Basic Installer

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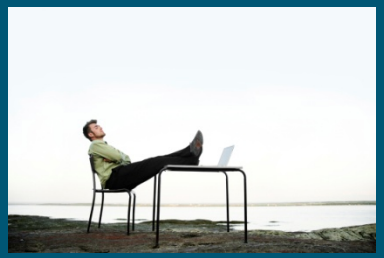
Course Objectives

- Outline an emerging career opportunity
- Demystify building science
- Challenge (a few) existing construction practices
- Provide a marketable building skill set

Part One AGENDA:

- **Logistics**
- **Objectives**
- **Background**
- **House as a System**
- **Pitfalls**
- **Break:**



- **The building envelope**

Questions we'll (try to) answer !

- **Why weatherize?**
- **What is weatherization?**
- **What is the installer's role?**
- **How are specific tasks done?**
- **How do I know if it's done right?**
- **How do I get work from MaineHousing?**
- **How do I get paid?**

- **Any other questions you have!**

Weatherization goals

- **Create Safe Indoor Environment**
- **Extend Dwelling Life**
- **Increase Comfort**
- **Save Money/Energy**

But my Daddy did it this way!

Construction training has always been essentially a Guild system where persons learn on the job from someone who learned the same way. Essential skills are transferred primarily by observation followed by "trial & error".

It is an excellent system with one major drawback: the skills taught are limited to those *that already exist*.

We want to give you a new skill set, beginning with a new way of looking at buildings.

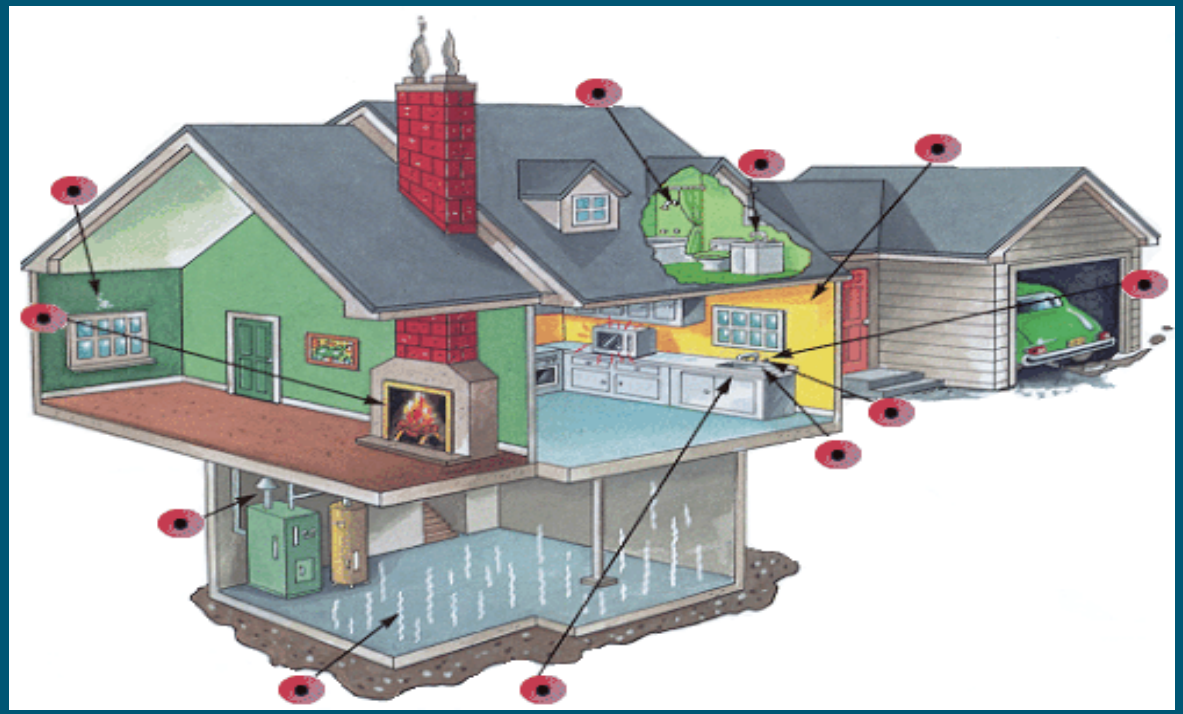
Why don’t Daddy’s methods work anymore ?

Houses:

- **are smaller (maybe ?)**
- **are tighter**
- **have more exhaust appliances**
- **have “weaker” natural draft combustion appliances.**
- **have less drying potential.**

They’re simply built out of different “stuff” !

Buildings are Systems !



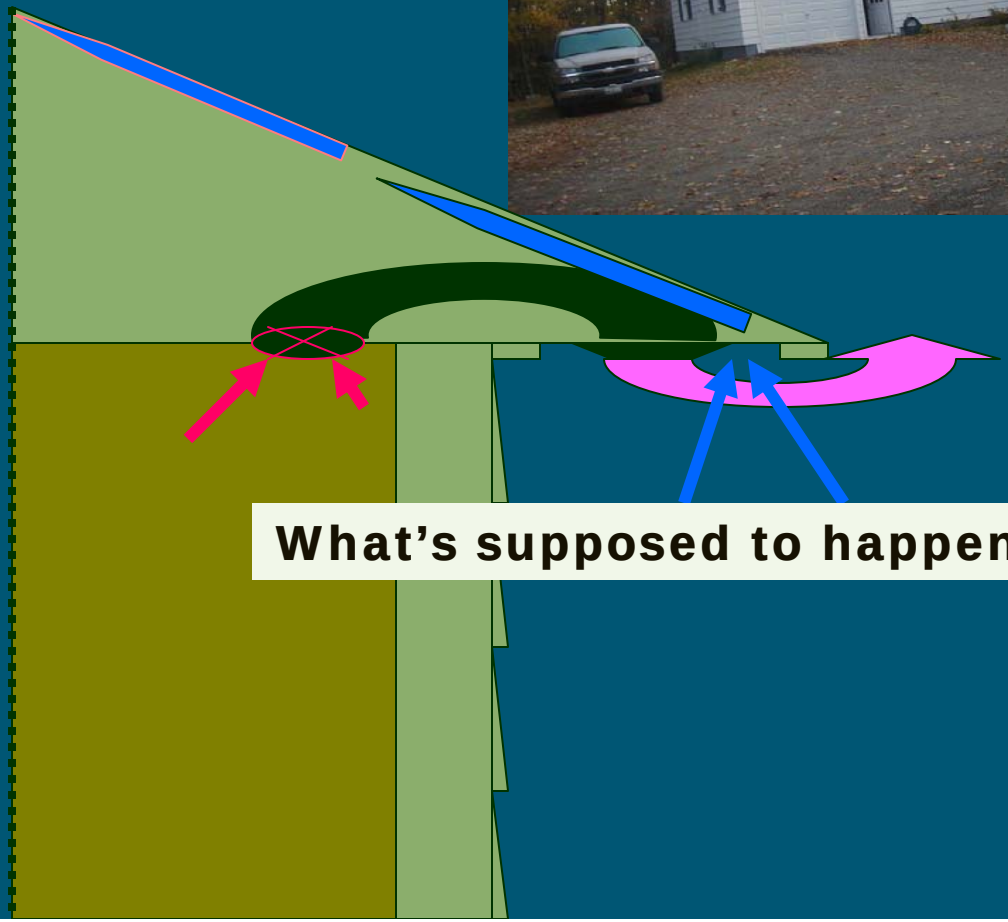
Everything in a house has the potential to effect everything else! This includes people! Airsealing increases interaction!

Fans

- **Bathroom & kitchen fans are sometimes installed to remove excess moisture from the home.**
- **All fans must be ducted to the building exterior, preferably through the gable end.**
- **Ducting should be metal or light duty PVC and should slope slightly to the exterior.**
- **All duct joints should be sealed.**
- **If possible, bury the duct in insulation**

If you must go through the soffit

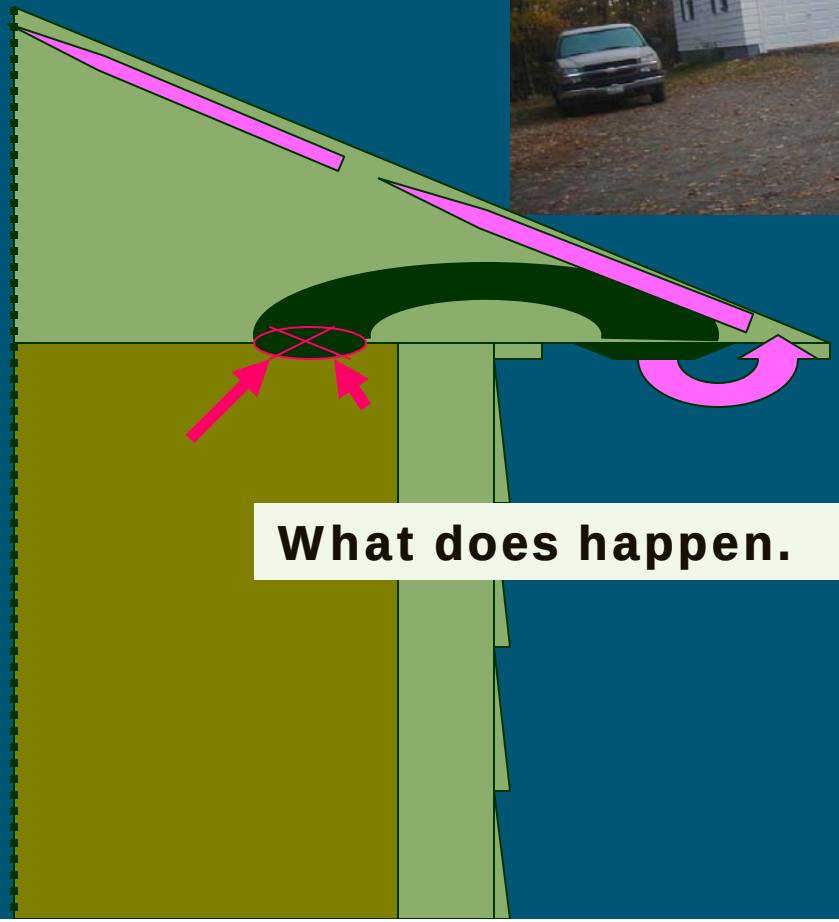
In this house, the bathroom fan is ducted to the roof soffit (overhang).



What's supposed to happen.

If you must go through the soffit

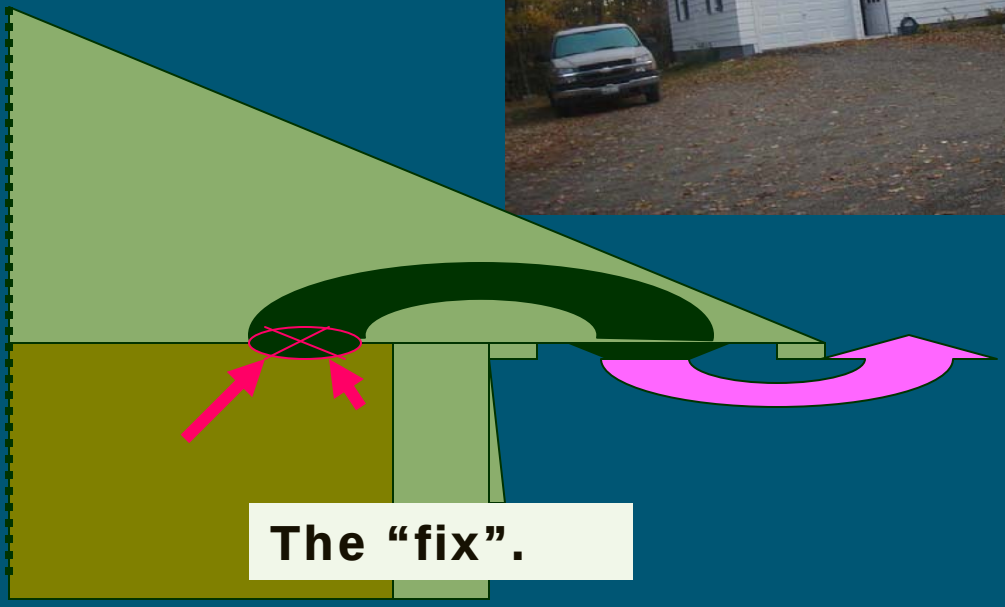
In this house, the bathroom fan is ducted to the roof soffit (overhang).



