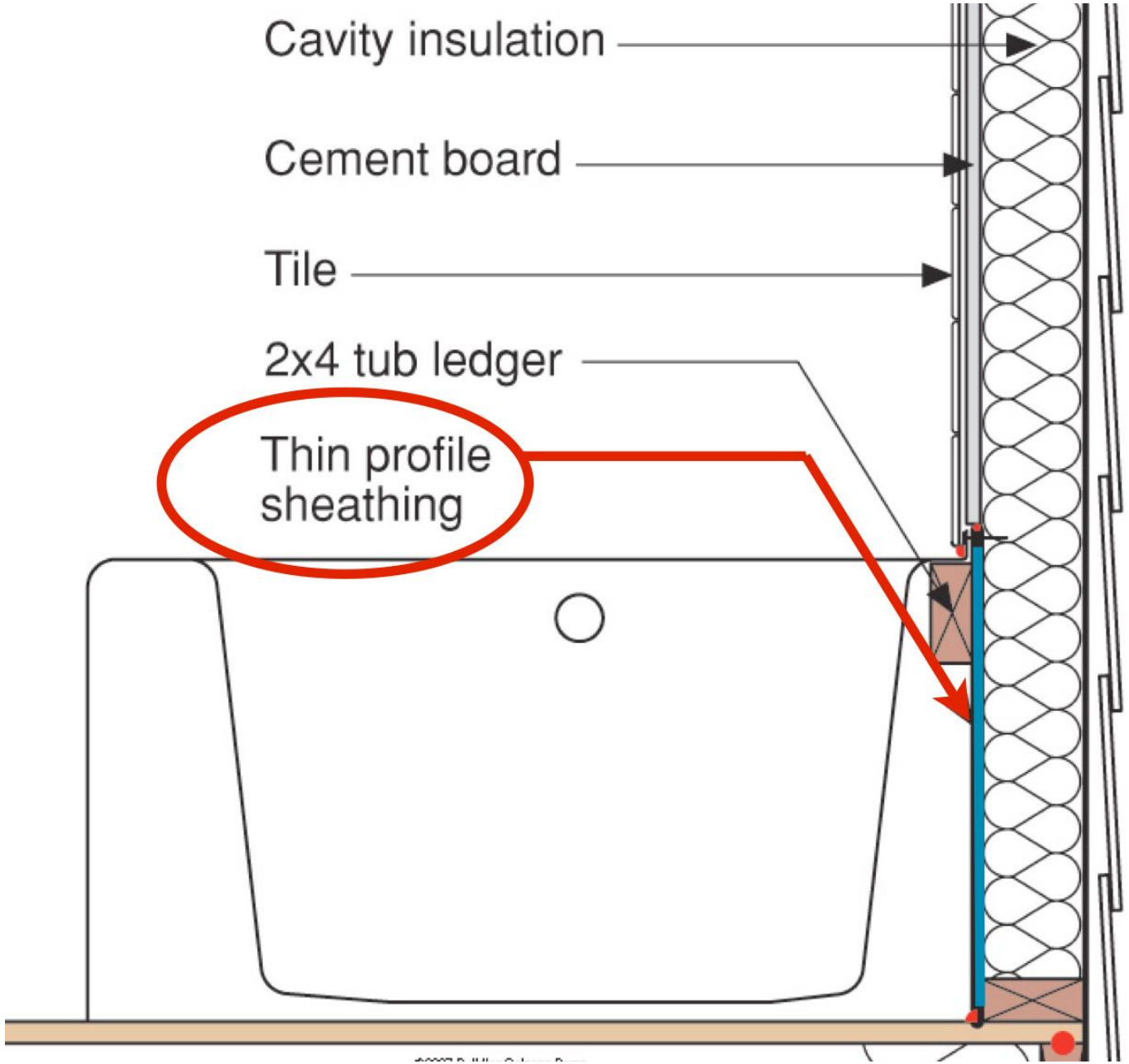
- Continuous air barrier completely around the building
- All penetrations must be sealed
- Must be durable to last the life of the building
- INTERIOR AB = 45+ connections
- EXTERIOR AB = 22+ connections

Air barrier at fireplace



Chimney shafts and penetrations

Tub Air Sealing



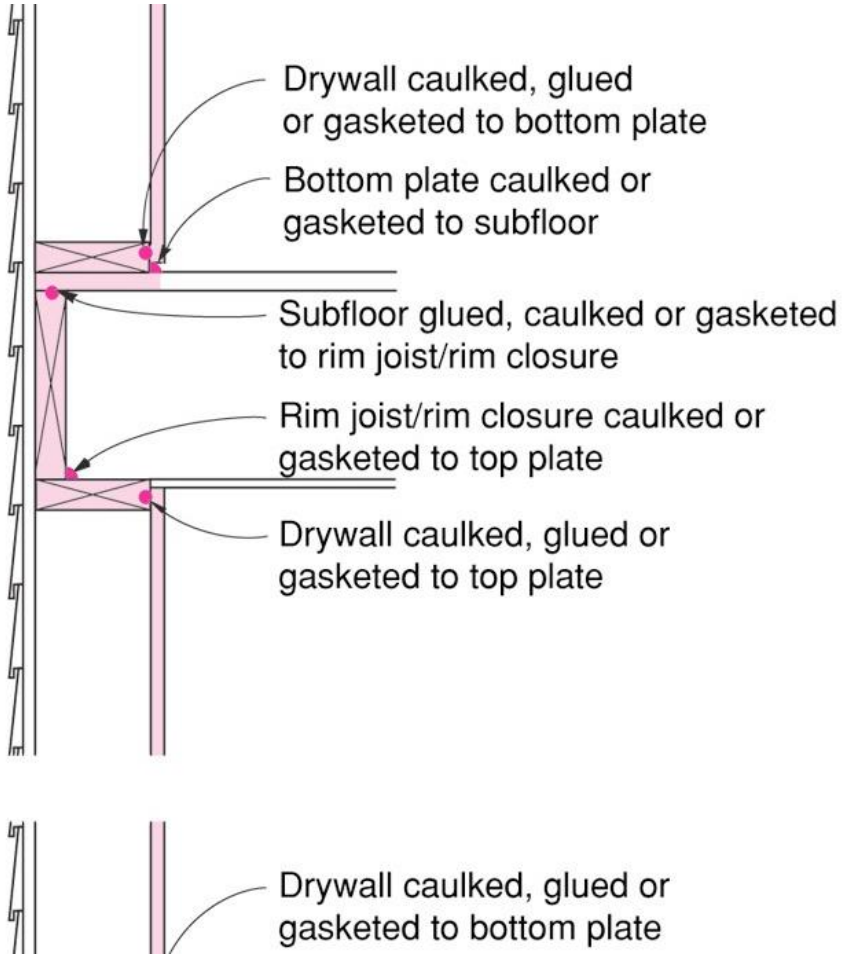
Provide rigid blocking

House to garage connections

Air-seal connections at house to garage

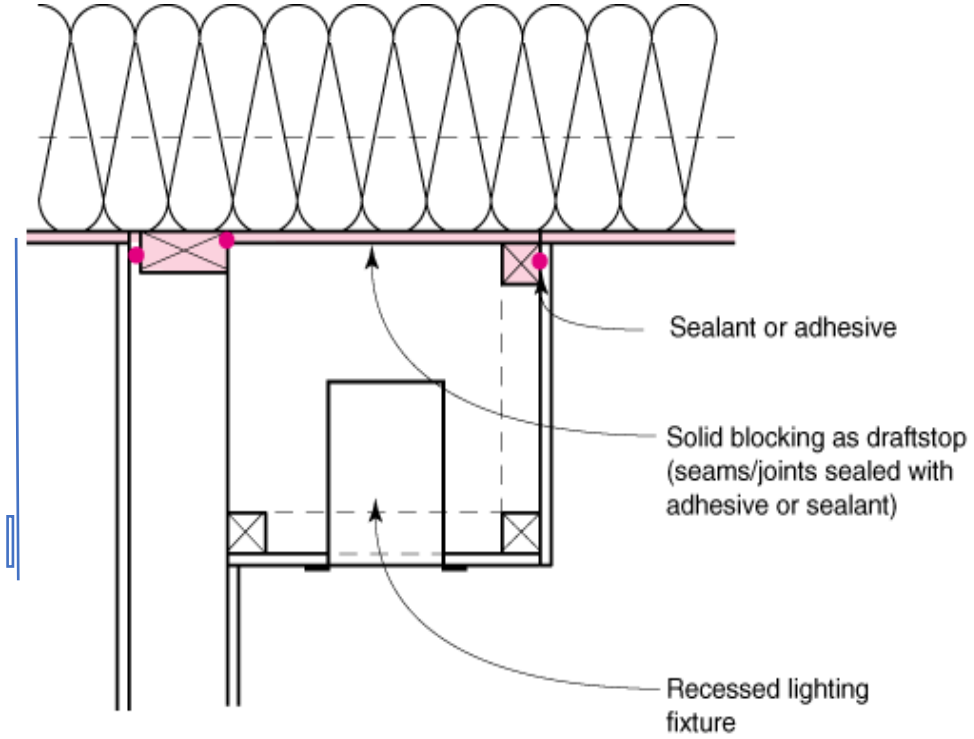
Air Flow Barrier-Interior

- Airtight Drywall Approach
- Connecting and sealing the materials to stop air flow
- Must be continuous through all penetrations



Plumbing, electrical & HVAC penetrations need attention

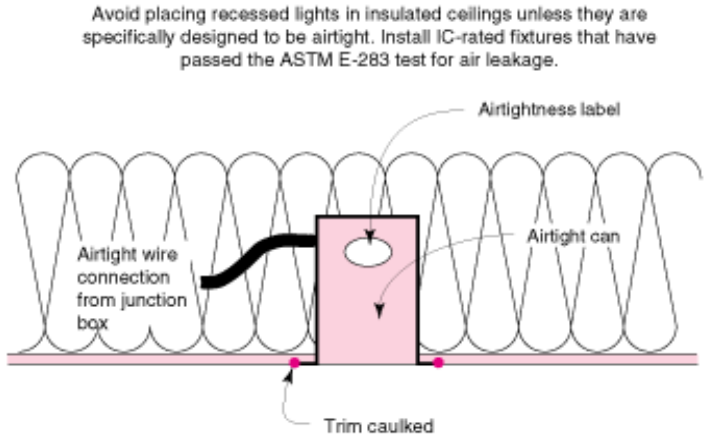
Soffits and knee-walls need to be prepared early



Air Sealed Recessed Light

of the Builder's Guide Building Science Corp. Joe Lstiburek

Select the best method for your fixtures



Air Sealed Recessed Lights

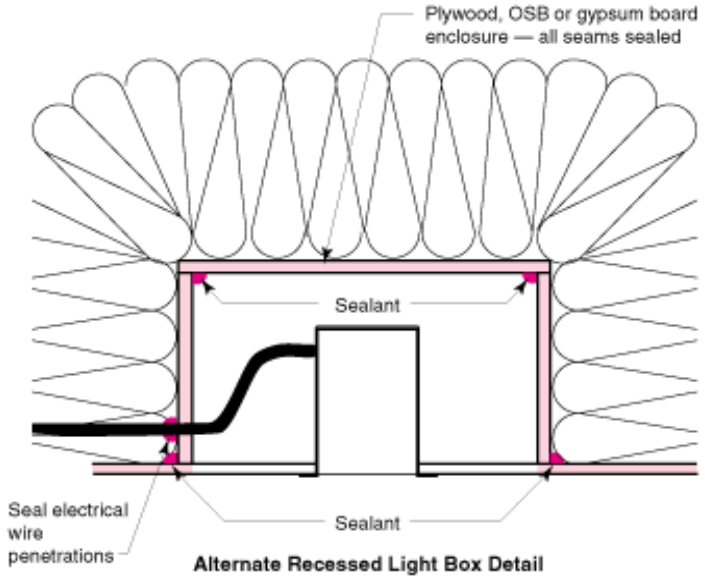
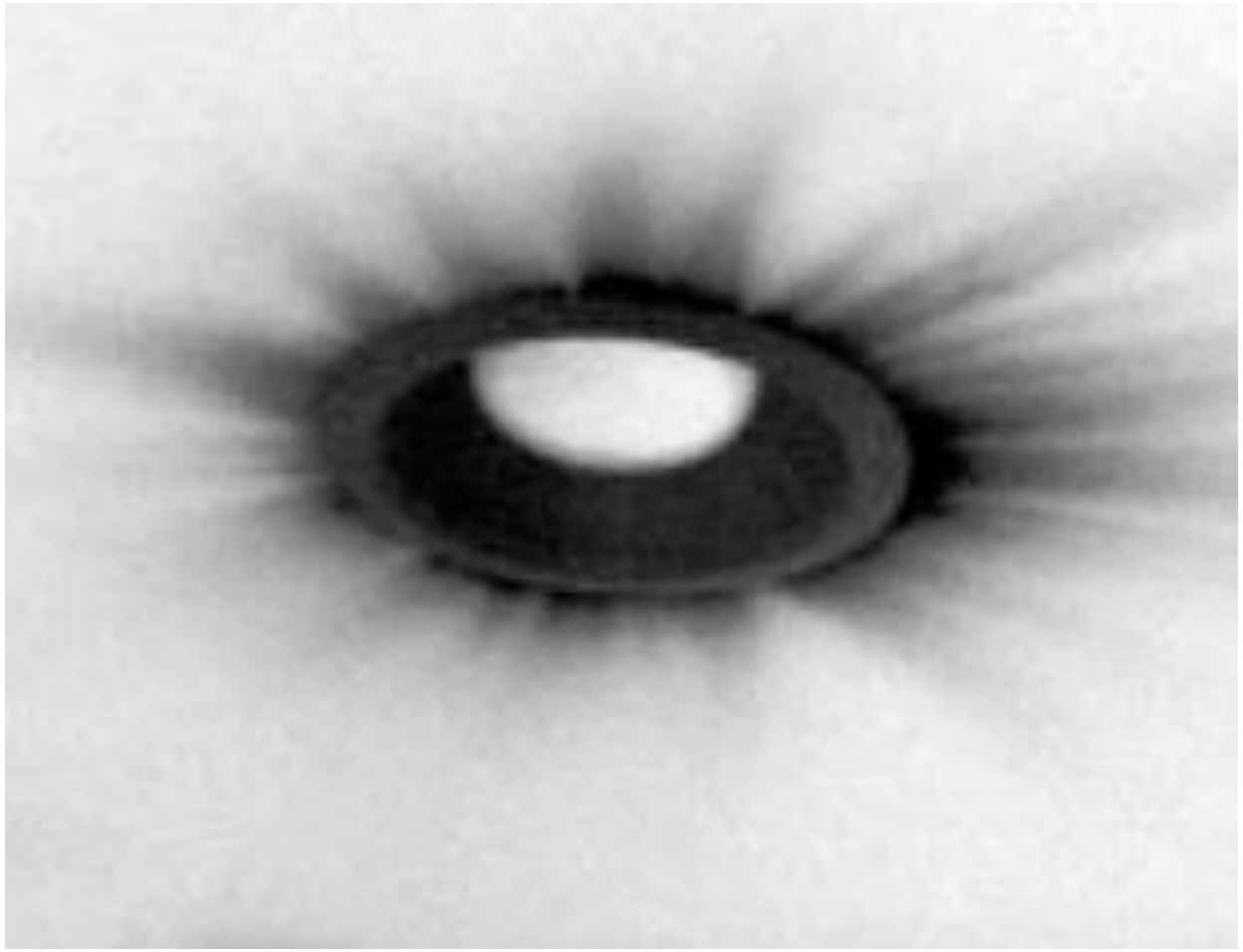