What does happen.

If you must go through the soffit

In this house, the bathroom fan is ducted to the roof soffit (overhang).



The “fix”.

Block the soffit vent openings for two feet on both sides of the vent hood.

Air Quality

Moisture…

Moisture

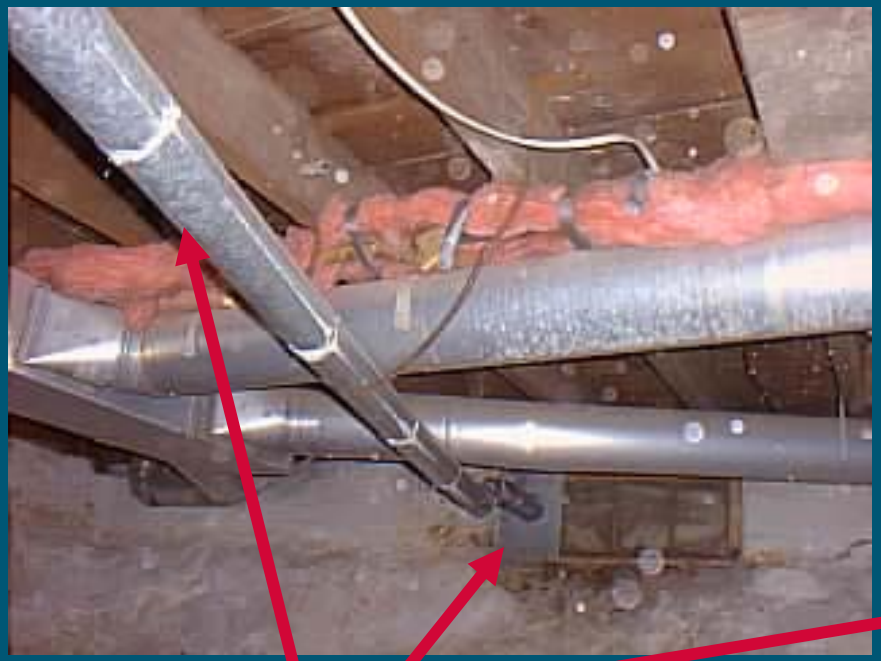
- **Moisture can be a pollutant when weatherizing.**
- **Wet basements & crawlspaces are particularly troublesome.**
- **6 mil poly or EPDM roofing work quite well as a ground cover.**
- **When installing a ground cover, all seams must overlap by at least 6 inches.**
- **Extend the ground cover up the wall and seal it to the backing on the wall insulation with foam.**

Mold!

Aldehydes, definitely; CO, maybe!

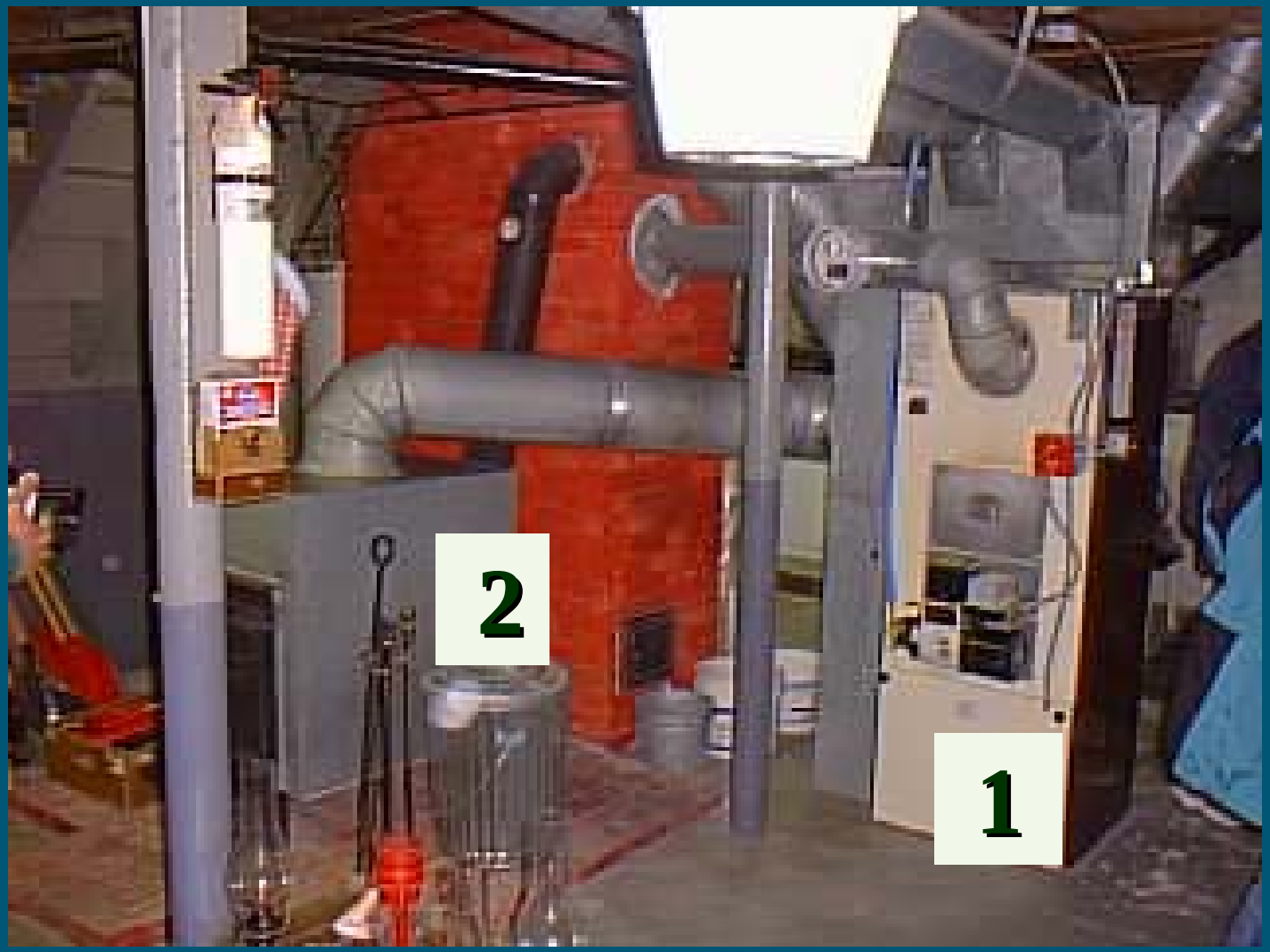
- **Dangerous !**

Poisoned Child!



The vent pipe above ends in a drier type hood at ground level on the eaves side below a 10/12 south facing steel roof.

Figure this one out!



BREAK !

The Building Envelope…

Buildings lose heat in two ways:

1. **Through surfaces – buildings really are large space heaters.**
2. **By heated air escaping.**

The escaping air caries moisture.

The surface separating heated space and non-heated space is called the <u>building envelope</u>

The Building Envelope…

Has three functions:

- Reduce surface heat loss.
- Keep the heated air in.
- Keep interior moisture away from cold surfaces.

How is it done?

Insulation reduces surface heat loss.

Air sealing reduces air transported heat loss.

Vapor retarders or barriers reduce moisture movement.

IMPORTANT: Stopping the air stops 99% of the moisture!

The Building Envelope…

All barriers & boundaries have to be in contact with each other!

- **Ideally, the pressure boundary, the thermal boundary and the vapor boundary (or retarder) should be one & the same. If not possible, they must be in physical contact.**
- **The three together make up**

the building envelope

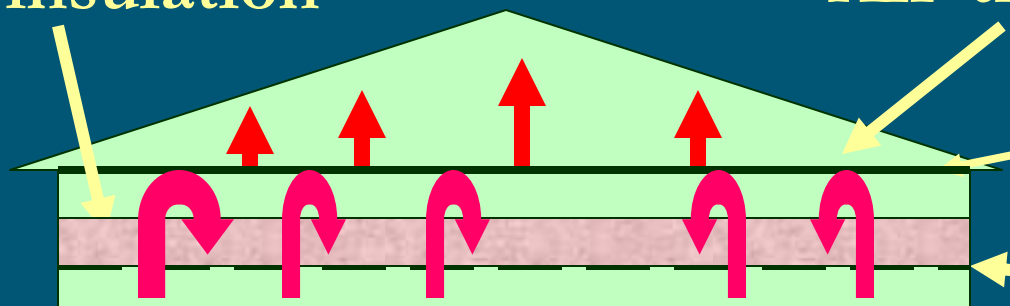
Why in contact?

- **Heat has the potential to move by any one of the three mechanisms at any given time. Stopping one without dealing with the others is pointless. Dealing with surface heat loss without considering air transported heat loss is even more pointless. If the barriers for each aren't in contact with the others, the contained heat will use whatever method available to pass each barrier successivly.**

An Example:

12” insulation

Air-tight plaster ceiling



No insulation

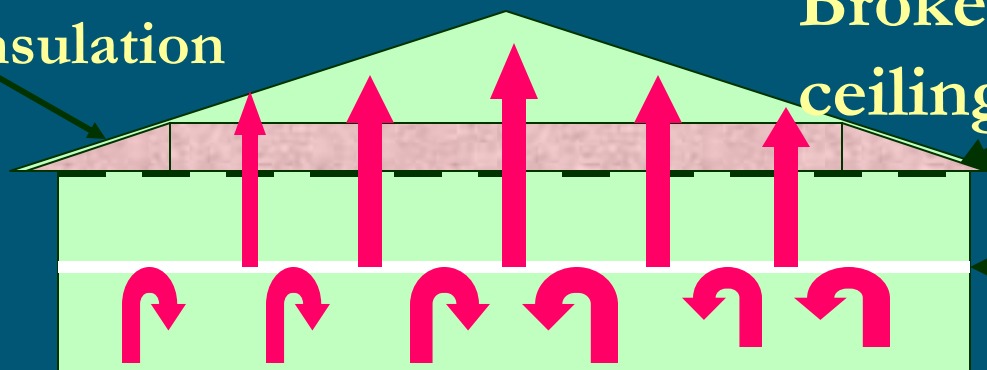
Porous block tile ceiling

By convection (stack - warm air rising), room air freely moves through the block tile & insulation, warming the area between the ceilings to the same temperature as the room below.

The heat then radiates/conducts through the un-insulated ceiling to the attic.

This configuration slows heat transfer, but, given enough time, the same amount of heat is lost as would be without the insulation!

Let's reverse the situation

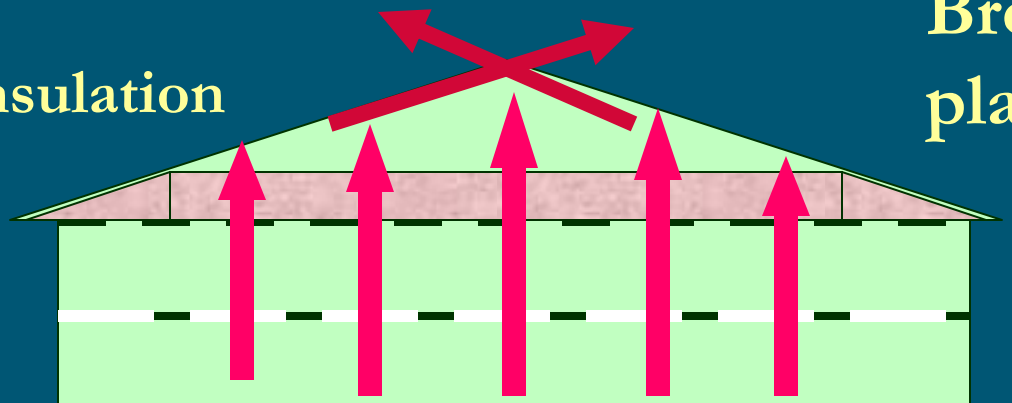


Room heat conducts/radiates through the air tight ceiling, warming the space between the ceilings to the same temperature as the room below.

By convection (stack - warm air rising), air above the drywall ceiling freely moves through the broken plaster & insulation, warming the attic to the same temperature as the area between the ceilings.

This configuration also slows heat transfer, but again, over time, the same amount of heat is lost as would be without the insulation!

Real Life !

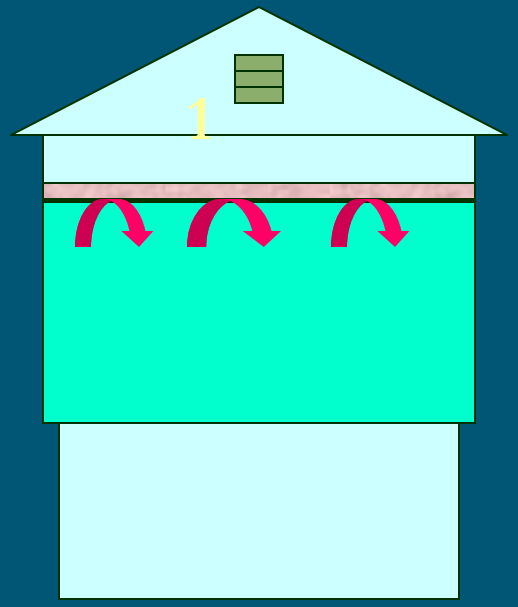


Convective air currents carry heat up through both ceilings, the insulation and the ridge vent.

The entire house generally behaves like a giant chimney !

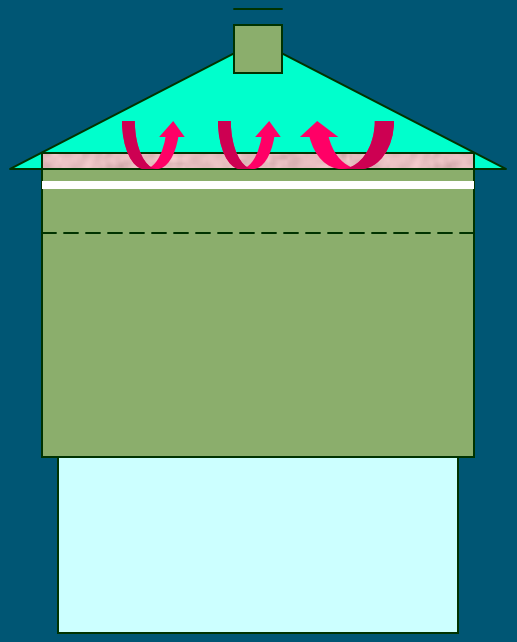
Which surface is better?

Everything else being equal, the house in winter, will use slightly less fuel as the surface area exposed to cold & the heated volume is smaller.



Which is better?

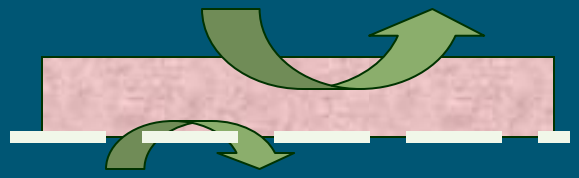
In summer, if exposed to the sun, the house will heat less & cool more quickly. There will be lower volume of sun heated air created & stored in the attic.



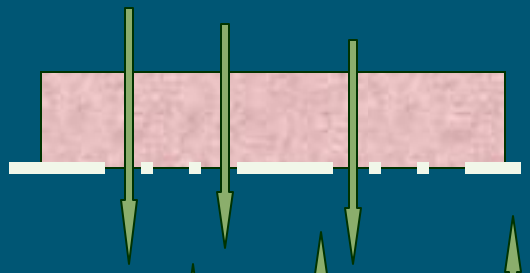
Choose what's best for the individual house!

Air Leakage Terms:

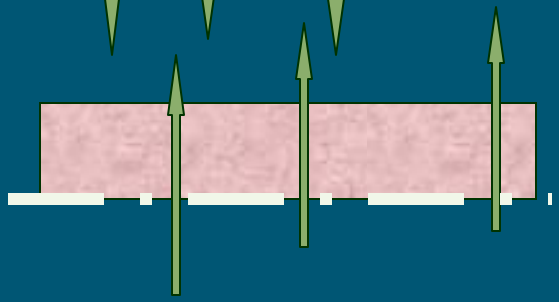
1. **Intrusion =**



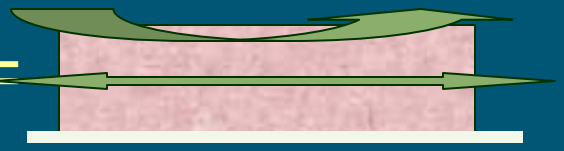
2. **Infiltration =**

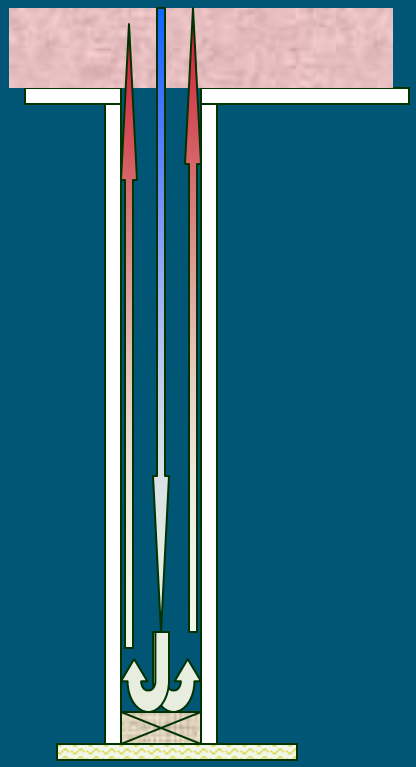


3. **Exfiltration =**



4. **Wind-washing =**





Looping

Insulation vs. air sealing

- **We know how to insulate!**
- **As an industry, we seem to believe that insulation stops air.**

‘T AIN’T SO!

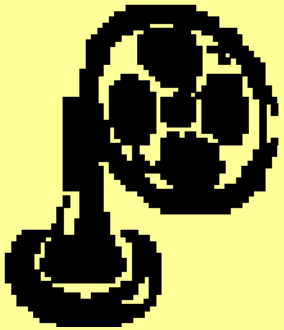
Part Two AGENDA:

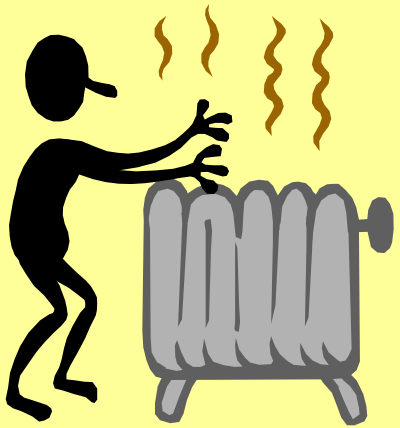
- **Review**
- **Understanding air movement**
- **Controlling air movement**
- **A little bit about surface heat loss:**
  - **Conduction**
  - **Convection**
  - **Radiation**
- **Break**
- **Keeping heat in**

Review

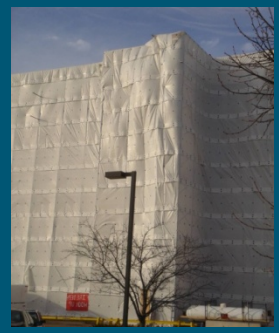
- **Houses are systems**
- **Heat is lost in two ways**
  - **Surface loss**
  - **Air transported loss**
- **Keeping heat in requires**
  - **Insulation**
  - **Air sealing**
- **We must stop moisture also**
- **We must deal with heat & moisture at the same surface**
- **Called the Building Envelope**

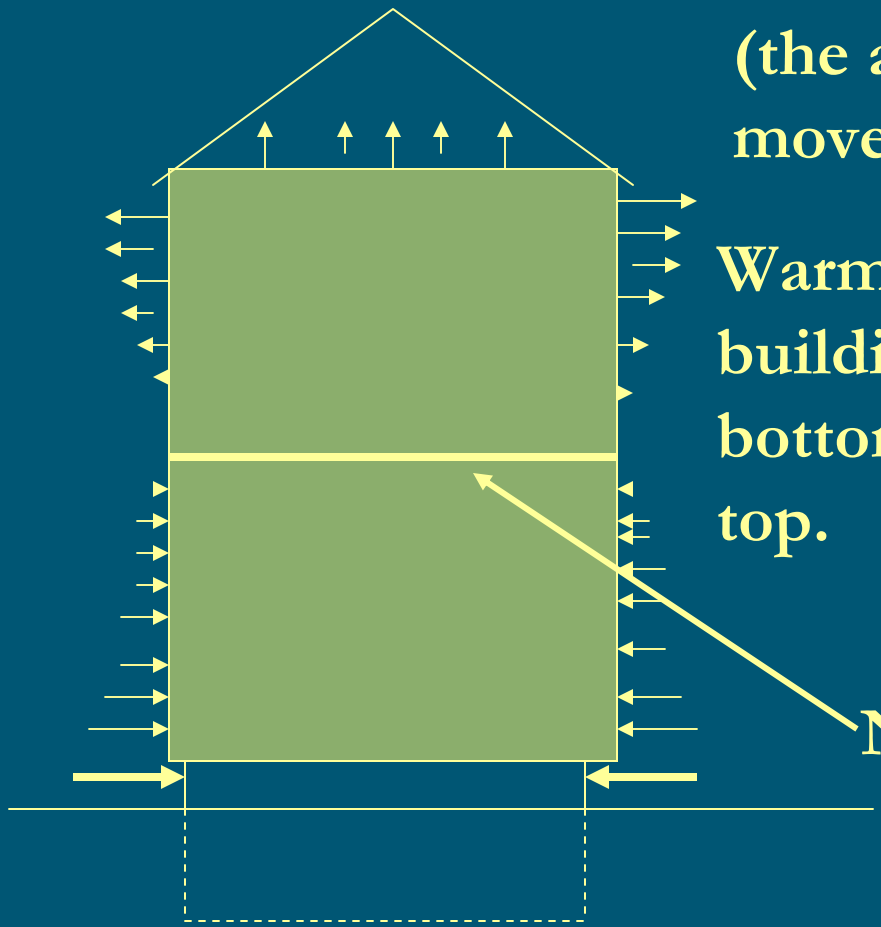
To control air leakage we have to understand it!





What drives air leakage ?
Stack Effect



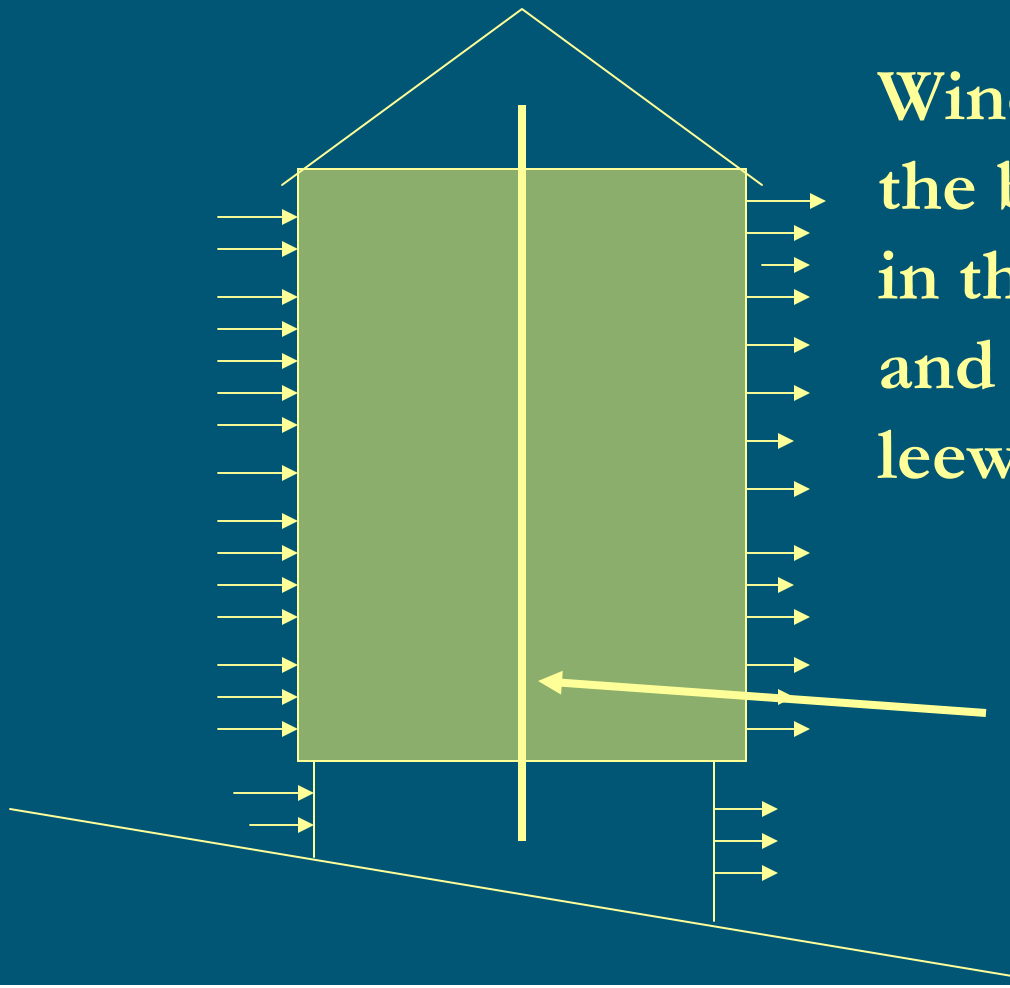


(the arrows indicate air movement)

Warm air rising inside the building pulls air in at the bottom & drives it out the top.