Figure 5e

Recessed Light Box Detail

lustrations courtesy of the Builder's Guide Building Science Corp. Joe Lstiburek

Air Leakage at recessed light



Getting to 1.5 ACH50 >

Fans

- Is the back-draft flap in working order?
- Back draft flaps on vents commonly don't work and can be a major source of air leakage.-up to 30CFM at 50Pa
- New exhaust fans available with airtight back draft flap

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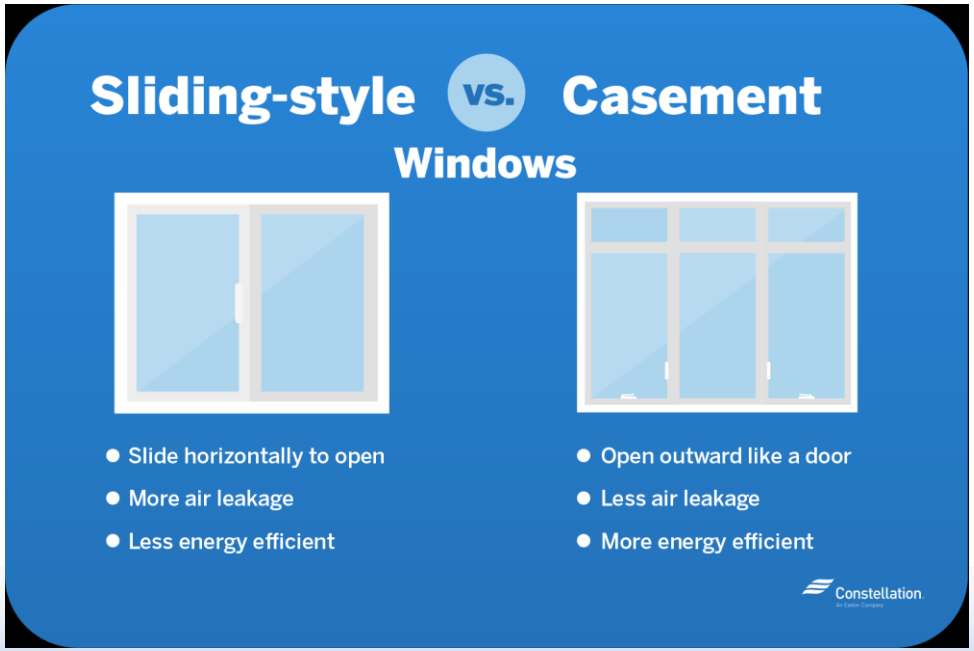
Getting to 1.5 ACH50 >

Windows

- Casement vs. slider.
- Windows are part of the air barrier system and the designated air barrier must be transferred to the window.



Courtesy of https://blog.constellation.com/

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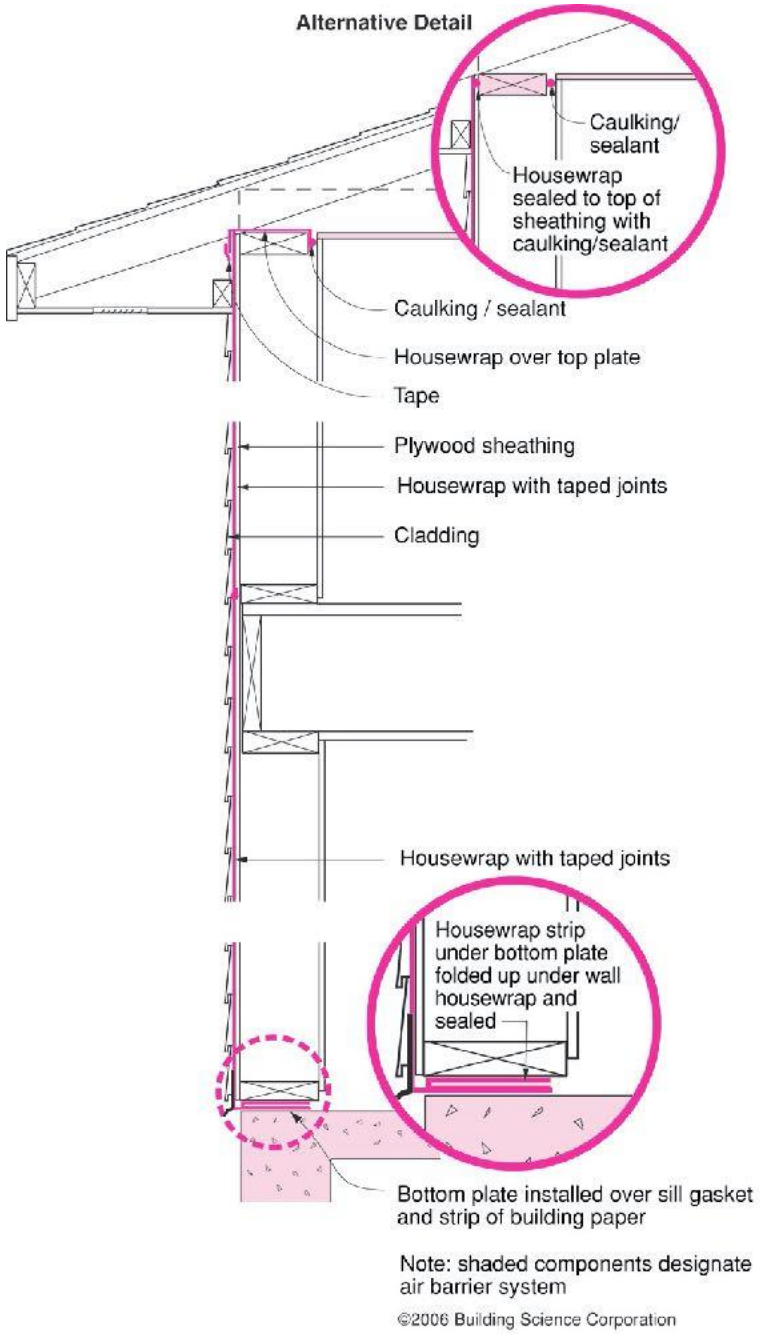
Air Flow Barrier-Exterior

A well detailed house wrap or weather barrier can also be an effective air barrier

It must connect to the foundation and the ceiling air barrier

Must be durable through the construction process

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YEAR SYSTEM
LIMITED WARRANTY
FROM THE CREATORS OF
AdvanTech Flooring
ZIP System
ESR #1473.
ESR #1474.
ESR #2227.

Air leakage in attached homes, towns and MURBS

- Air leakage through Common assemblies is an issue (walls/floors)
- Need to start talking in NLR and NLA as opposed to ACH50 (surface area vs volume)

Compartmentalization

Compartmentalization, as a concept, dates back to the Empire State Building during the Great Depression. It was espoused as an approach to deal **with durability, fire safety**, **comfort**, and **indoor air quality in high-rise and multifamily construction.** However, the concept was not formally memorialized until Handegord (Canadian IRC (2001).

What are air sealing issues with attached units?

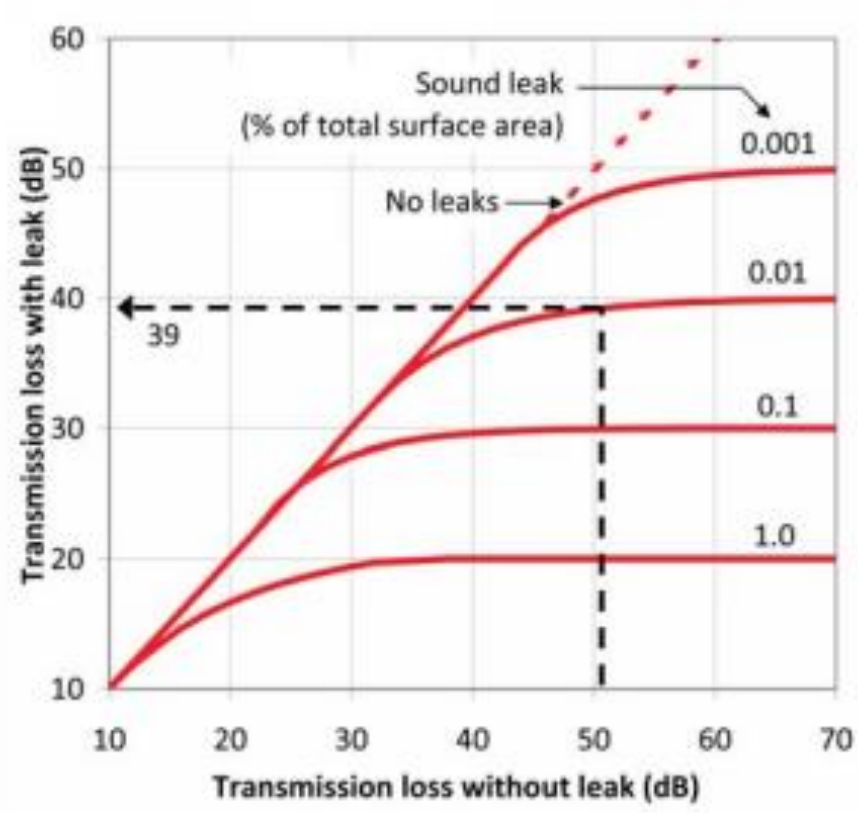
AIR LEAKAGE AND SOUND TRANSMISSION

Sound travels by:

1. Structure borne elements- vibration(energy)

2. Air borne sound waves or vibrations

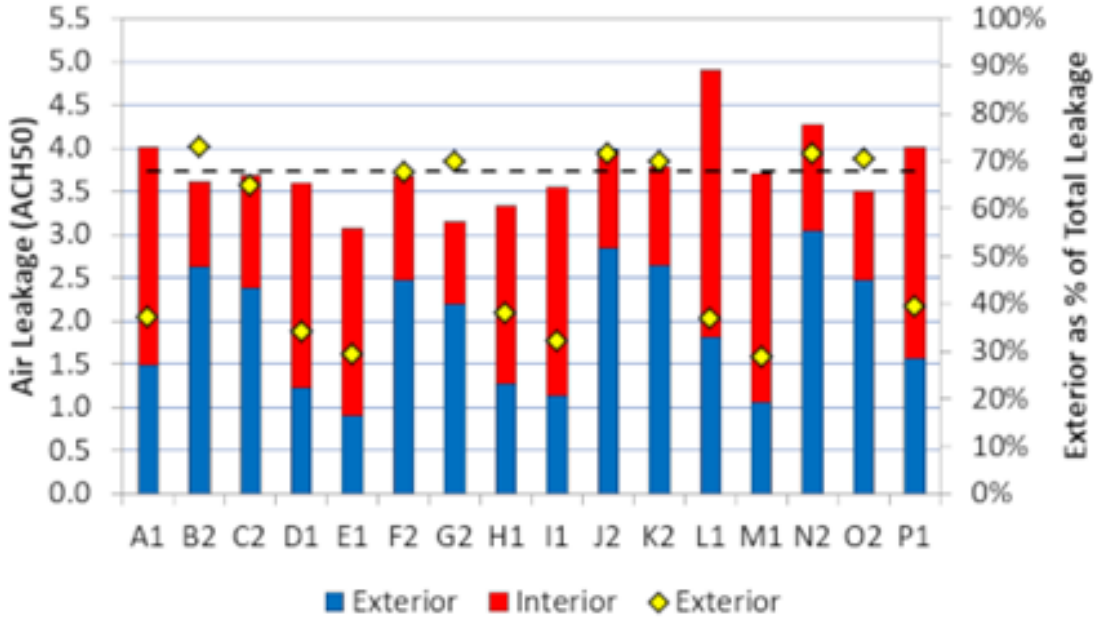
3. An opening or crack 1/100th of 1% of a total wall's surface area can reduce the sound transmission loss (tl) of a wall from 50 to 39 db.



2016 Minnesota Case Study : 16 unit MURB Air tightness Case Study

Exterior –to-interior Air vs Interior-to-interior Air

- Completed using guarded testing protocol
- Guarded testing is incredibly expensive (as opposed to individual suite or whole building testing(where possible)
- Nearly impossible to reproduce if results are questioned after occupancy



This chart shows the measured leakage of the 16 units in a garden style building. Each bar represents a unit's total leakage, divided between exterior (blue) and inter-unit (red).

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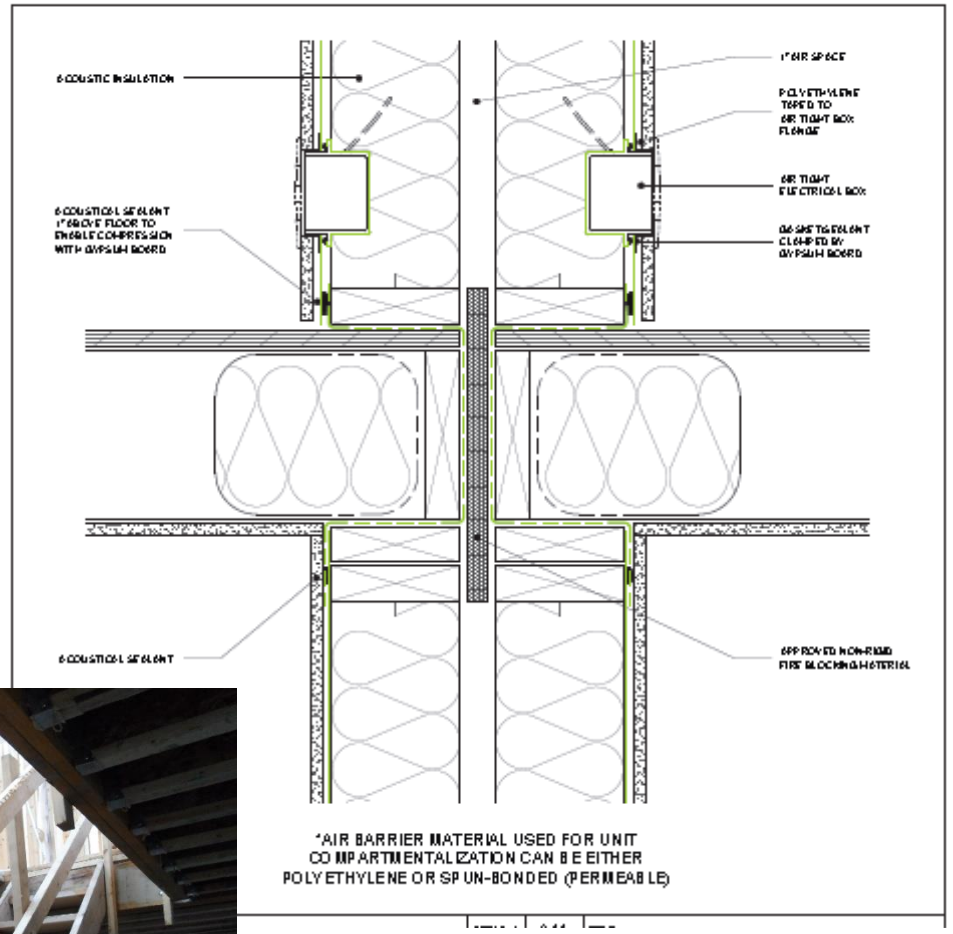
What are air sealing issues with attached units?