Neutral pressure plane

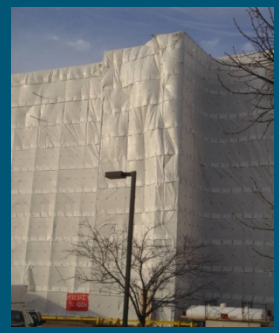
What drives air leakage ?
Wind

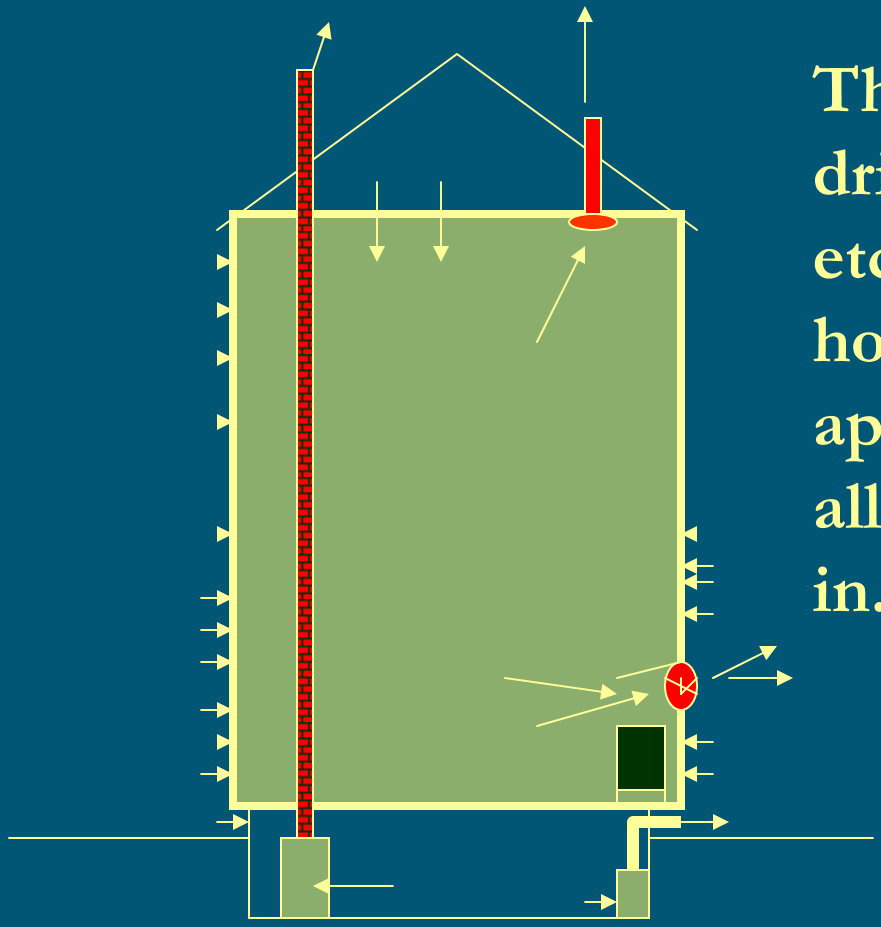


Wind blowing against the building pushes air in the windward side and sucks it out the leeward side.

Neutral pressure plane

What drives air leakage ?
Fans & Pumps

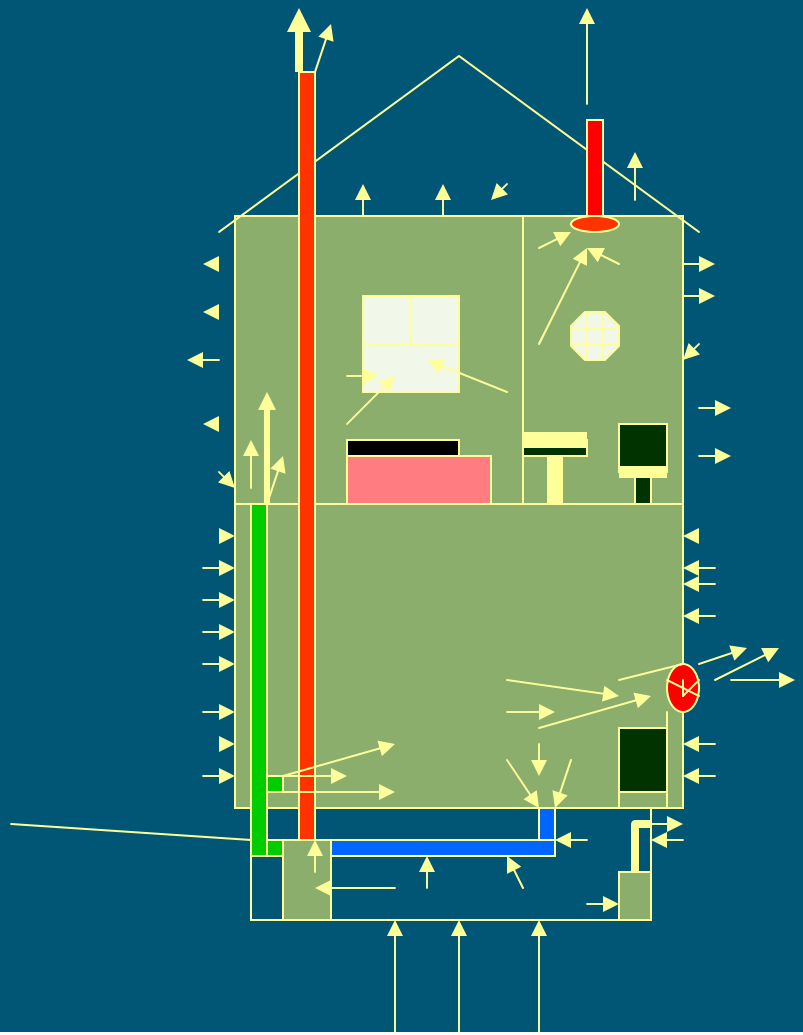




The heating system, clothes drier, kitchen & bath vents, etc. all pump air out of the house. If enough exhaust appliances are turned on, all envelope holes will leak in.

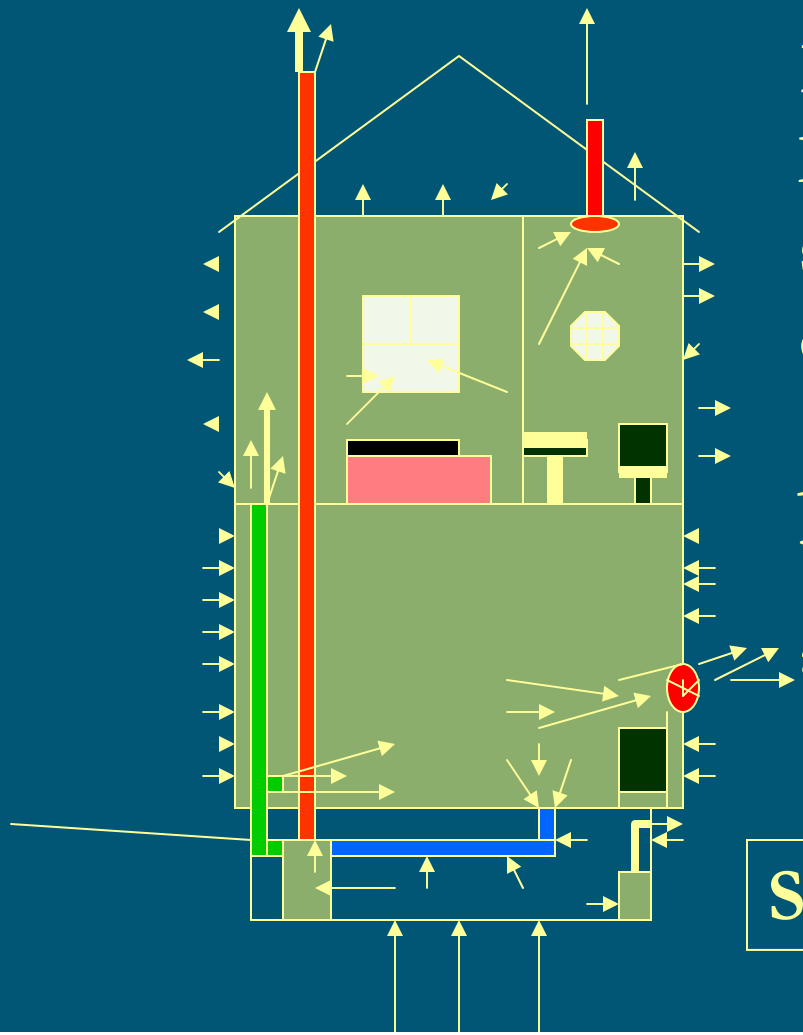
There is <u>no</u> neutral pressure plane!

What drives air leakage ?
Warm Air Heating Systems



Warm air heating systems add another variable: Rooms without return grilles are typically pressurized

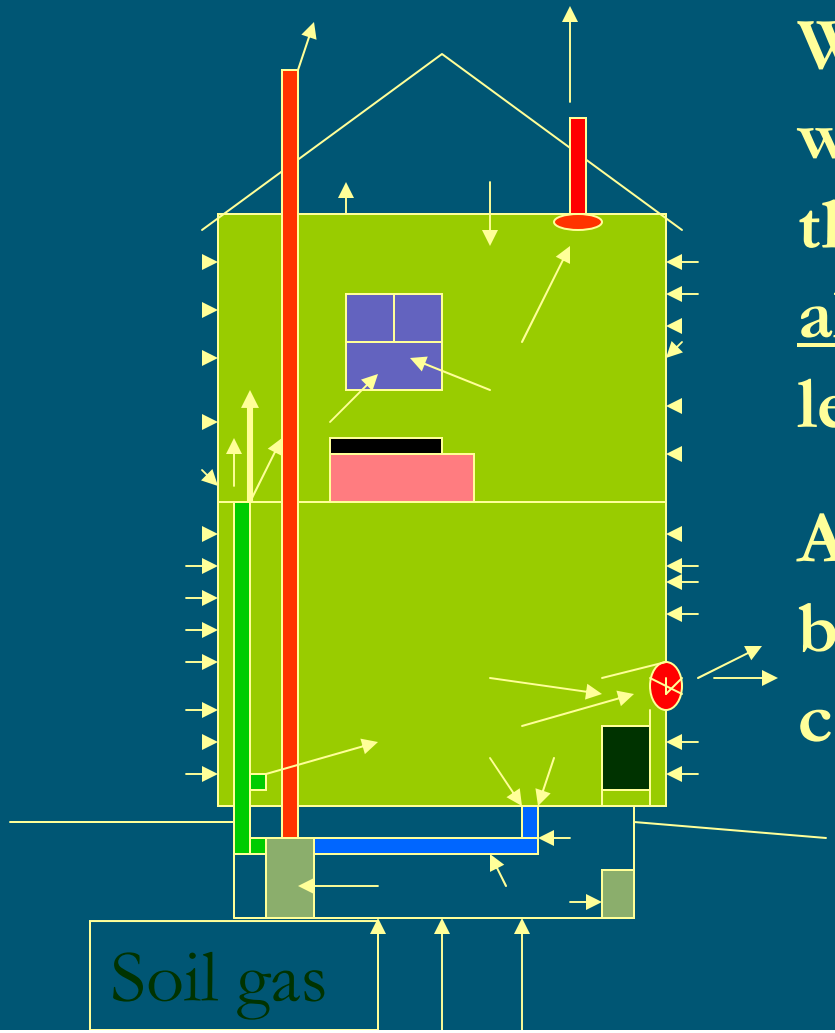
What drives air leakage ?
Warm Air Heating Systems



Return ducts are typically leaky. If so, the furnace will suck air from the basement depressurizing it.

Any pollutant in the basement will be distributed about the house.

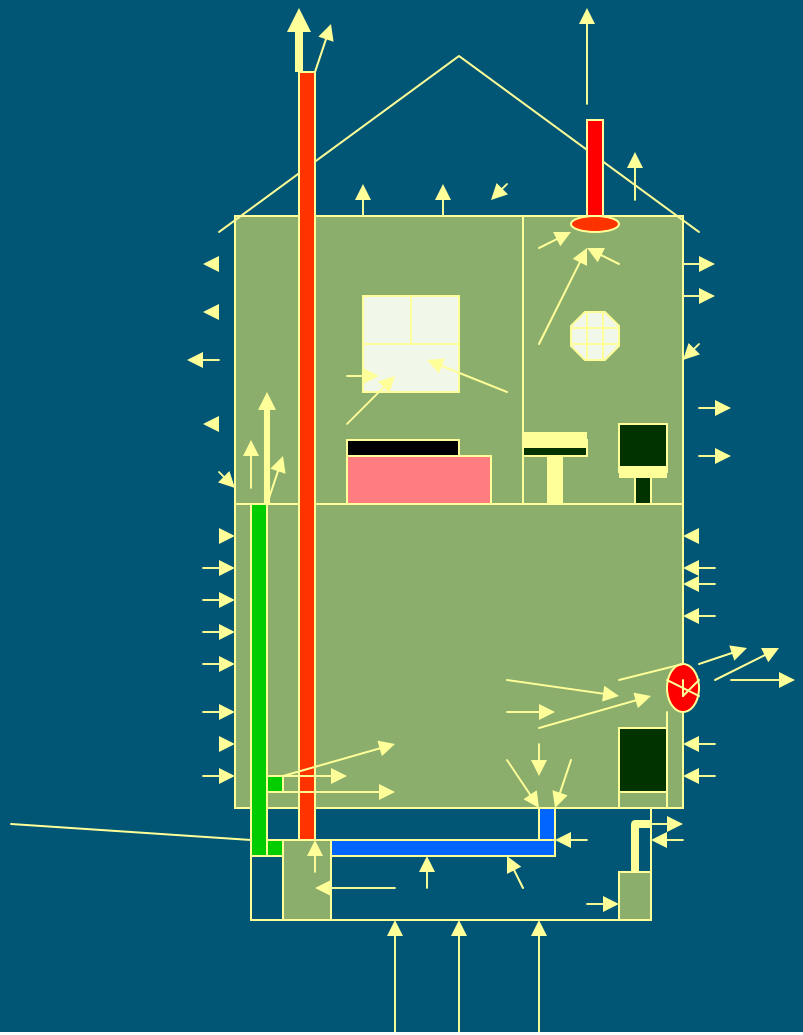
What drives air leakage ?
Warm Air Heating Systems



What happens when a window is opened with the furnace running? Air always takes the path of least resistance.

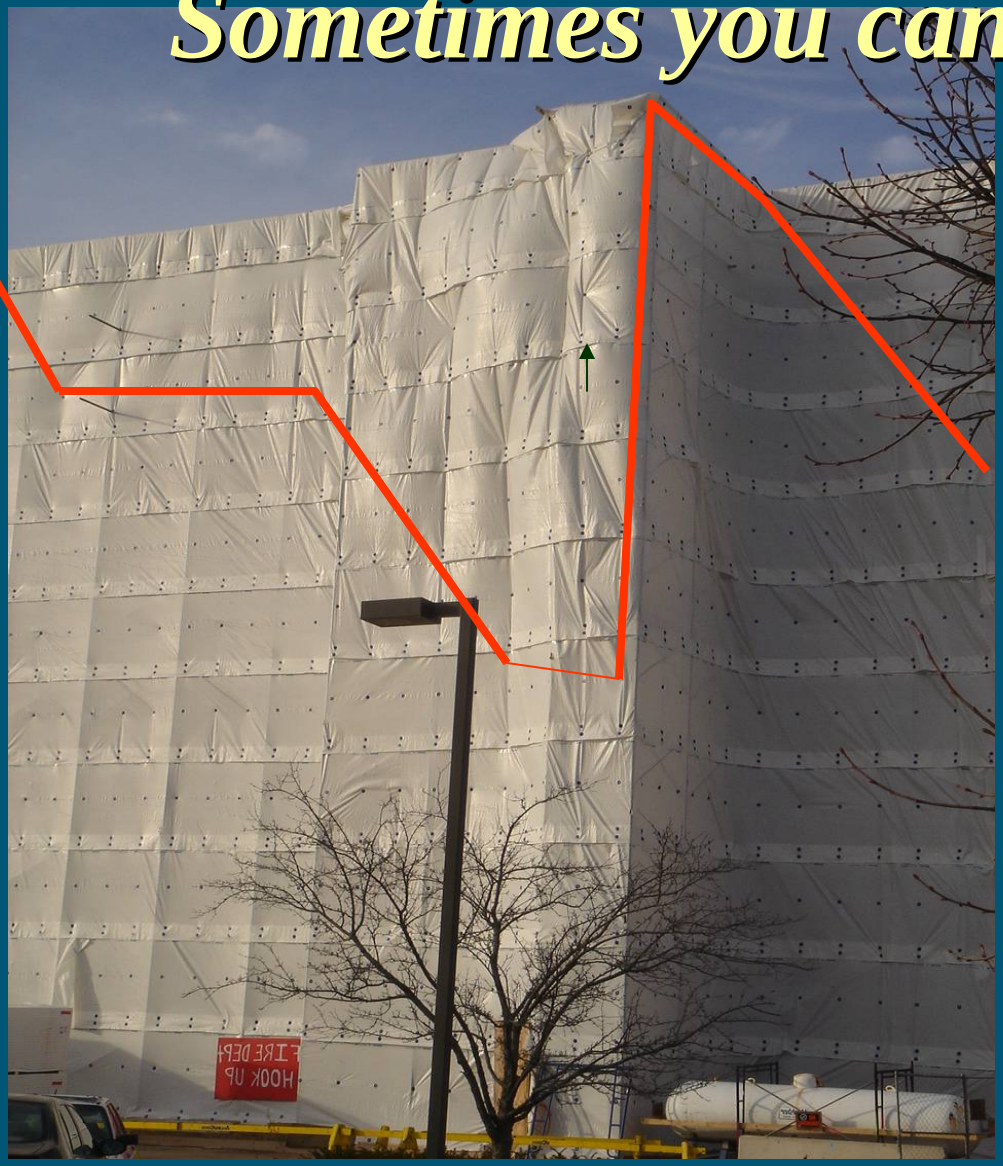
Any air going out has to be replaced by air that comes in.

What drives air leakage ?
Warm Air Heating Systems



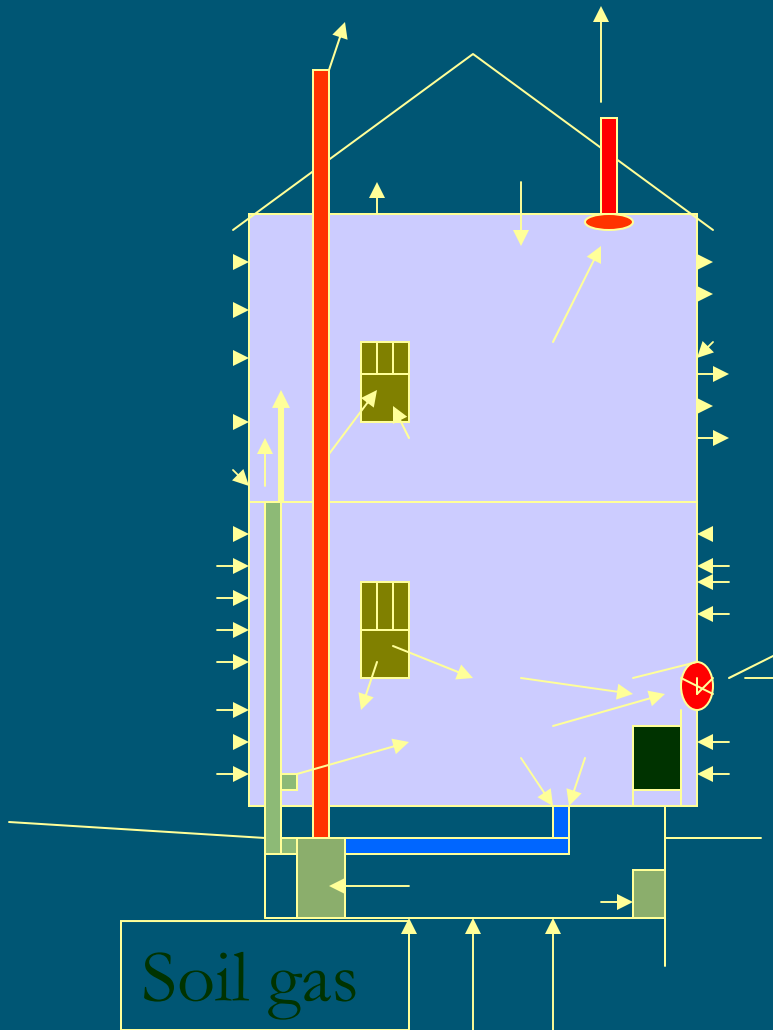
Air sucked from the basement can be particularly dangerous. It often contains pollutants, including flue gasses. (CO!)

Sometimes you can see it !



In a real building, the neutral pressure plane is determined by all the "drivers" operating at once.

In the Real World: Everything Happens at Once



All drivers constantly move air in & out of a house. Some holes leak in, while others leak out, depending on driving force strengths.

Controlling unwanted air movement by plugging the holes is key to saving energy

Remember Surface heat Loss?