Compartmentalization is the key

Understanding air can infiltrate between units in:

- Common walls
- Common floors



Tight Construction

HOW TIGHT - Residential

- US IECC 2015< 5 ACH@50 Zones 1,2
  3 ACH@50 Zones 3+
- “Canadian Code” 3.0 ACH@50
- ENERGY STAR 2.5 ACH@50
- Zero Energy 1.5 ACH@50
- Passive House 0.6 ACH@50
- New PROPOSED ZEH 2024 IECC 1.5-2.5ACH

A game changing solution

AeroBarrier is a convenient, cost effective approach that seals homes in less than 3 hours and provides verification that the air-tightness requirement has been achieved.

Changing the Way Homes are Built with:

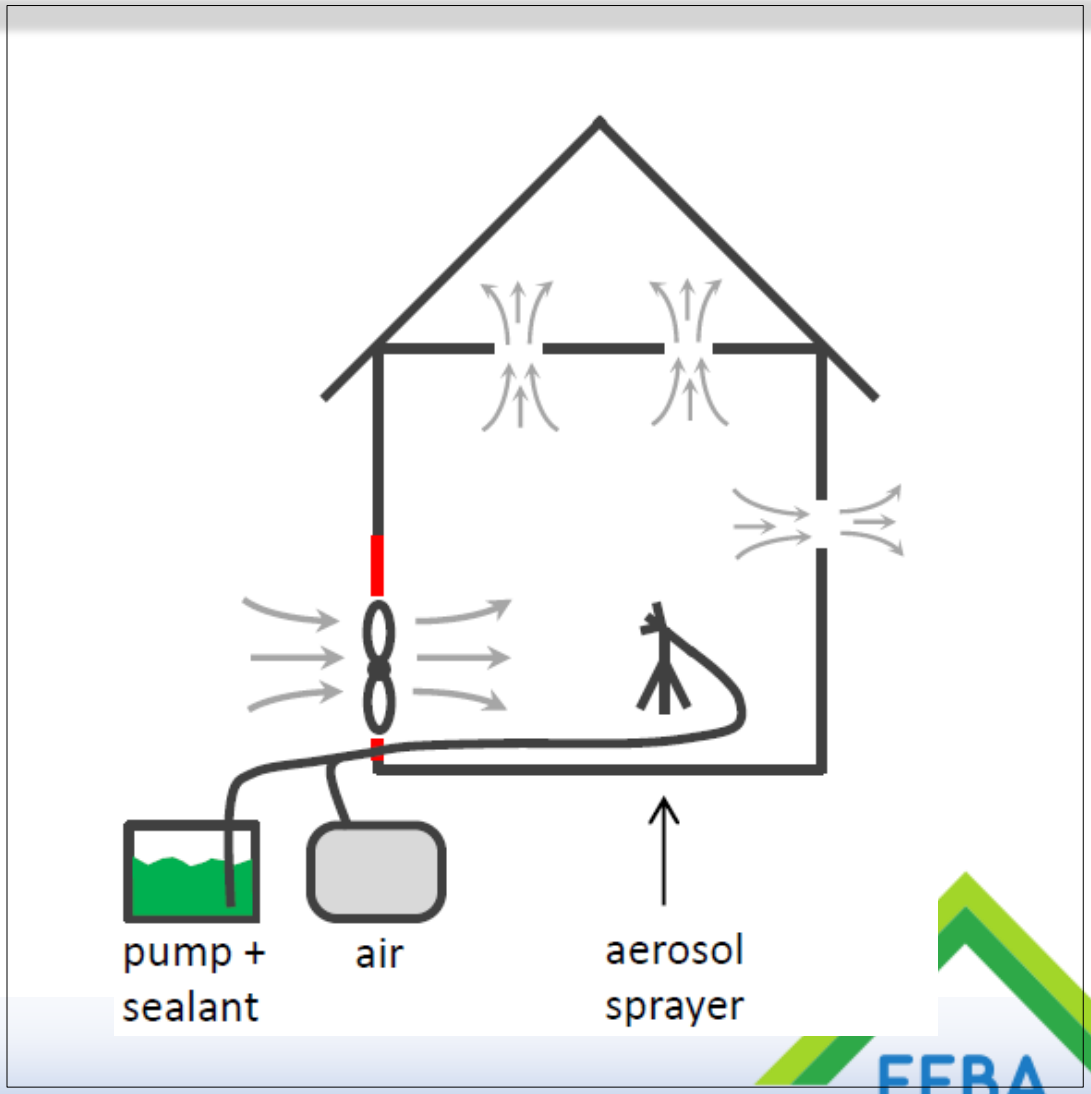
- Consistently tighter building envelopes
- Verified and documented results
- A single process
- Time saving

The AeroBarrier process

STEP 1:

Prepare house for sealing. Cover all intentional openings (drains, bathroom vents, etc.) and horizontal surfaces, set up sealing equipment, and pressurize the building / home.

Typically 100 Pascal



Deploy the nozzles

Up to 8 tripods

2 nozzles each

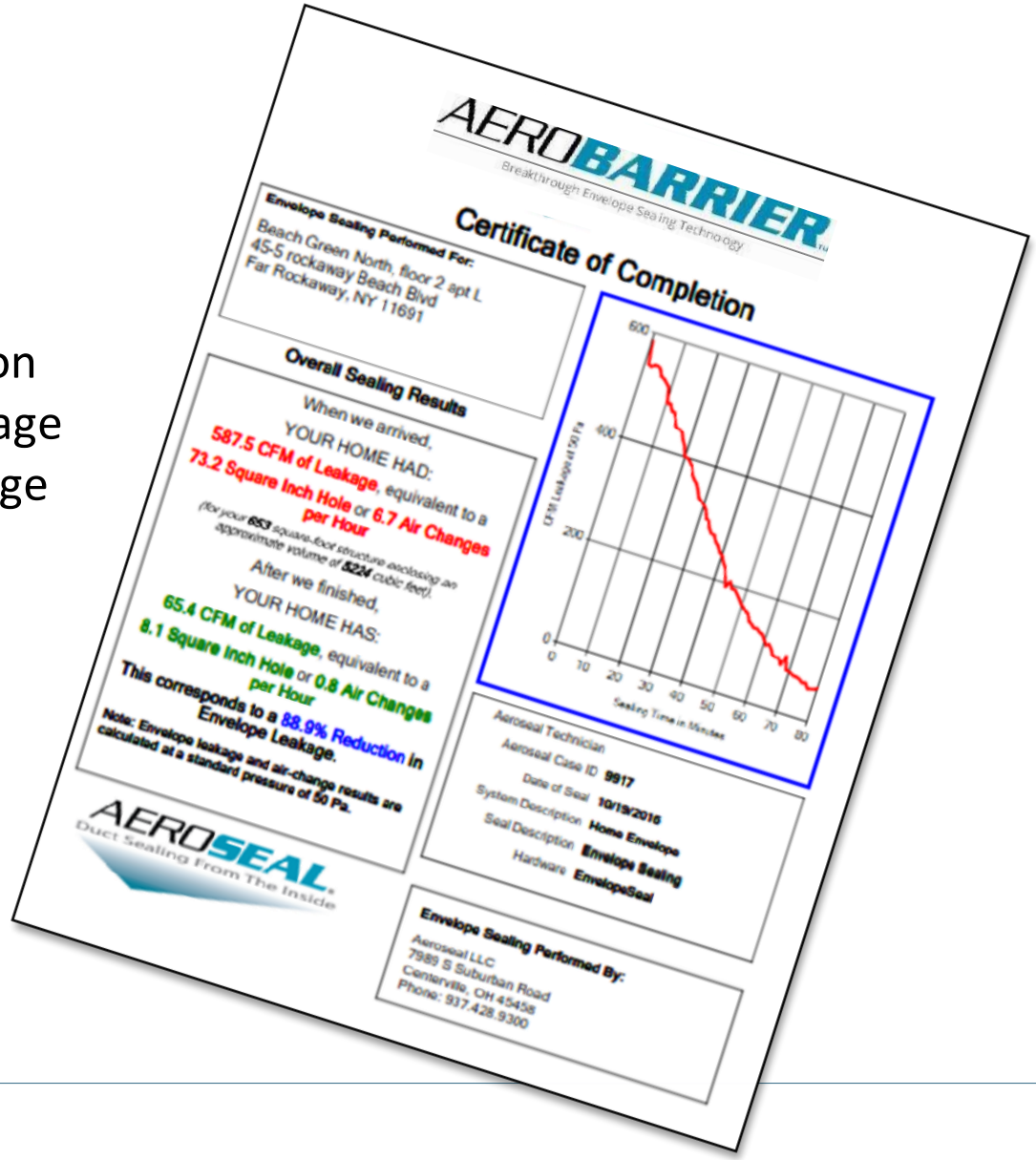
Air and sealant to each

Holes that the Sealant is really good at - 1/2” or under

The AeroBarrier process

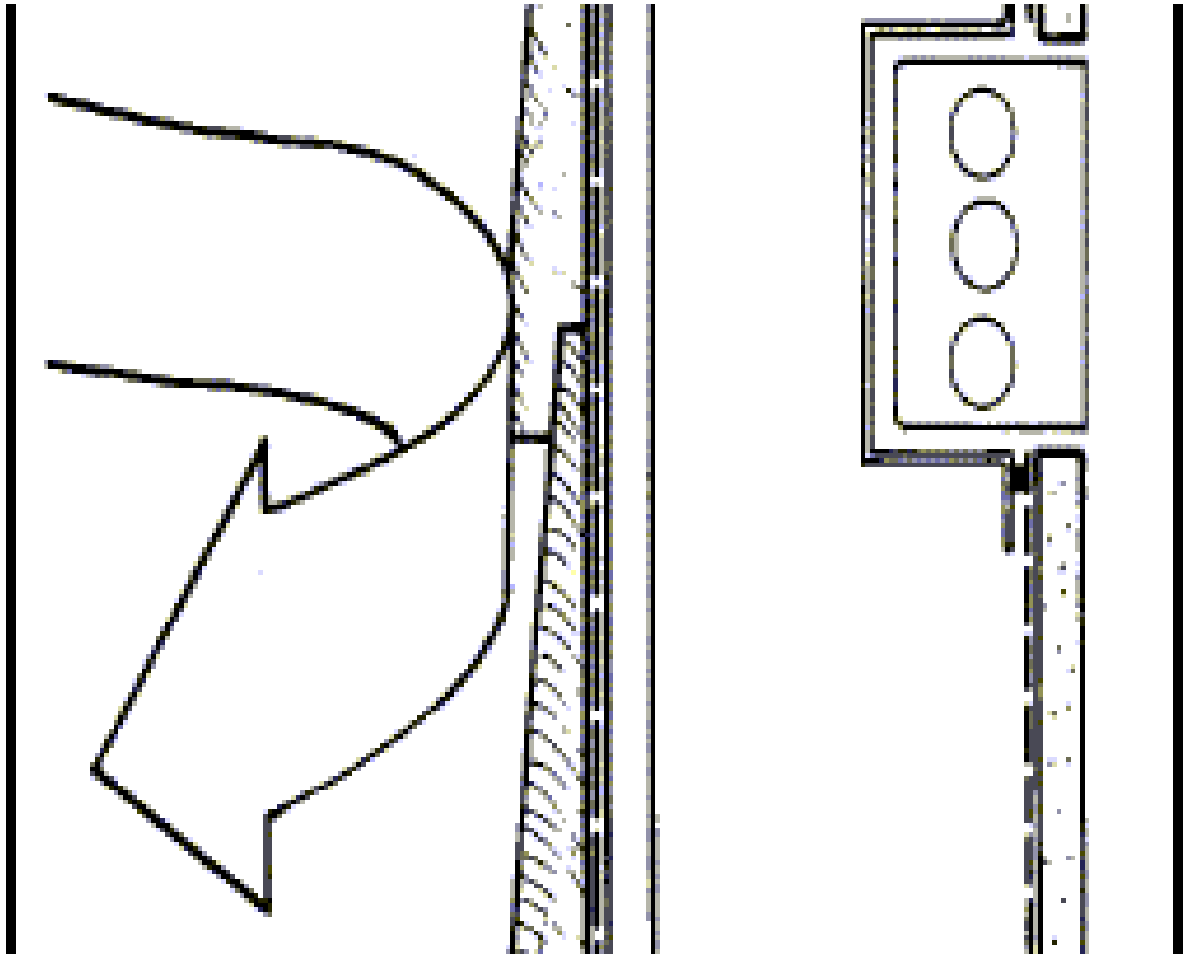
Verified Results!

Every seal provides a certificate of completion outlining the sealing work. Pre and post-leakage are captured and the seal duration and leakage reduction are all displayed on the graph



Air Sealing Summary

- Reduce energy loss
- 1/3 of htg/clg bill can be from air leakage
- Reduce infiltration of harmful air
- Garage connection
- Improved comfort
- Less drafts
- Less noise & dust



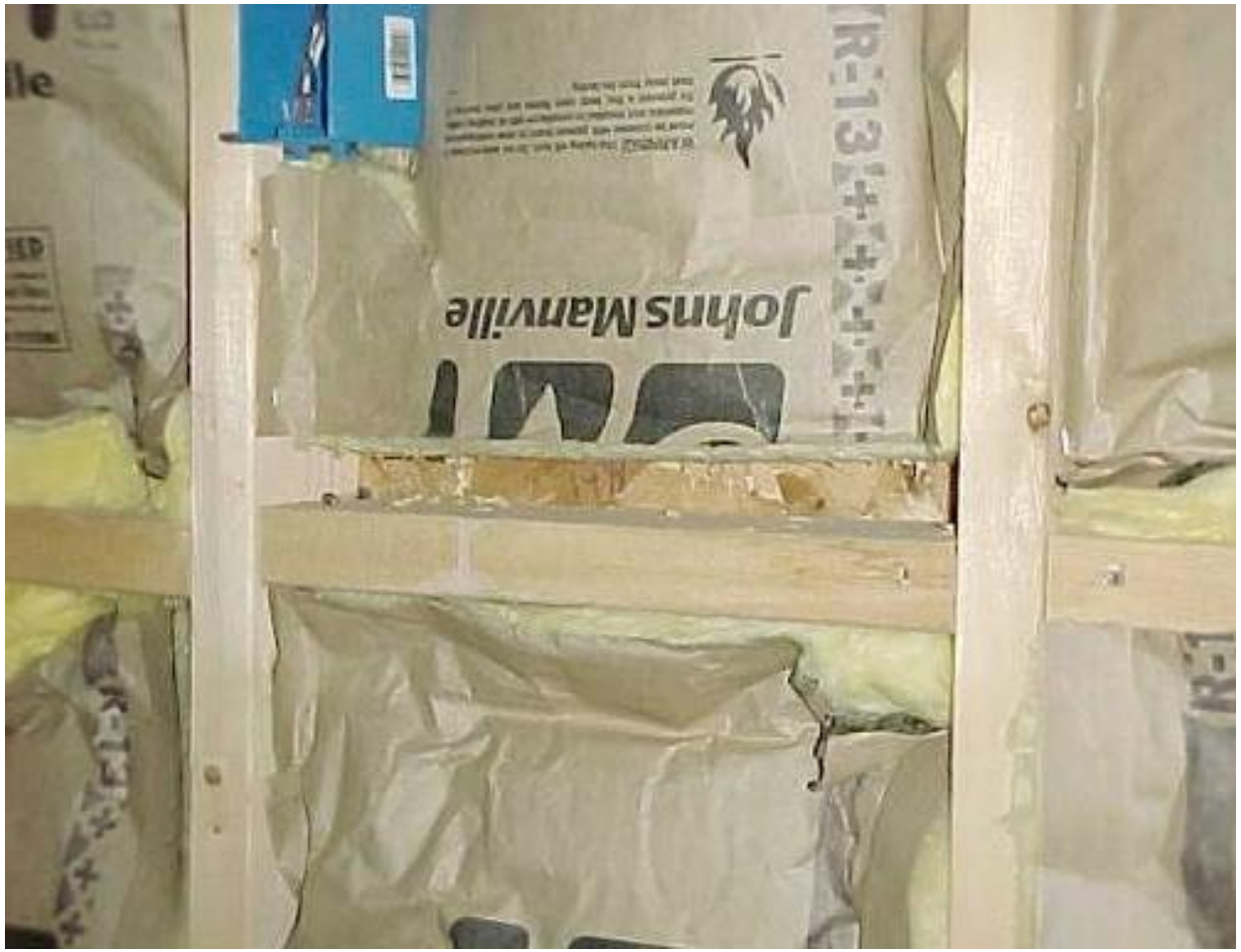
Insulation Installation

Insulation Must....

Be installed properly:

- No compressions
- No voids
- Touching all 6 surfaces
- Be properly mixed (foams)
- Be compatible with other materials
- Be combined with an air barrier or be one
- Not be subjected to constant wetting cycles

Poor installation affects comfort, performance and durability




CertainTeed
CertainTeed

Compressions and voids reduce performance

Poor Spray foam installation

Insulating is a system

More choices offer better performance

Careful installation of all insulating systems are essential for good performance

Blown cellulose insulation

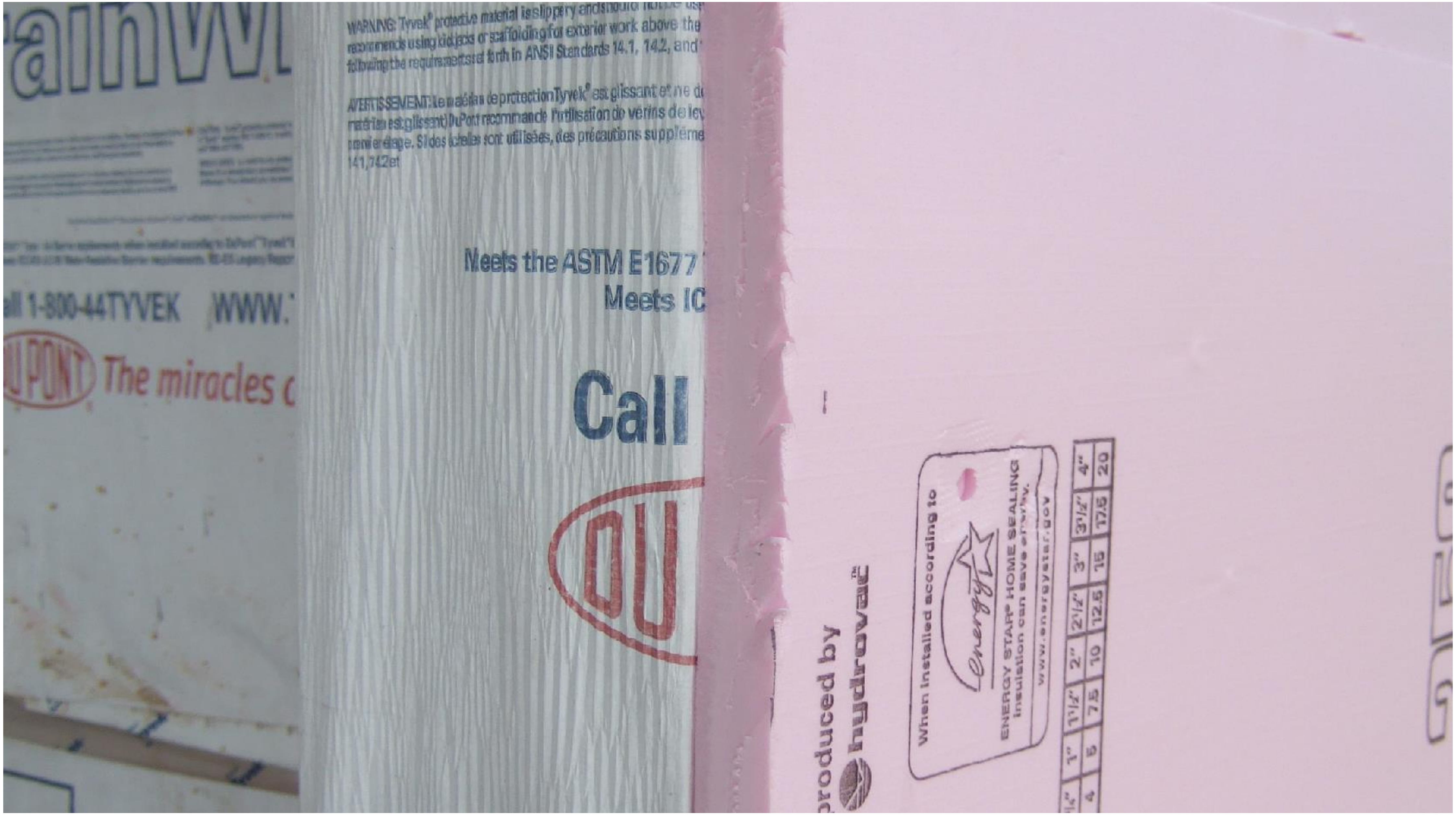

BEARING BLOCK

High density blown fiberglass

SPF- spray polyurethane foam

Again.....benefits of exterior insulation


Weather Resistive Barrier
Weather Resistive Barrier
Weather Resistive Barrier
Weather Resistive Barrier



Meets the ASTM E1677
Meets IC
Call
1-800-44TYVEK
The miracles
When installed according to
ENERGY STAR® HOME SEALING
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produced by

Insulated concrete forms resolve issues

Structurally insulated panels provide high R-Value assemblies

Window Systems

Windows

- Provided natural light and ventilation
- Passive solar heat
- Architectural element
- 1/3 to 2/3 thirds of total AC loads

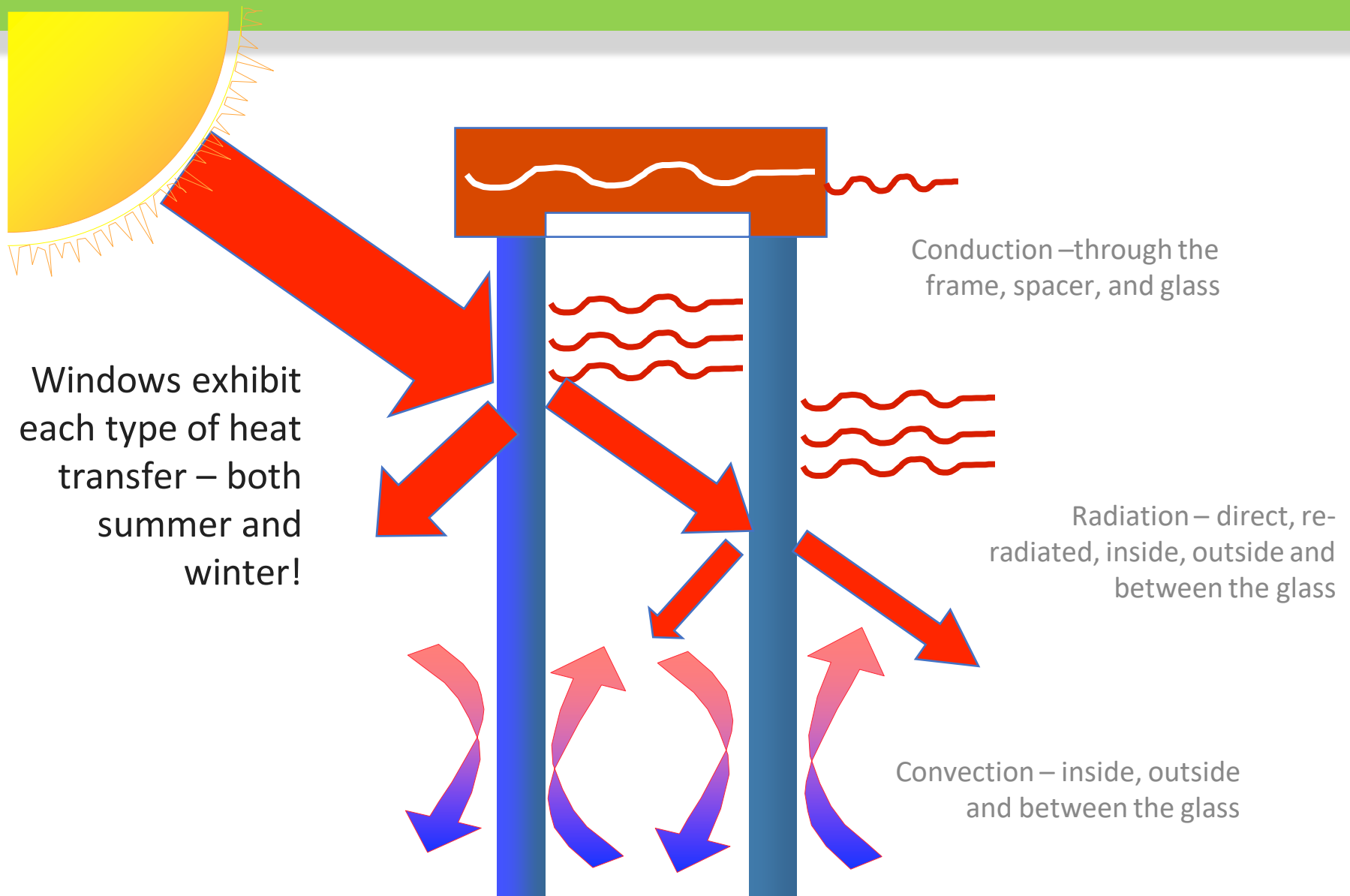
What defines high performance windows?

- Heat gain & heat loss reduction
- Energy efficiency
- UV light reduction
- Durability
- Wind and rain resistance

Four technologies are common:

1. Low emissivity coatings
2. Insulated spacers
3. Gas filled
4. Insulated frame tech.

Summertime Heat Gain



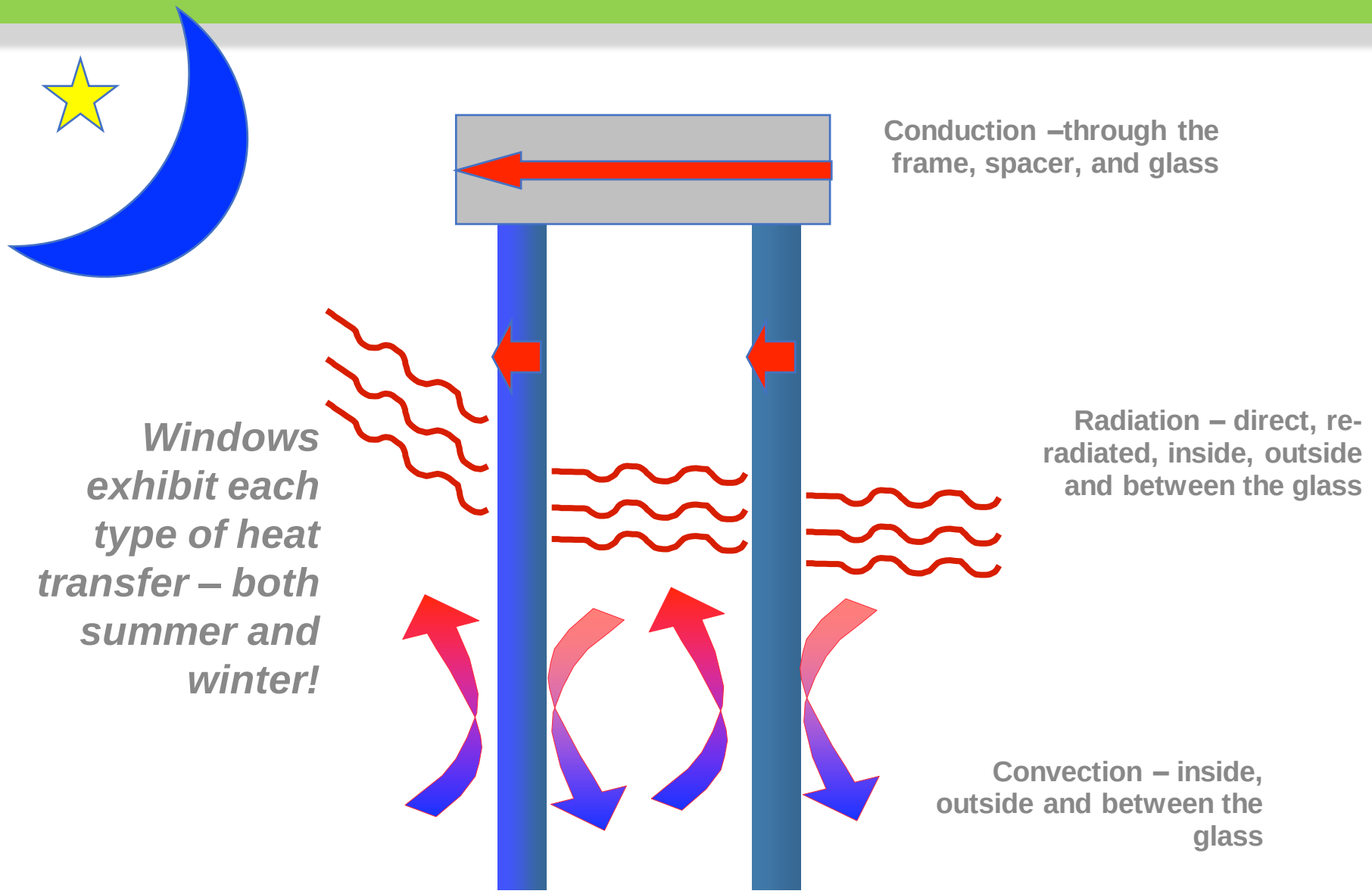
Windows exhibit each type of heat transfer – both summer and winter!

Conduction –through the frame, spacer, and glass

Radiation – direct, re-radiated, inside, outside and between the glass

Convection – inside, outside and between the glass

Wintertime Heat Loss



Conduction –through the frame, spacer, and glass

Radiation – direct, re-radiated, inside, outside and between the glass

Convection – inside, outside and between the glass

Windows exhibit each type of heat transfer – both summer and winter!