Heat moves by three basic methods:

(1) Conduction

Surface heat loss

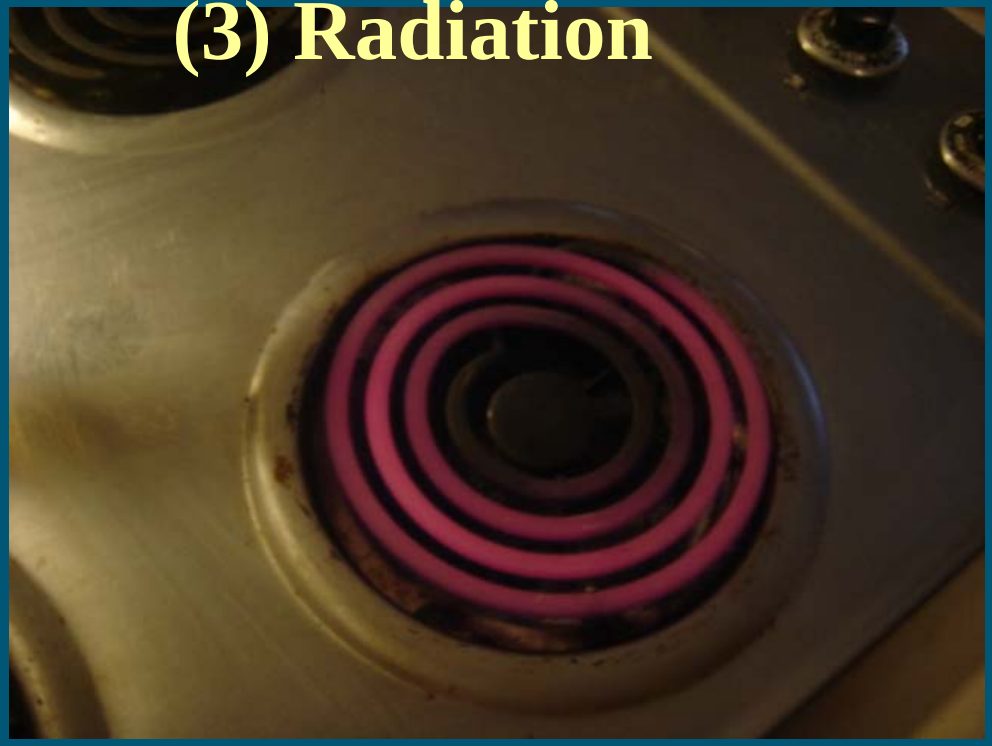
Heat moves by three basic methods:

(2) Convection

Surface heat loss

Heat moves by three basic methods:

(3) Radiation



Surface heat loss

Conduction **Convection** **Radiation**

Insulation reduces conductive & convective movement by trapping small pockets of air. Reflective insulation slows radiation.

Putting it all together!

- **Few insulations stop air.**
- **Air sealing does not stop surface heat loss.**
- **99% of moisture movement comes from air movement.**
- **Airsealing greatly reduces moisture movement!**

BREAK !

Keeping Heat In!

- **Attic air sealing**
  - **Chimney chases**
  - **Plumbing chases**
  - **Recessed lights**
  - **Wires**
- **Basement air sealing & insulation**
  - **Bulkhead doors**
  - **Fill pipes, utility penetrations**

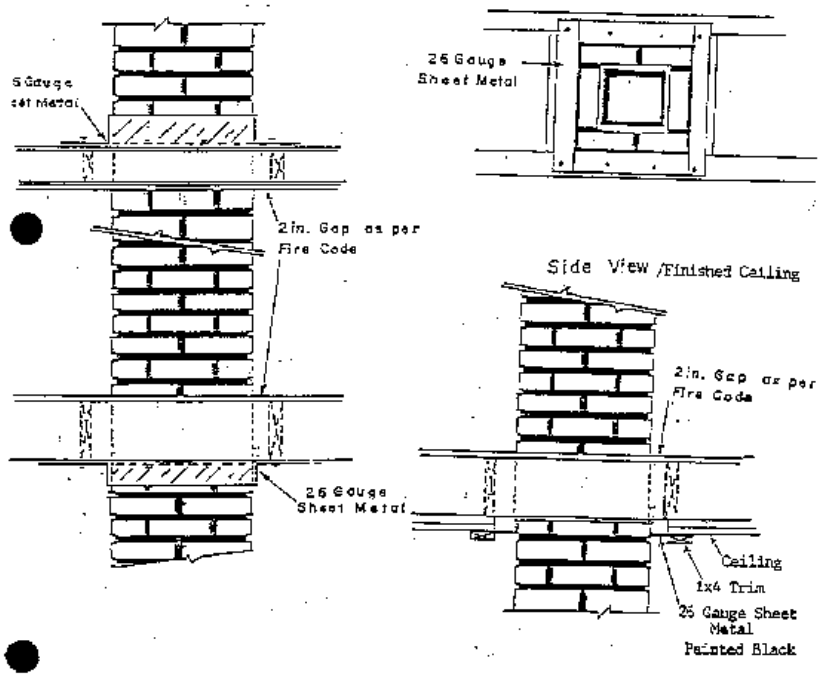
Looking down a chimney chase

Chimney..before ..during..after

Detail for Sealing Thermal Bypass Around Chimney

Side View

Top View/Bottom View



Side View /Finished Ceiling

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Fig 2; Sec D

Clearances…

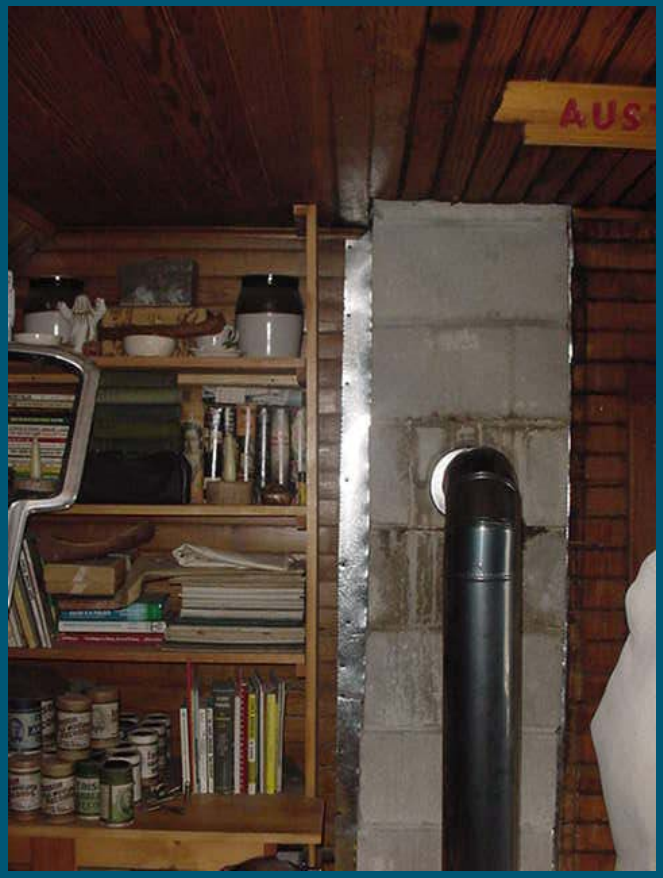
Framing in

Done !

Insulation Dam

Chimney seal

- The hole can be vertical as well!



Before & after !

Demo

- **Use prop to demonstrate chimney seal installation**
- **10-15 minutes**

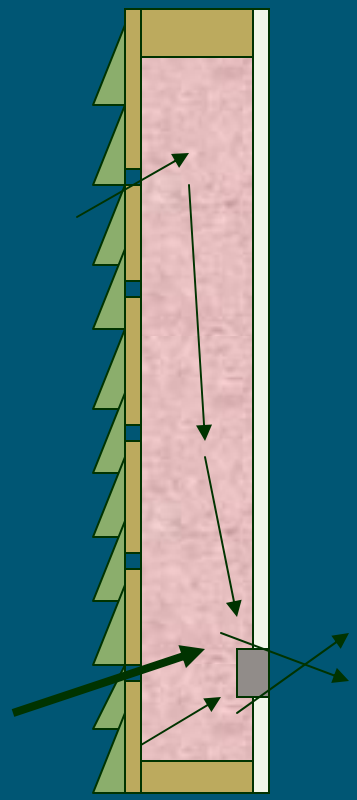
Part Three AGENDA:

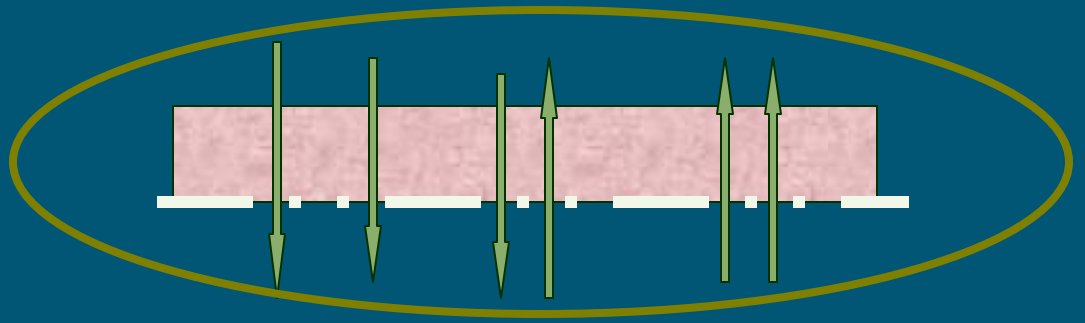
- **Review**
- **Attic airsealing**
- **Basement airsealing**

Review

- **Surface heat loss:**
  - **Conduction**
  - **Convection**
  - **Radiation**
- **3 mechanisms move air:**
  - **Wind**
  - **Stack**
  - **Fans**
- **Airsealing is often ignored**