Where is the 2018 code headed- Glazing

Fenestration	Window U-Factor		Window SHGC		Skylight U-Factor	
Climate Zone	2009	2012	2009	2012	2009	2012
1	1.2	0.65	0.3	0.25	0.75	0.75
2	0.65	0.4	0.3	0.25	0.75	0.65
3	0.5	0.35	0.3	0.25	0.65	0.55
4	0.35	0.35	NR	0.4	0.6	0.55
5	0.35	0.32	NR	NR	0.6	0.55
6	0.35	0.32	NR	NR	0.6	0.55
7	0.35	0.32	NR	NR	0.6	0.55

= increased

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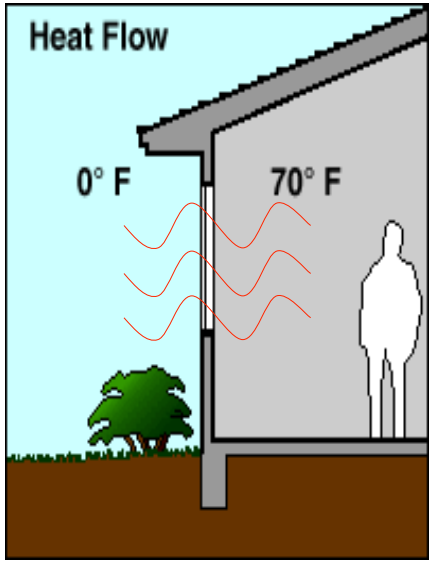
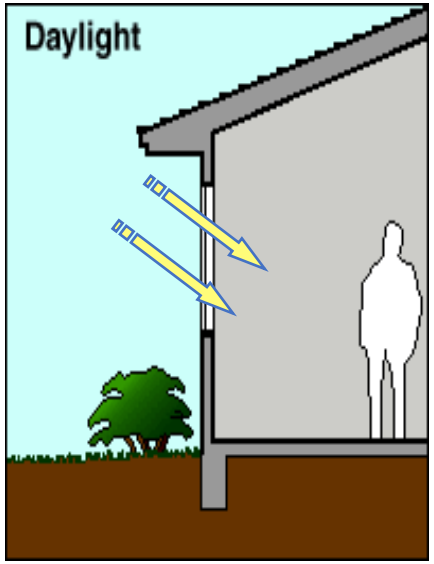




NFRC
National Fenestration Rating Council
CERTIFIED

ENERGY PERFORMANCE RATINGS

U-Factor (U.S./I-P)	Solar Heat Gain Coefficient
0.30	0.36

ADDITIONAL PERFORMANCE RATINGS

Visible Transmittance	
0.59	———

Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. Consult manufacturer's literature for other product performance information.
www.nfrc.org

ENERGY STAR

ENERGY STAR® Qualified in All 50 States

Design Pressure (PSF)

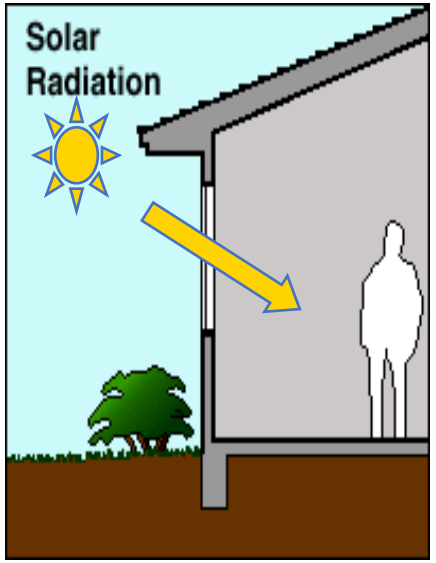
DP 30

WDMA HALLMARK CERTIFIED

F-C50 60" x 72"

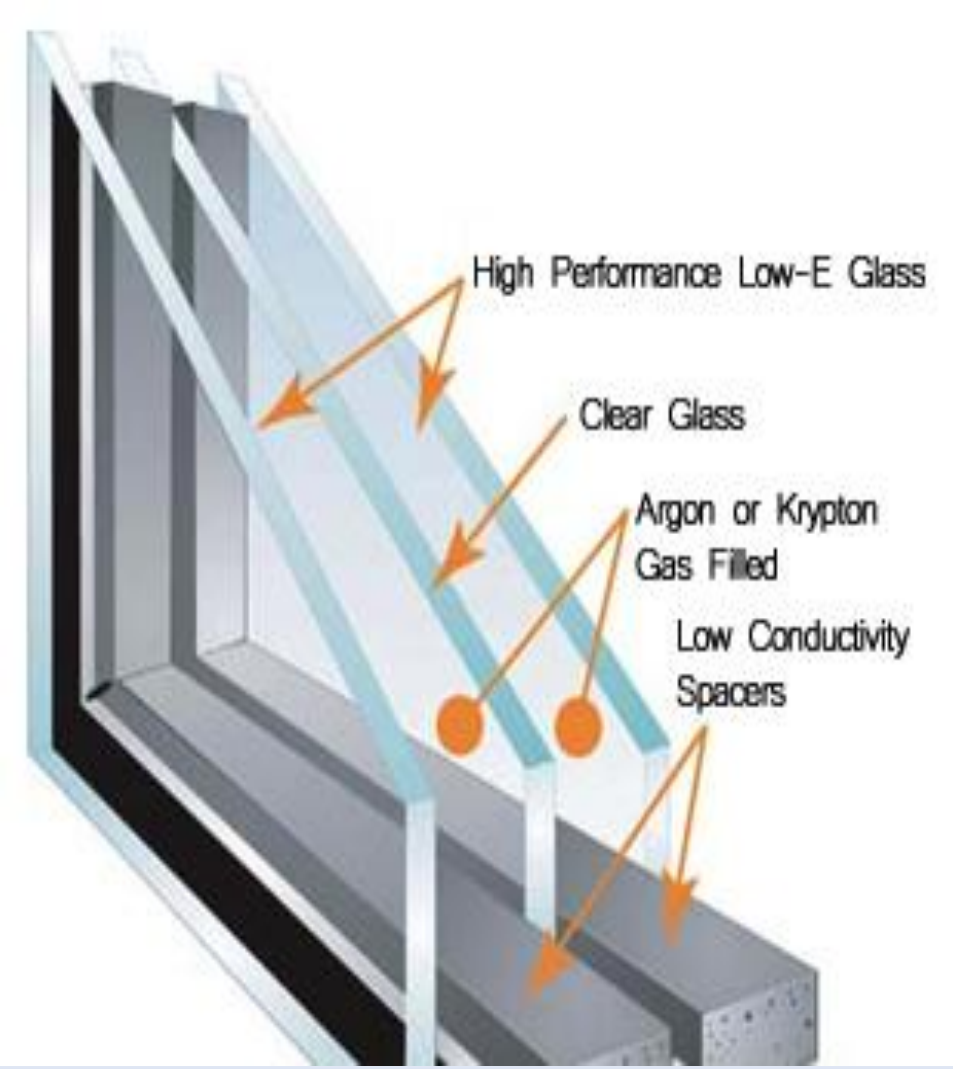
Tested to ANSI/AAMA/NWWDA 101/I.S.2-97 or NAFS-1

Meets or exceeds M.E.C., C.E.C., & I.E.C.C. Air Infiltration Requirements WDMA Hallmark Certification Program



ENERGY STAR

HIGH PERFORMANCE HOMES AND KEY WINDOW CONSIDERATIONS YOU DON'T GENERALLY THINK OF…



- Solar energy gain
- AC loads
- Comfort
- Condensation
- Installation
- COST

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Windows - AC and Solar Heat Gain (SHGC)

Air Conditioning

- Fastest growing peak load
- Most costly electrical use in most homes
- Heat Gain Load determined primarily by windows (40 to 50% of cooling load in glass!)
- Duct size is determined by cooling (not heating) in most new EE homes

=

ELECTRIC GENERATORS DIRECT	3-Ton	4-Ton	5-Ton
Central Air Conditioners			
Breaker	30-Amp (240V)	40-Amp (240V)	50-Amp (240V)
BTUs	36,000	48,000	60,000
Smallest Generator	14kW	17kW	20kW

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A Tale of Two Houses

House before & after improvements

Standard Clear Double Glazed

U = .65

SHGC = .68

4.0 Ton AC Unit

Double Glazed Low-e, Low SHGC

U = .32

SHGC = .32

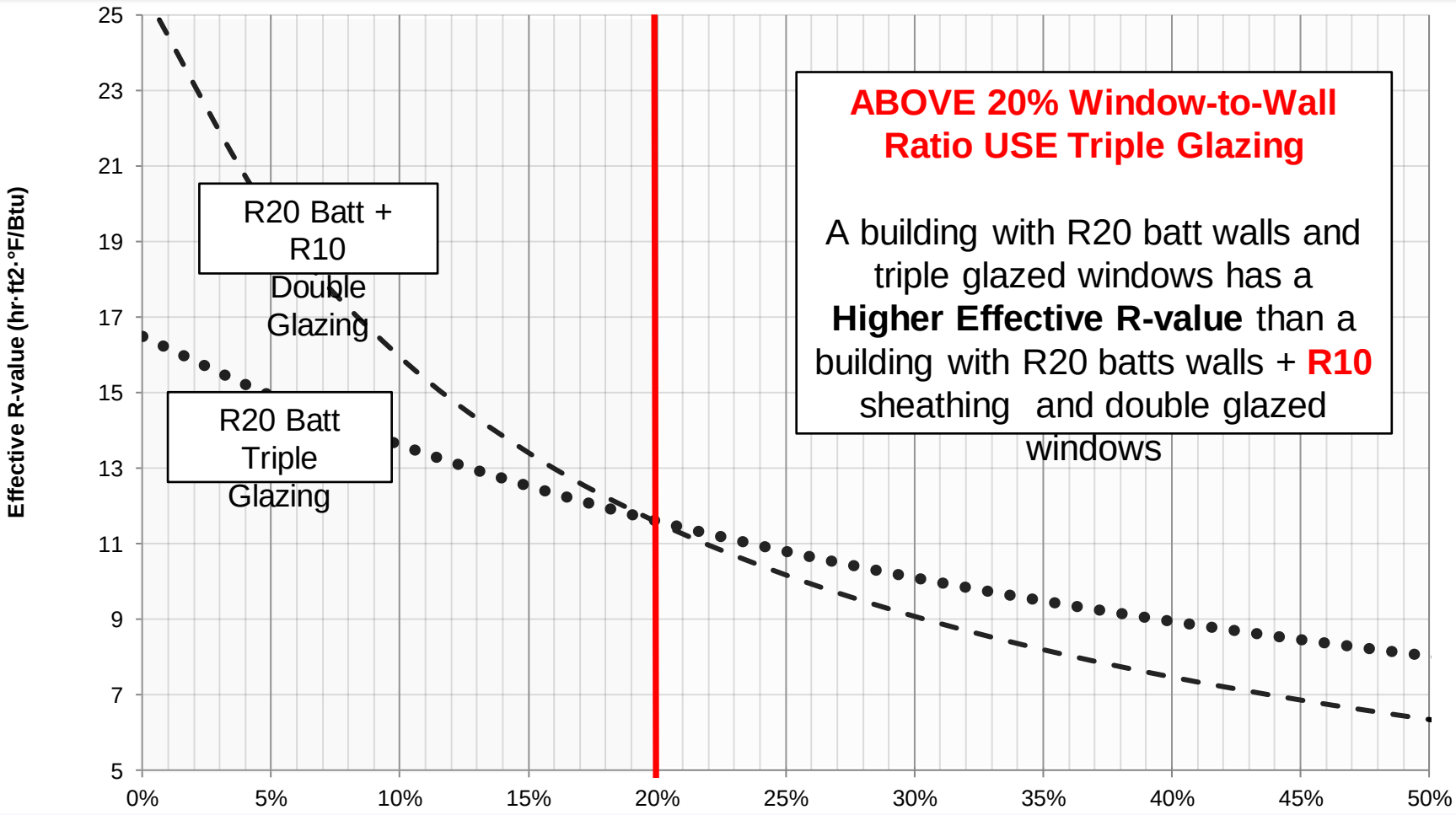
2.5 Ton AC Unit

WHY PICK BETTER THAN MINIMUM GLASS ?

Amount of Glass in New Homes : More or Less?

2000 or before:	**8 to 10%...**
2010 to 2016:	**12% to 17%....**
2016 New product showing:	**17% to 25%+**

Effective R-value
Triple Glazing vs. R10 Sheathing



Windows and Thermal Comfort
Does Triple Pane really make a difference?

ASHRAE 55 and Windows: Zone 5-6:

- 1m from glass, patio door
- Winter: Acceptable room side glass threshold temp= 57F or 14C
- Summer: Discomfort comes from any hour/elevation with solar gain greater than 70 btu/hr·ft²·°F

- Single, metal frame:
  - Winter: 3000+ hrs of discomfort
  - Summer: 300+ hrs of discomfort

- Double , insulated, SHGC 0.55
  - Winter: 500+ hrs of discomfort
  - Summer: 75+ hrs of discomfort

- Triple: insulated, SHGC 0.22
  - Winter: negligible
  - Summer: negligible

Window Performance: Condensation Resistance

- CR measures how well a window resists the formation of condensation on the inside surface.
- CR is expressed as a number between 1 and 100.
- The rating value is based on interior surface temperatures at 30%, 50%, and 70% indoor relative humidity for a given outside air temperature of 0° Fahrenheit under 15 mph wind conditions.
- The higher the number, the better a product is able to resist condensation.
- CR is meant to compare products and their potential for condensation formation.
- CR is an optional rating on the NFRC label.
- Ideal for cold climates is 70<

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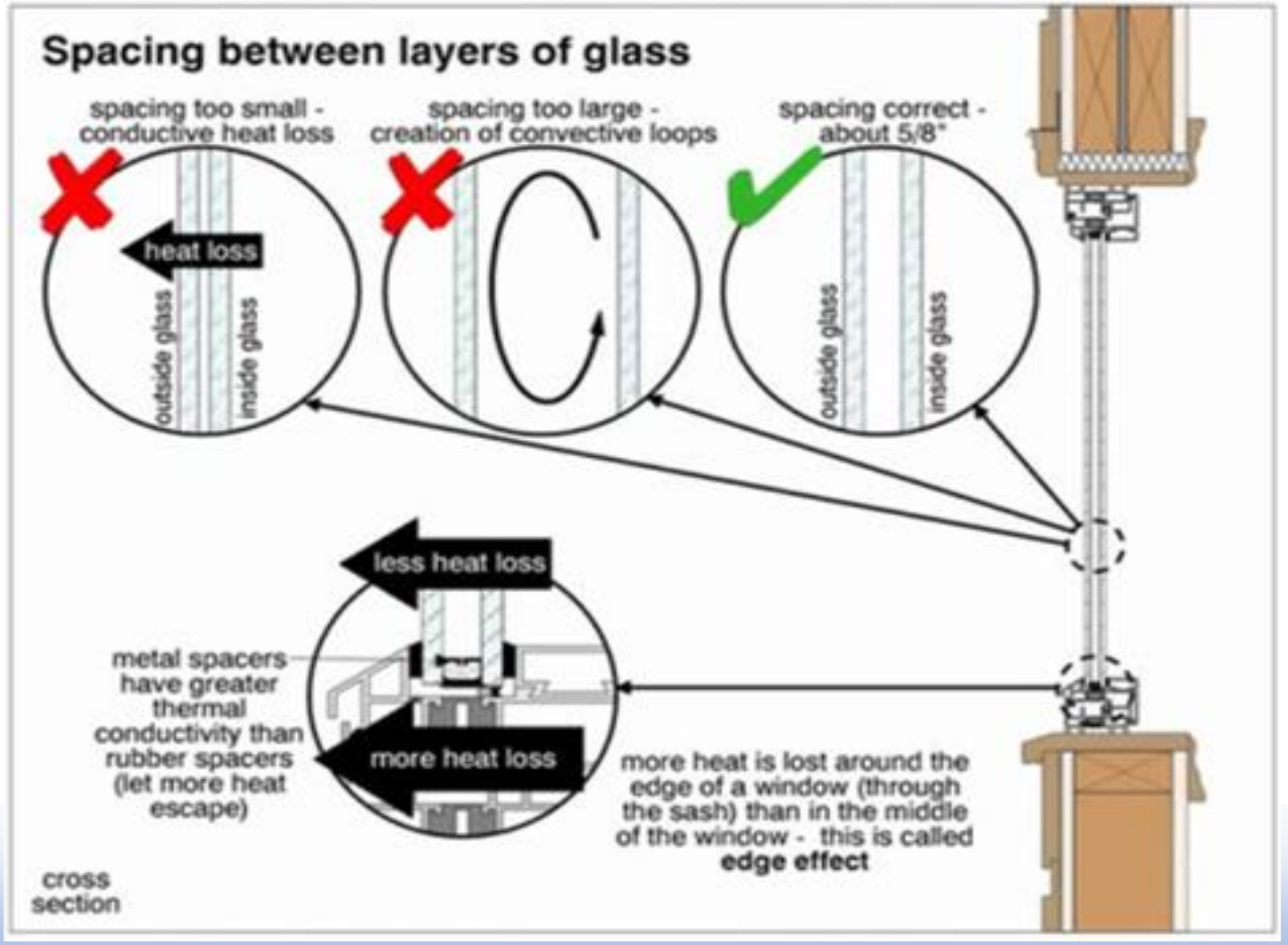
Windows



Glass spacing is important

For maximum efficiency, glazings should be sealed with an air space of no less than 15 mm (about 5/8”)

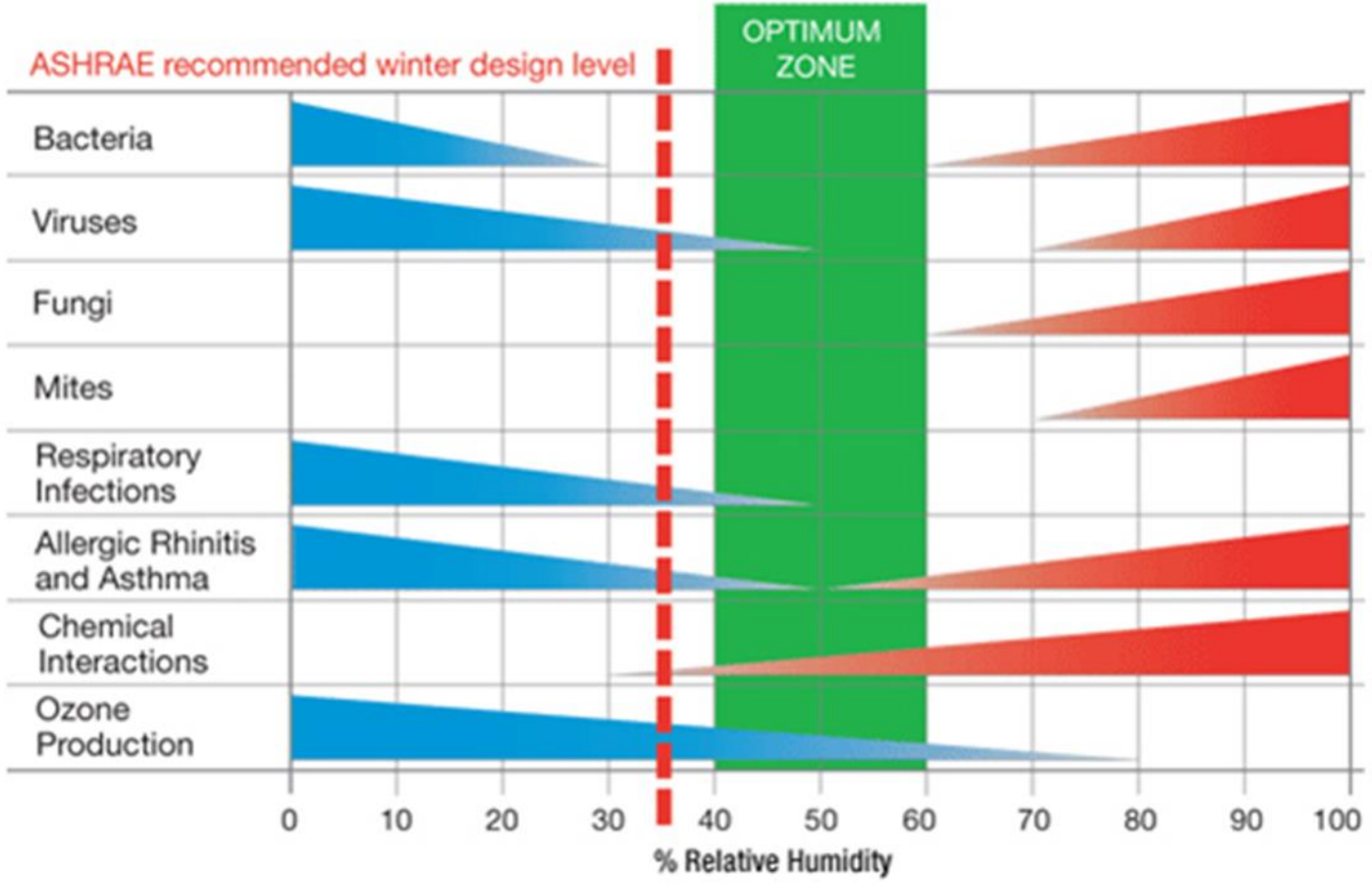
In accordance with the Department of Labor and Industry's statute 326.0981, Subd. 11,

"This educational offering is recognized by the Minnesota Department of Labor and Industry as satisfying **1.5 code/energy hours** of credit toward **Building Officials and Residential Contractors** continuing education requirements."

For additional continuing education approvals, please see the continuing education credit section in the conference agenda booklet.

Condensation Resistance

Healthy Relative Humidity and Windows.



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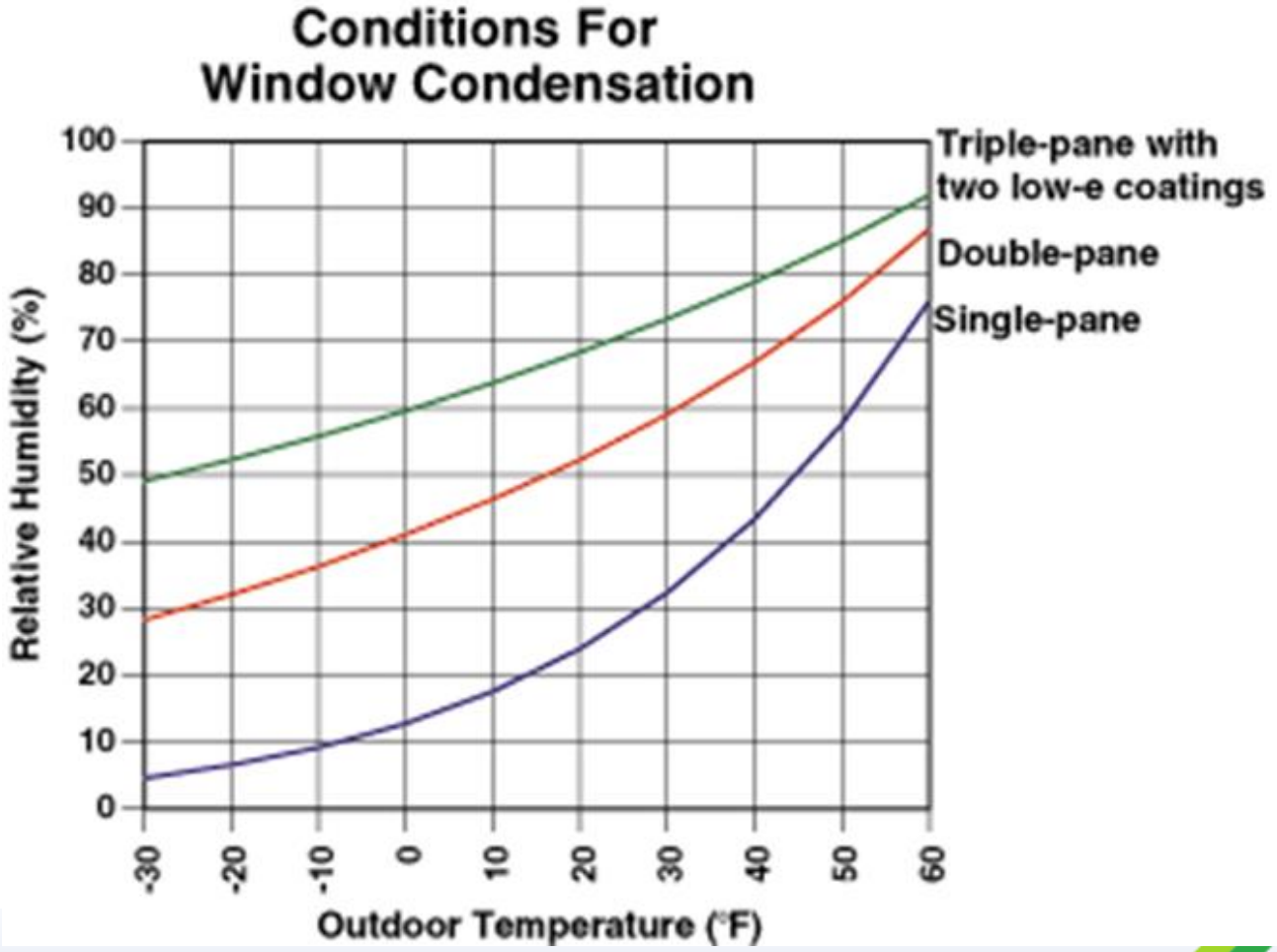
Condensation Resistance

Healthy Relative Humidity and Windows.



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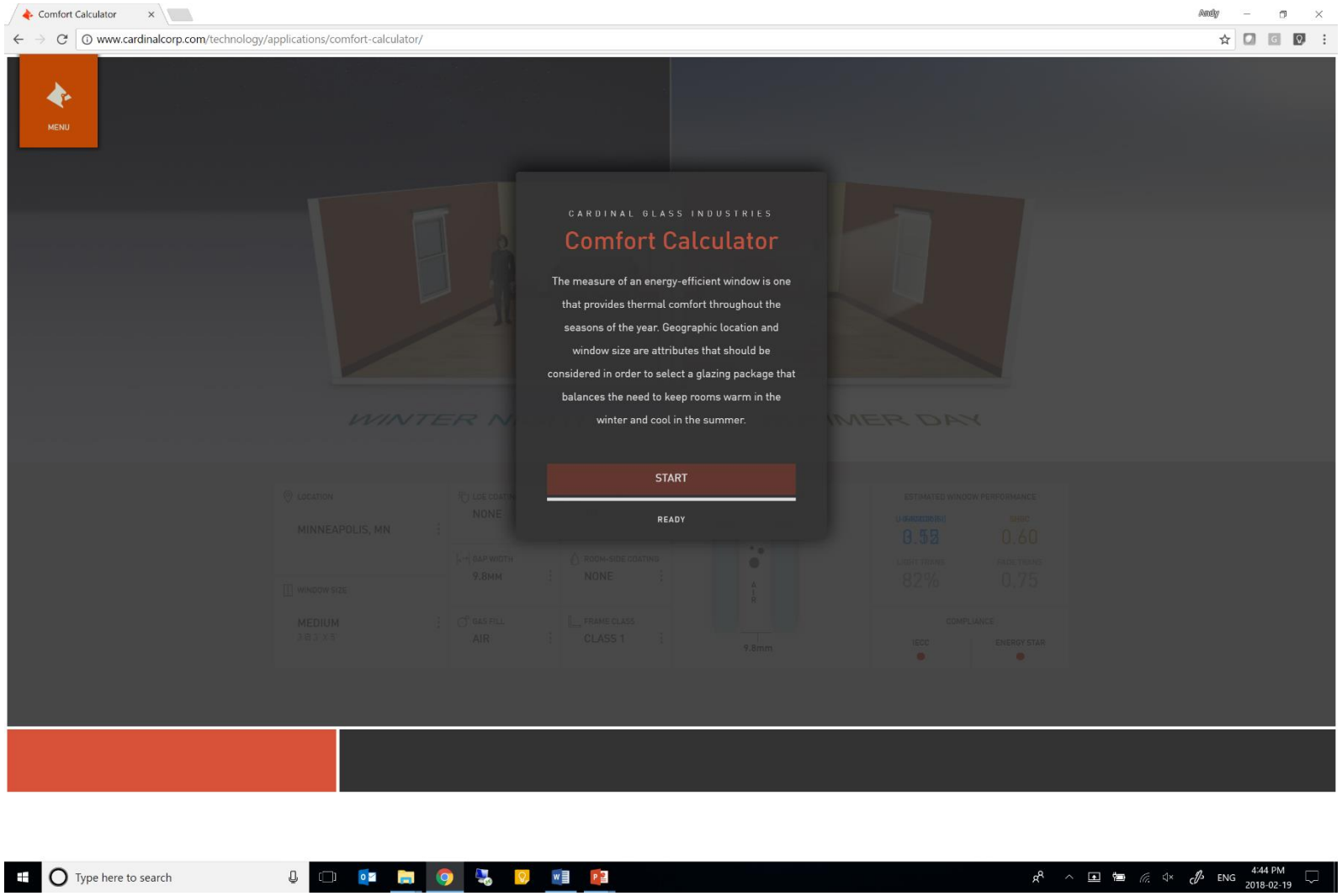
Windows and Thermal Comfort

http://www.cardinalcorp.com/technology/applications/comfort-calculator/

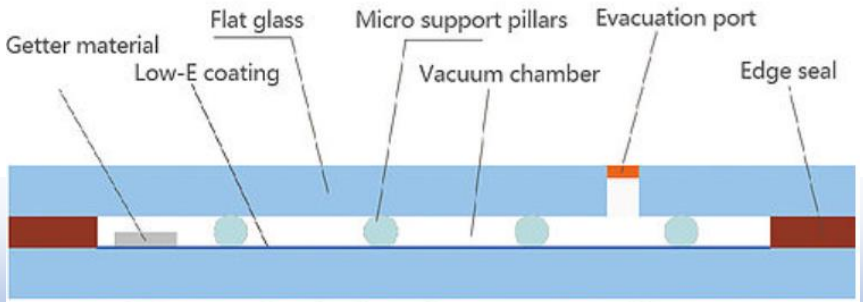


Electrochromatic or “ Dynamic” Glass

- Optimized SHGC
- Occupant controlled or…
- HVAC integrated controls

Vacuum Insulated Glass (VIG)