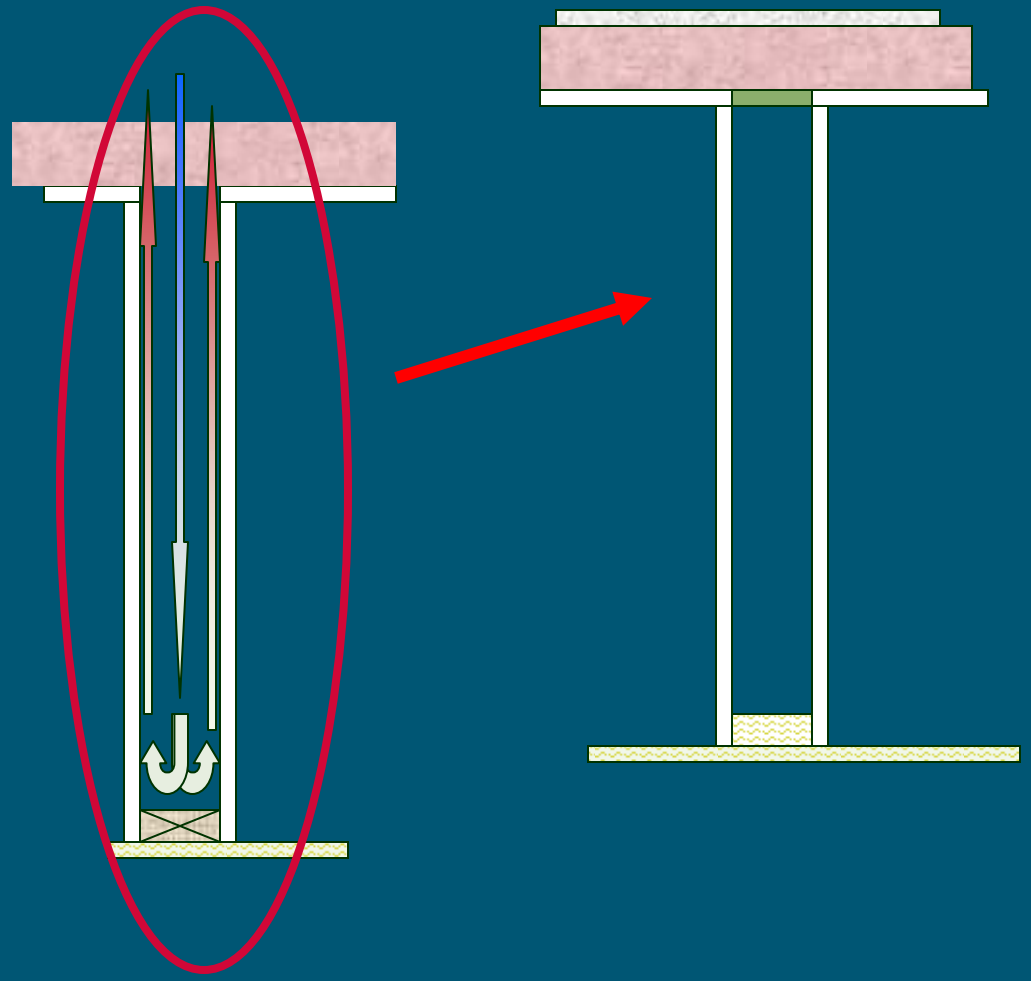
Infiltration & Exfiltration



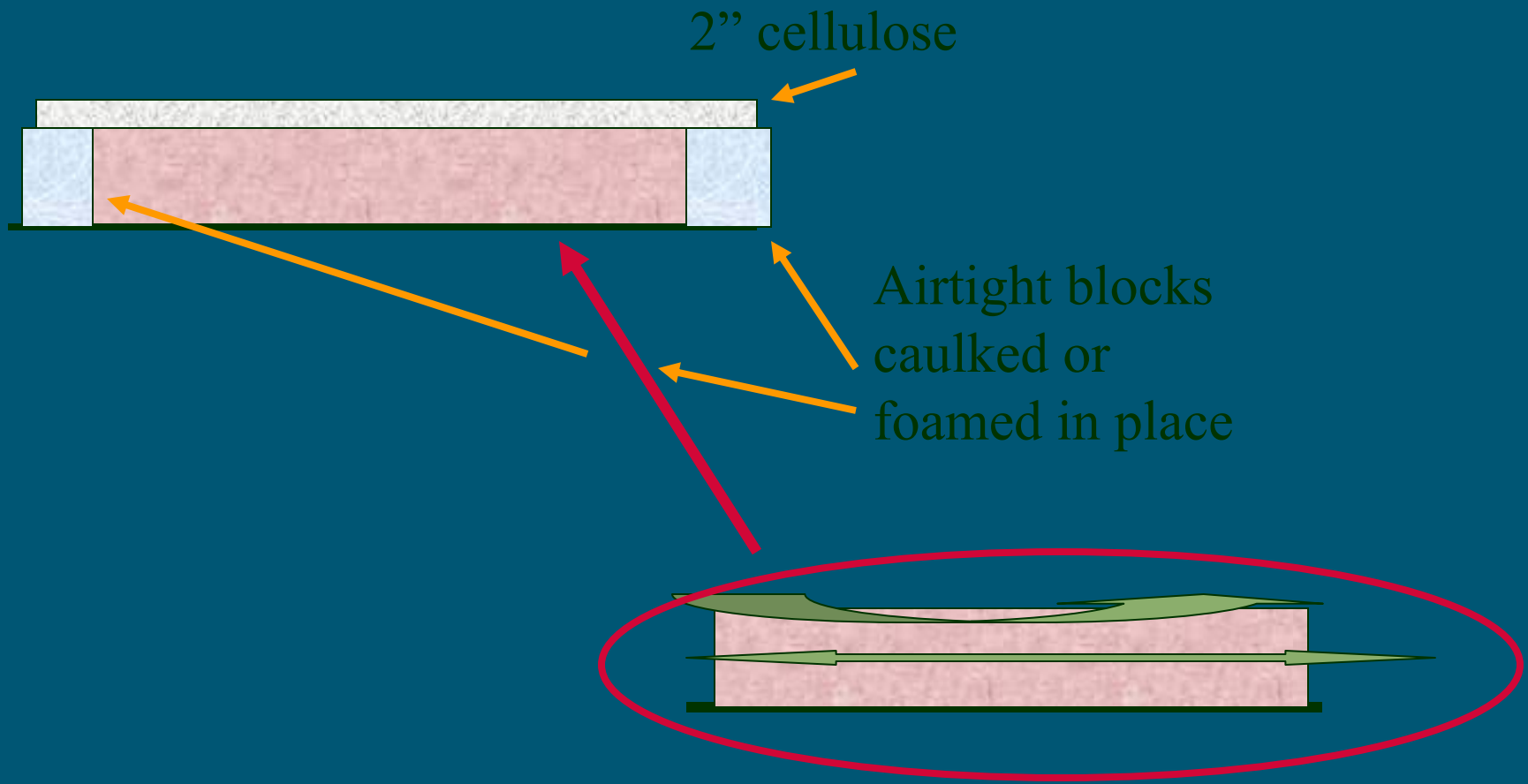


Looping & Intrusion

Lift attic insulation, caulk solid block in place, replace insulation, dust over with cellulose



Windwashing



At the top…& at the bottom

- **Fold- down attic stair**
- **Insulated cover**
- **Weatherstrip**

- **Sandwich door with weatherstrip**
- **Wall drape sealed at bottom**
- **Box sill insulation**

Plumbing chases

Vent stack

Pipe bypass

*Dropped Soffit**

- **Often open to attic or floor cavity above.**
  - **– Airseal by creating a solid surface at the ceiling level. Insulate over to R-40 in attic.**
- **May contain fans or lights.**
  - **– Treat by airsealing housings to drywall or by sealing pipe & wire penetrations through created ceiling level surface (above)**
- **Stuffing soffit cavity with insulation will not aireal & is not acceptable.**

*** Enclosed box over kitchen or bathroom wall cabinets**

Recessed lights in envelope surfaces

- **Check for IC (Insulation Contact) stamp.**
- **No IC stamp means nothing within 3” of the “can”, nor may it be enclosed* in any fashion!**
- **Non IC units require damming – 3” clearance**
- **Recessed lights in “non-envelope” surfaces are ok if envelope air sealing is done right.**

*** The illustration on page 3-10 of NWFG is in error**

Wires through envelopes

- **<u>Every</u> wire penetration must be sealed**
- **Locate (in attic)**
  1. **by stains on insulation**
  2. **measure (in room) fixture to hatch & from hatch in attic**
  3. **check under attic insulation above wall outlets & switches.**

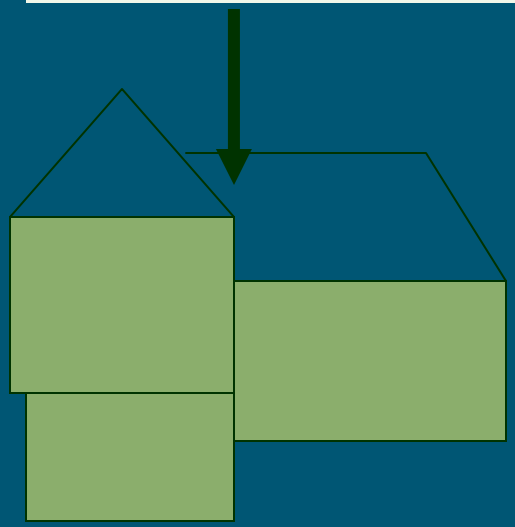
By-passes are everywhere!

Ventilation sometimes brings moisture in !

- Insulation will not air-seal !

Tri-level

Platform construction does not guarantee a top plate you need it !



When airsealing remember:

- **All combustion appliances must vent properly.**
- **Driers must be vented to the exterior.**
- **Garages must be airsealed from living space.**
- **All bathroom & kitchen fans must be vented to the exterior.**
- **Buildings with unvented combustion appliances in use will not be airsealed.**
- **Always do a CAZ test at the day's end!**

Hatches

Hatch under construction

*Attic hatches – good**

* But not good enough!

Attic hatches – Right!

BREAK !

Perimeter wrap & box sill insulation

Bulkheads

Bulkhead door, foam caulk, box sill

Perimeter wrap & ground cover

Perimeter wrap & bulkhead

Perimeter wrap & ground cover

Spraying two-part foam


Foam and
ground cover

Part Four AGENDA:

- **Living space airsealing**
  - **Doors & windows**
  - **Molding, trim, etc.**
  - **Electric fixtures**
- **Air sealing & insulating techniques by framing style**
- **CAZ Testing & the Neil Moyer chart**

Review

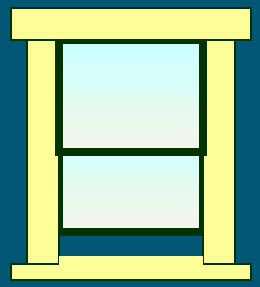
- **Infiltration & Exfiltration**
- **Windwashing & Looping**

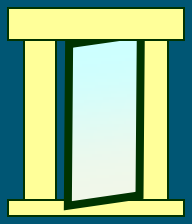
Airsealing Detail

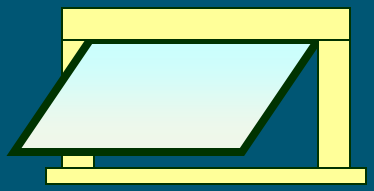
- **Weatherstrips & doorsweeps**
- **Adjusting locksets & built-in weatherstrips**
- **Sash locks**
- **Caulking technique**
- **Duct sealants**

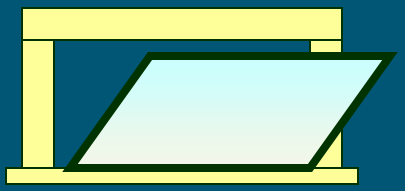
Four basic window types

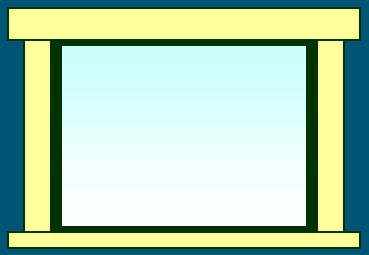
- Single or double hung
- Casement
- Awning (or hopper)
- Fixed











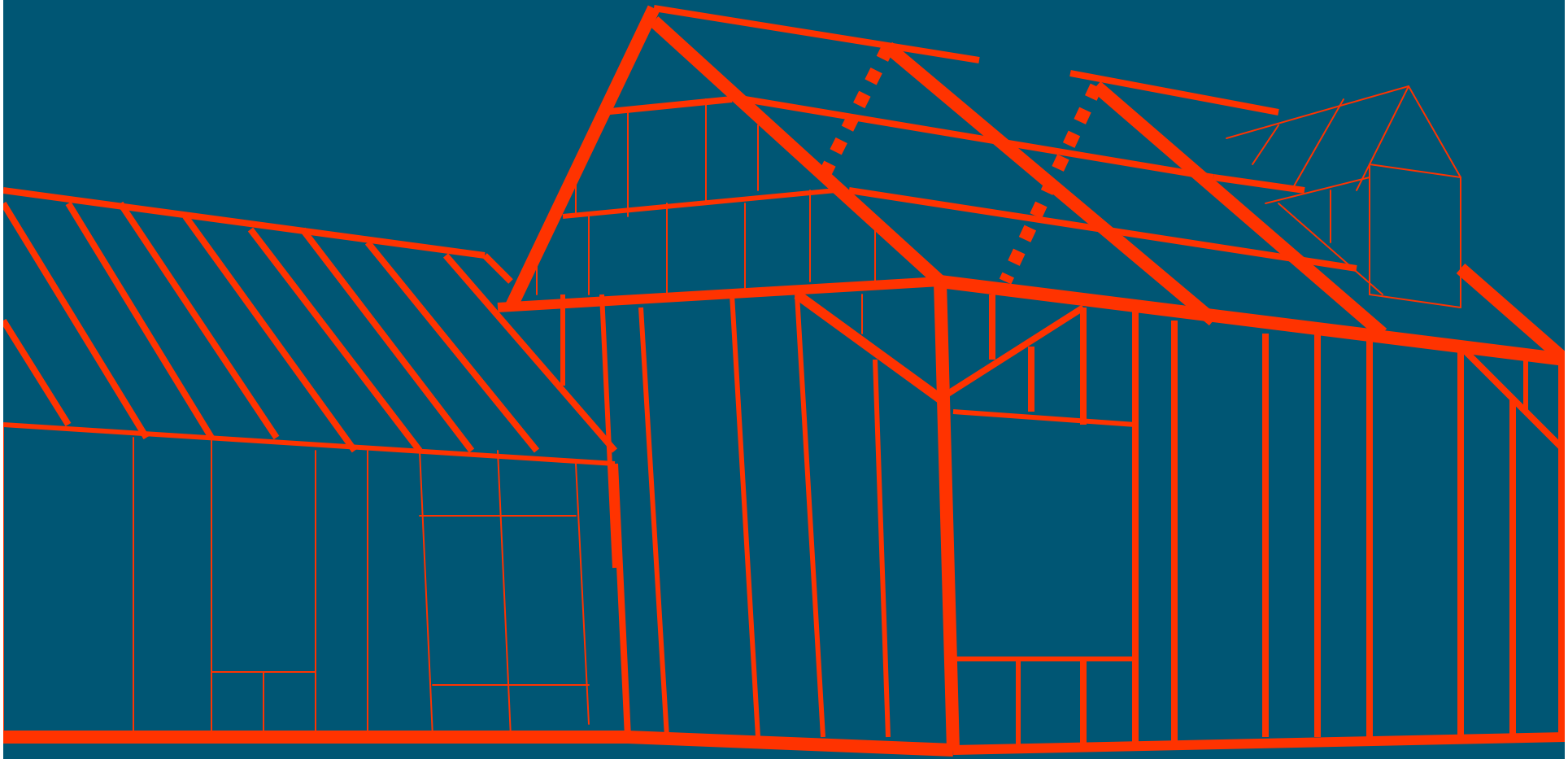
Holes are everywhere !