- R10+ windows?
- 2 pane arrangement
- COG (Center of glass) vs EOG (Edge of glass) – A big deal
- Edge seal (weld) is highly conductive



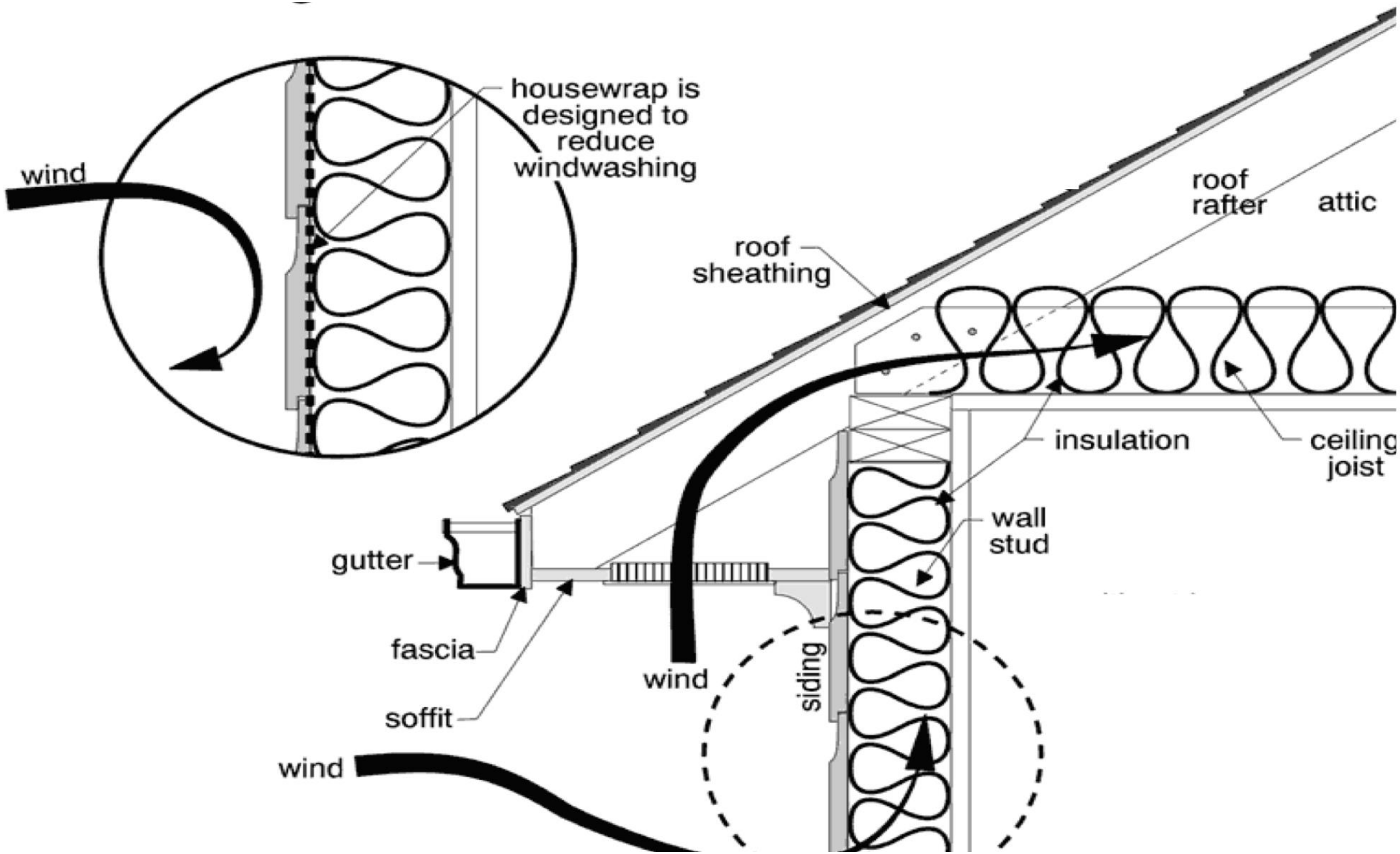
Vacuum insulating glass structure diagram

What does a roof system need?

- Protection from rain penetration
- Drainage
- Flashing
- Durability
- Ventilation (always needed?)
- Proper insulation levels

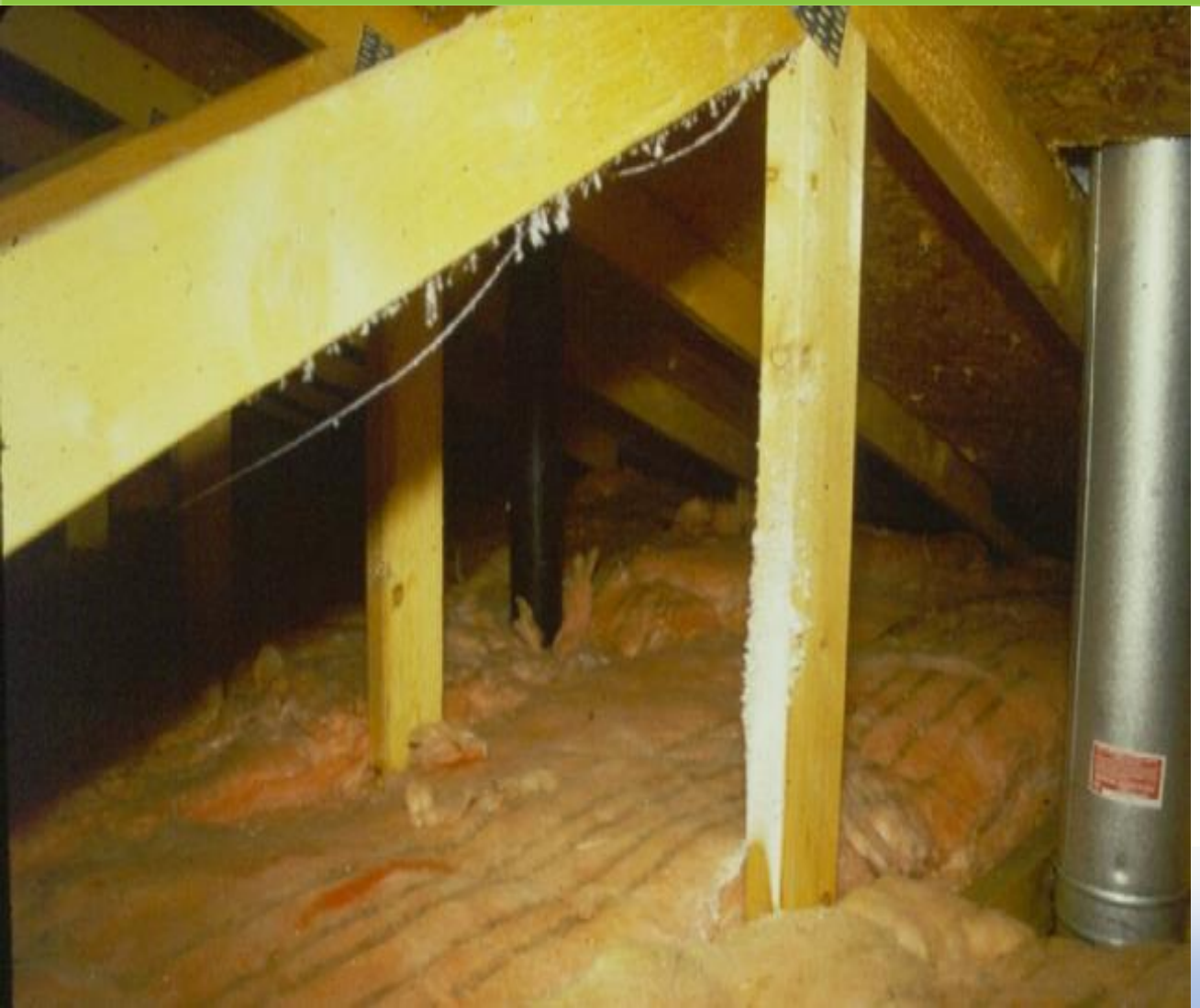
Sound like our wall systems?

Hipped roof details make insulating difficult


housewrap is designed to reduce windwashing
wind
roof rafter
attic
roof sheathing
insulation
ceiling joist
wall stud
gutter
fascia
soffit
wind
siding
wind

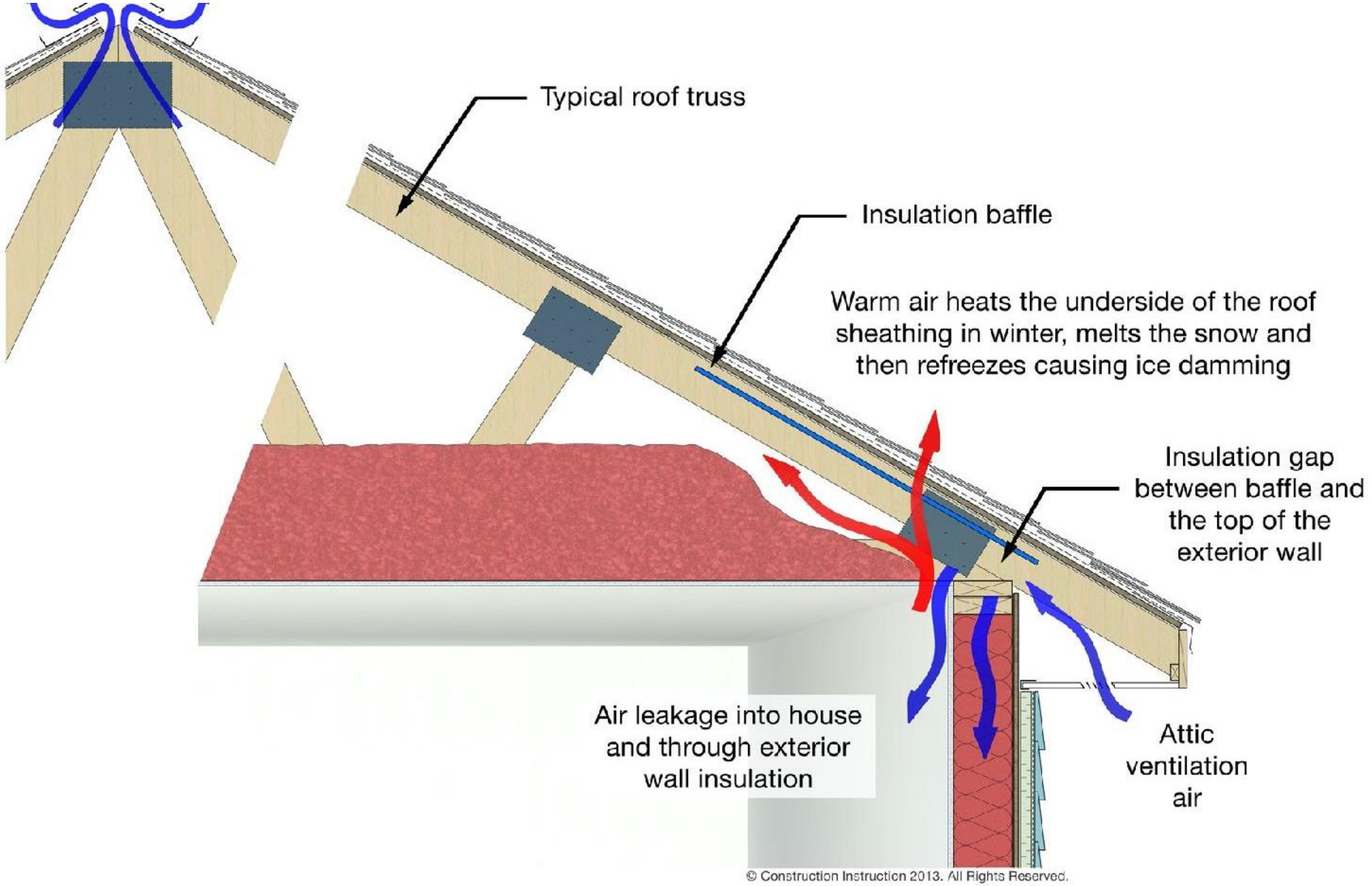
Attic Ventilation Strategies

Attic: Moisture Control



"Attic Rain"

- Cold air cannot hold much water vapour; therefore in cold temperatures, ventilation air may not be adequate to remove moisture that has moved into the attic space by air leakage or diffusion.
- This results in frost build-up in the attic space that melts, damaging wood framing, insulation, and drywall and buckle the roof membrane as a result of sheathing movement.
- This is a bigger problem in the Prairies, with their cold weather, and coastal regions with damp air.


Typical roof truss
Insulation baffle
Warm air heats the underside of the roof sheathing in winter, melts the snow and then refreezes causing ice damming
Insulation gap between baffle and the top of the exterior wall
Air leakage into house and through exterior wall insulation
Attic ventilation air
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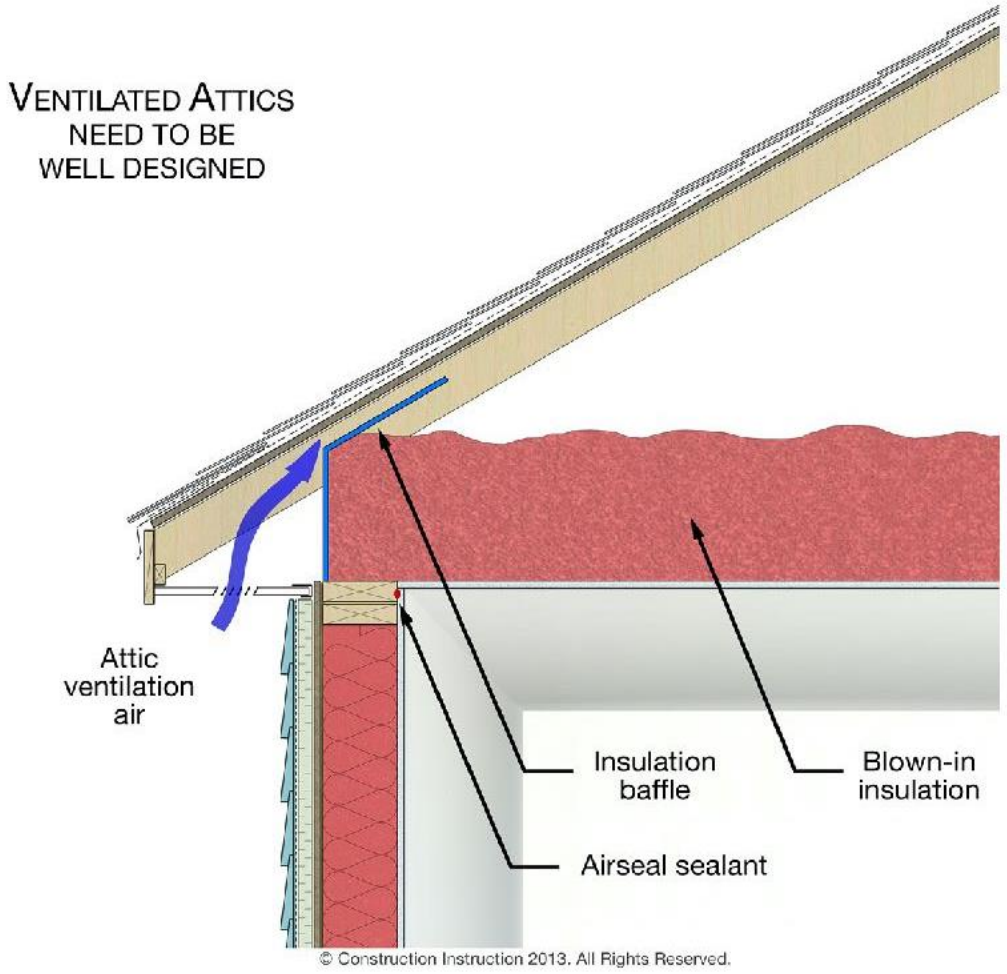
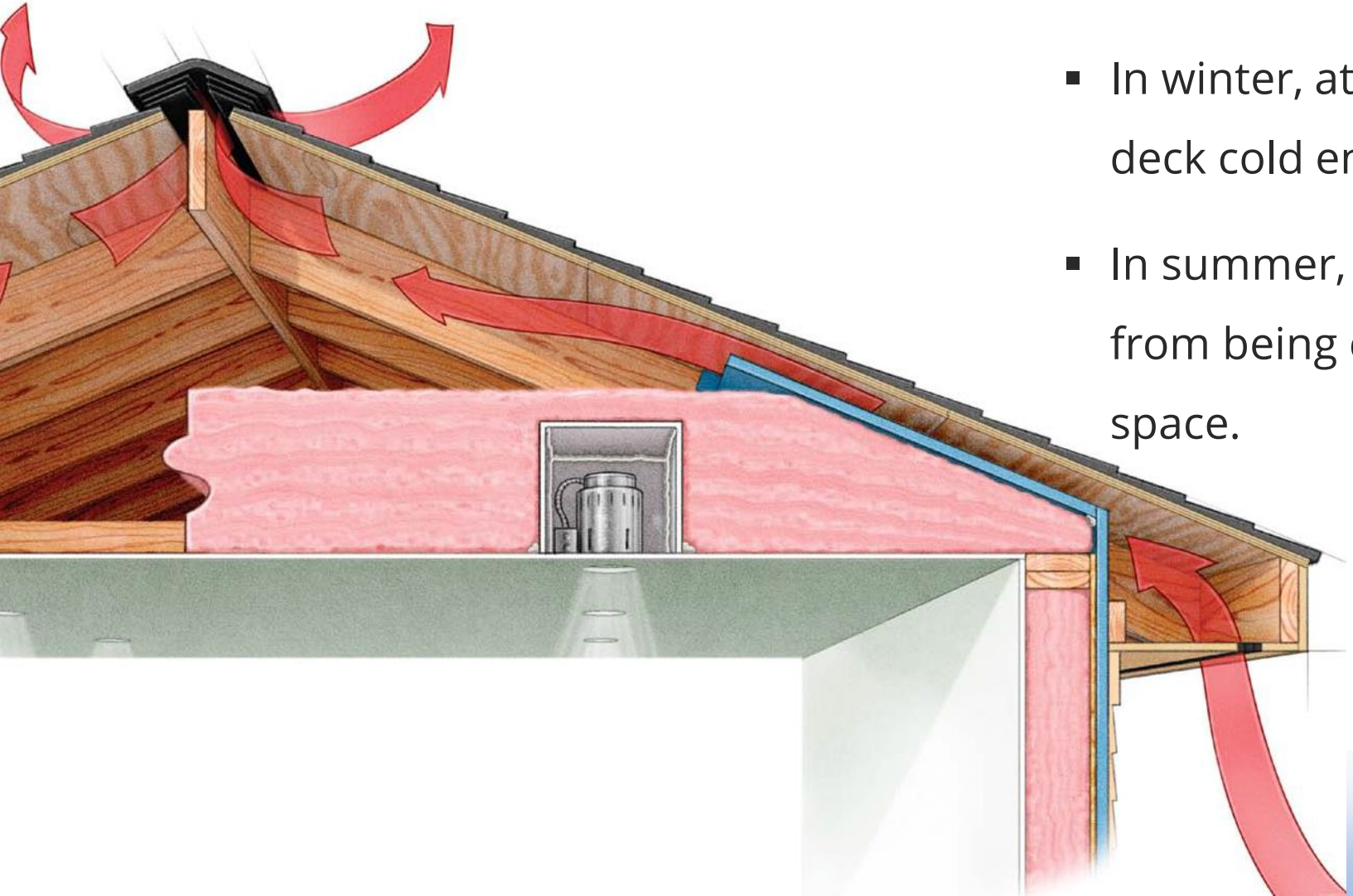
Ventilated attics need good design



Airsealing at wall to roof interface

Ducts and Air Handlers in Conditioned Space

Attic: Ventilation: There was a time when it was all we needed

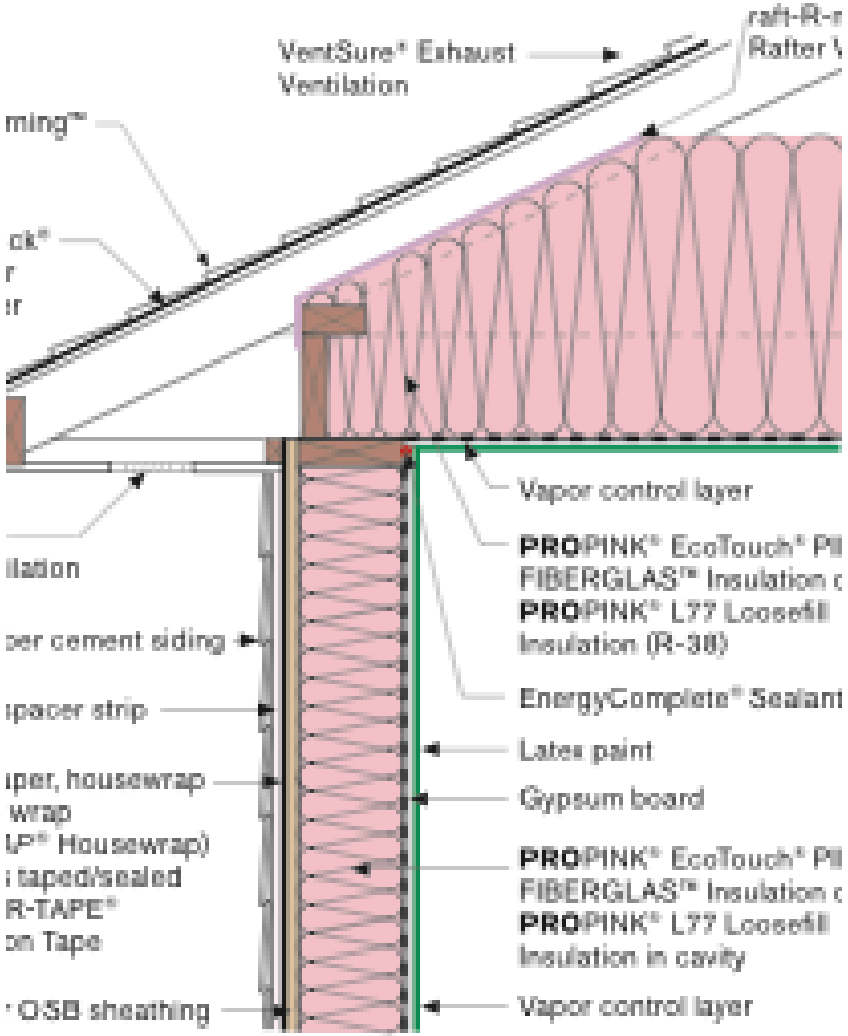


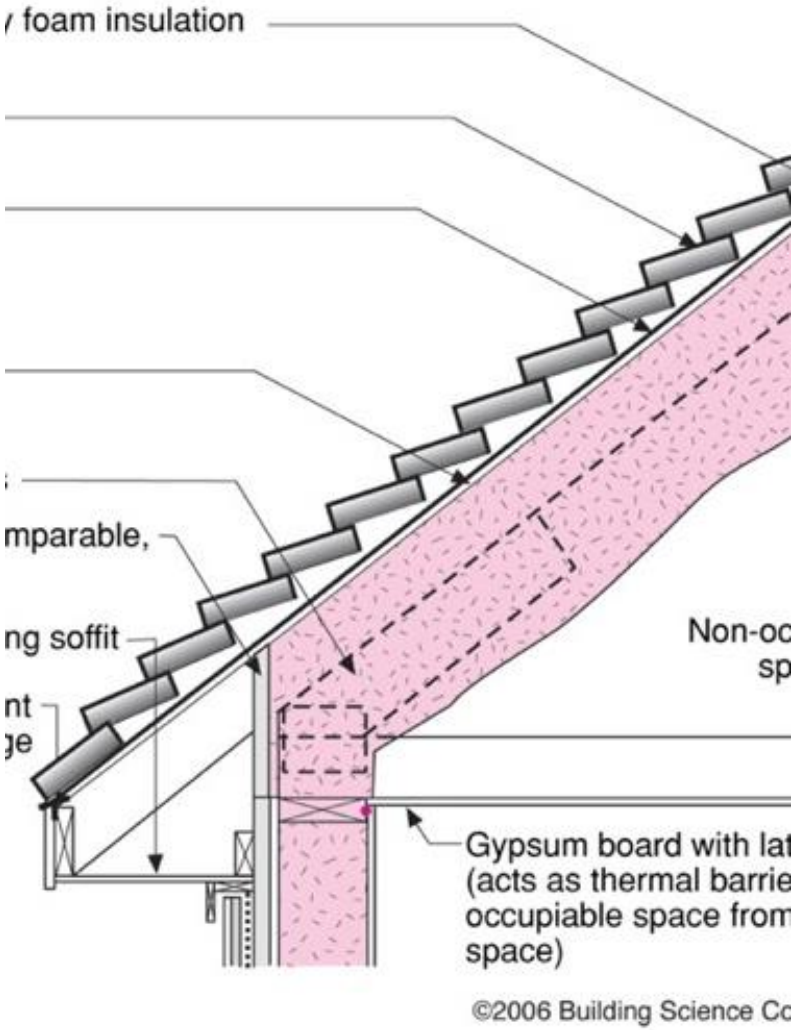
- In winter, attic ventilation keeps the roof deck cold enough to prevent ice damming.
- In summer, attic ventilation prevents heat from being conducted to the conditioned space.

Attic: Ventilation may not be enough anymore…

- **¾ of year, ventilation works due to buoyant/warmer air rising out of the attic.** Sometimes this is aided by wind.
- **Higher R value/insulation in attics has DECREASED conductive heat loss to attic**… attics are now COLDER… **which limits stack effect or venting potential**.
- **Airtightness/air barriers are more critical than ever** to ensure warm, MOIST air does not infiltrate into attic.

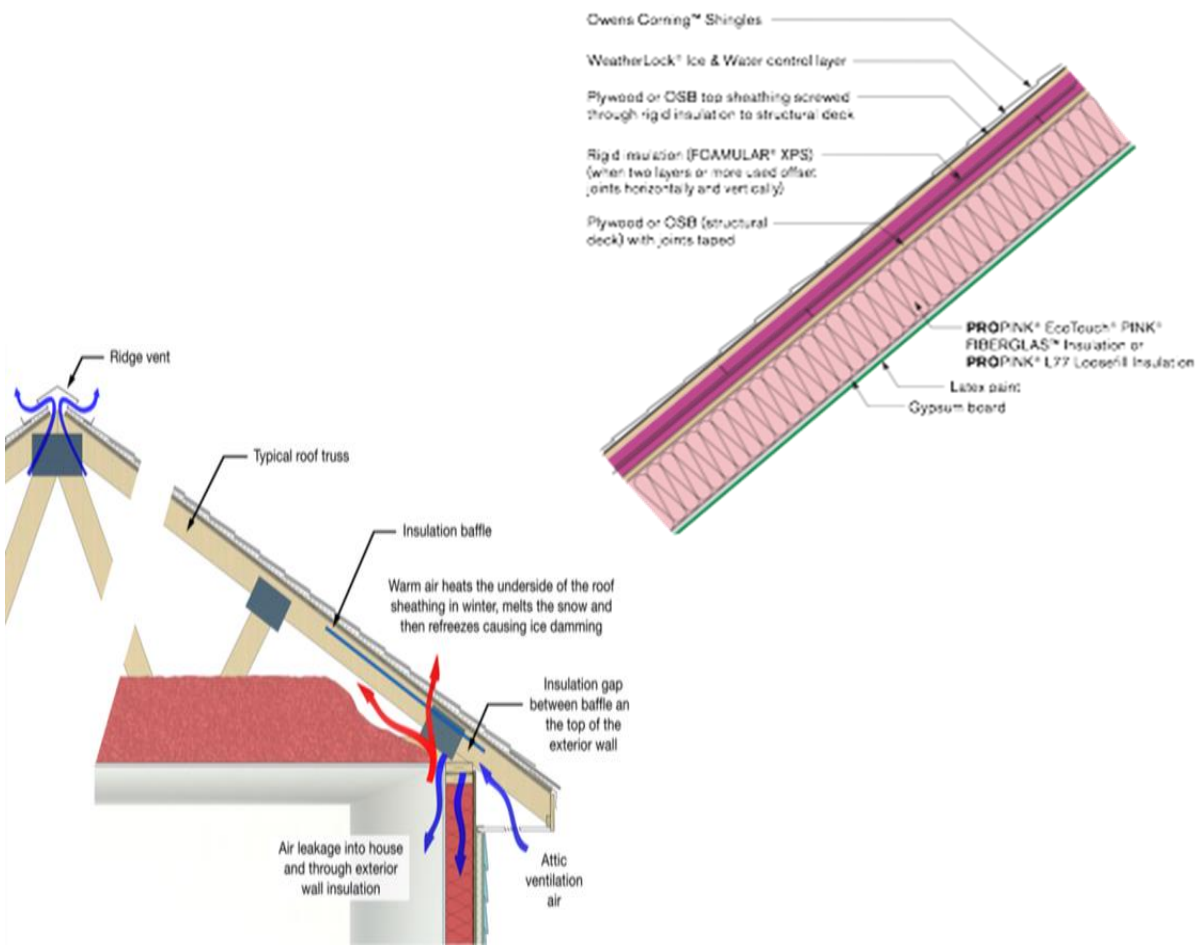
Vented/Unvented? Conditioned/Unconditioned?





netzero home
The ultimate in comfort and efficiency

Attic: What is the goal of venting, air tightness or even NON-vented insulation assemblies?



The "Building Science" goal is to keep the:

- Attic "air" at the same/similar temp and RH as OUTDOOR conditions.
- Roof Sheeting at equilibrium moisture content with the outdoor RH and temperature.

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The ultimate in comfort and efficiency

Attic: “Hidden Gutter” concerns

- **Roof vents NEED soffit vents to work**. Removing soffit vents SHORT CIRCUITS the ventilation of warm/moist air out of roof vents.

Houses That Work Module 2 Summary

An optimized enclosure

- Water managed foundations
- High performance walls
- Appropriate window selections
- Resilient roof assemblies