WHICH FRAMING TYPE IS IT ?

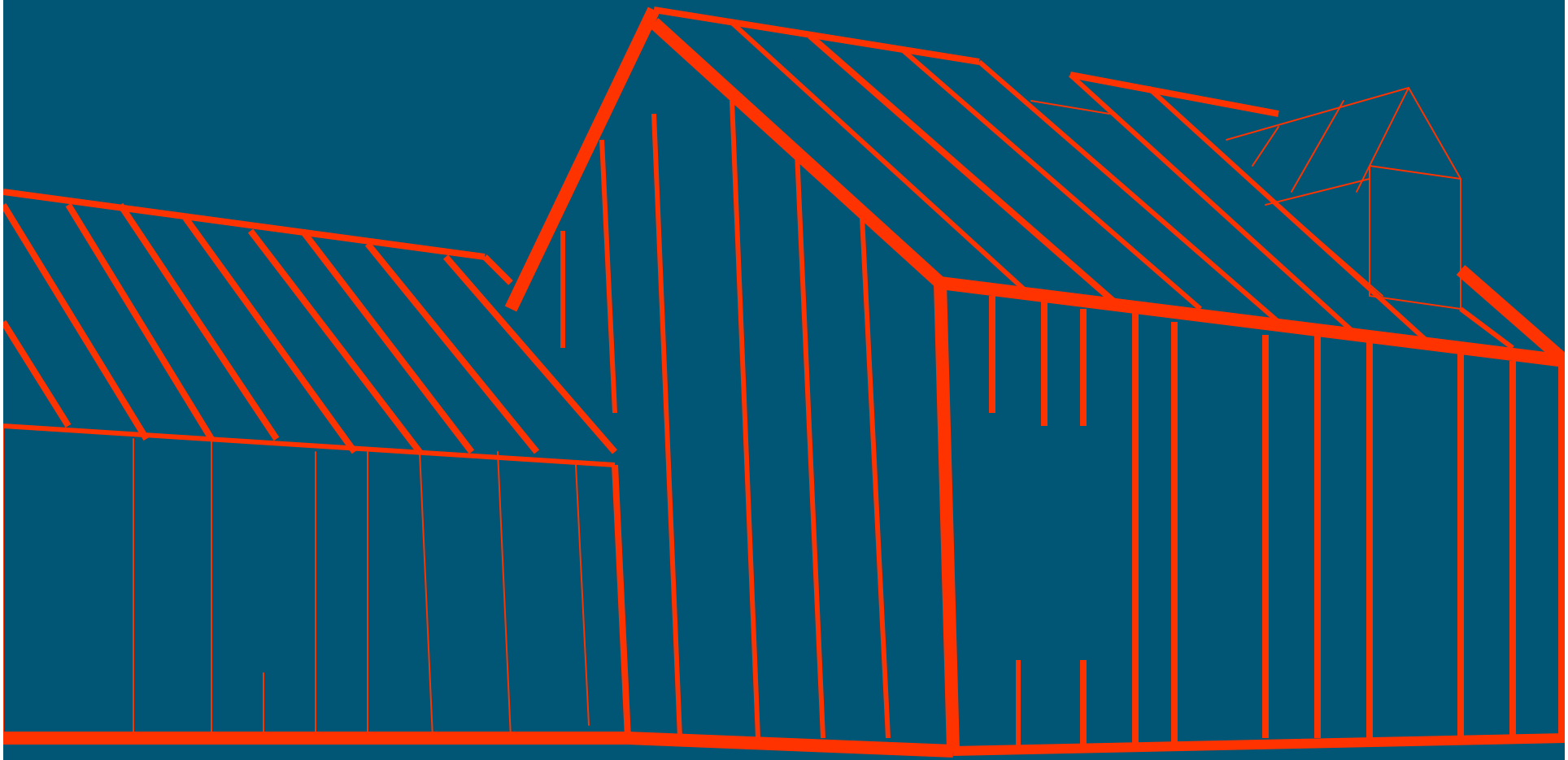
Construction details

- Why do we care?
- The building dictates how we address it !
  - –Insulation products
  - –Installer techniques
- Detail, detail, detail !

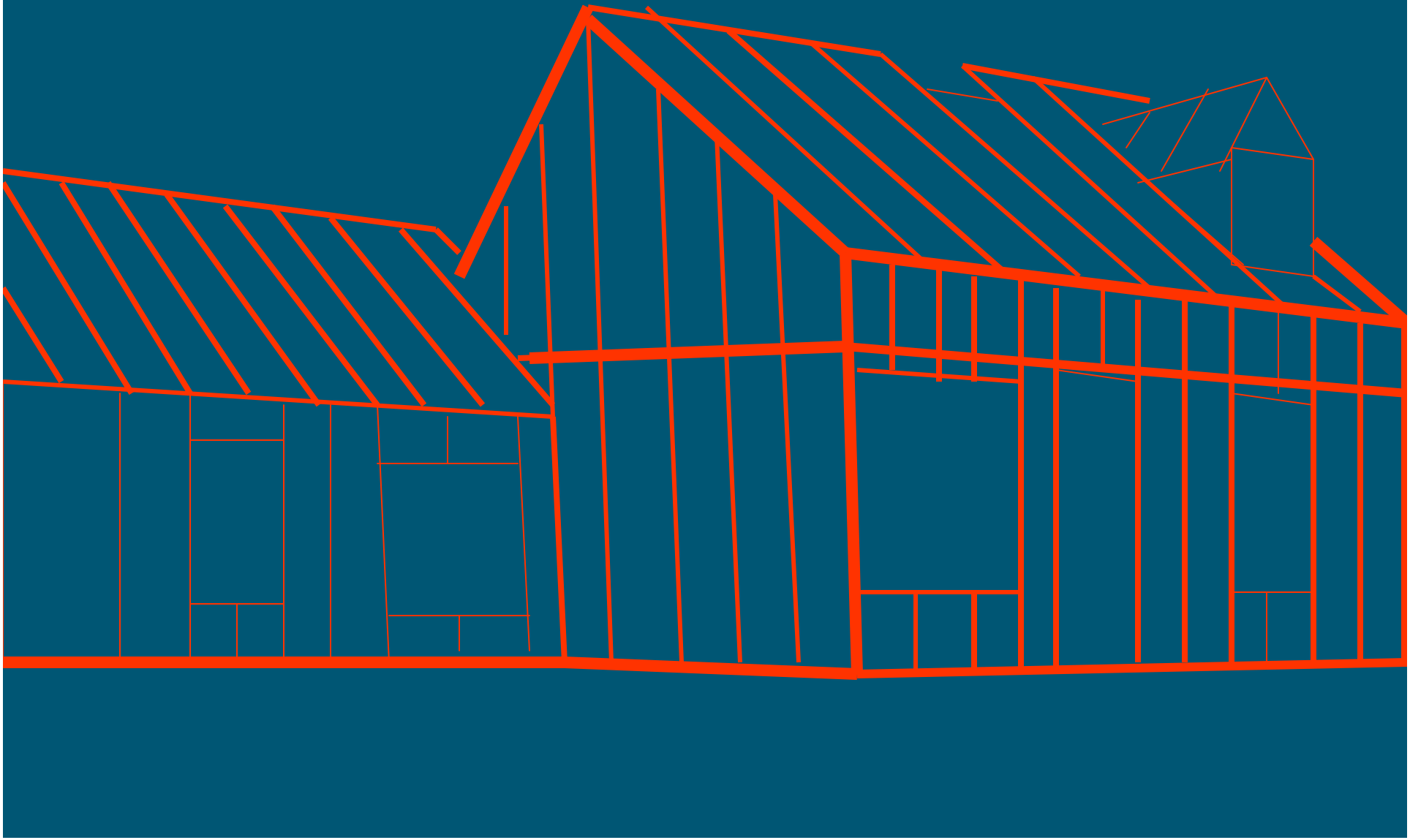
POST & BEAM



BALLOON



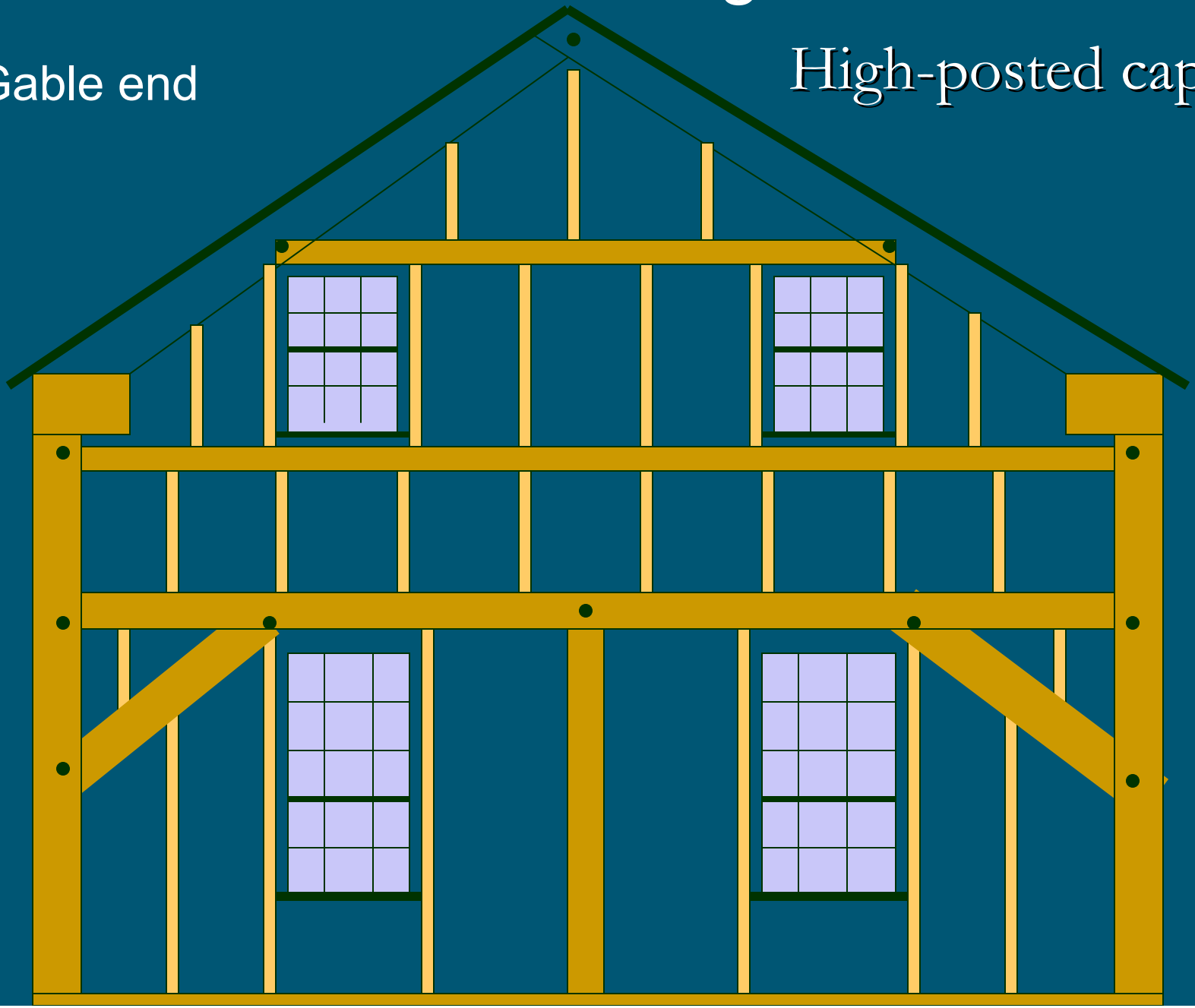
PLATFORM



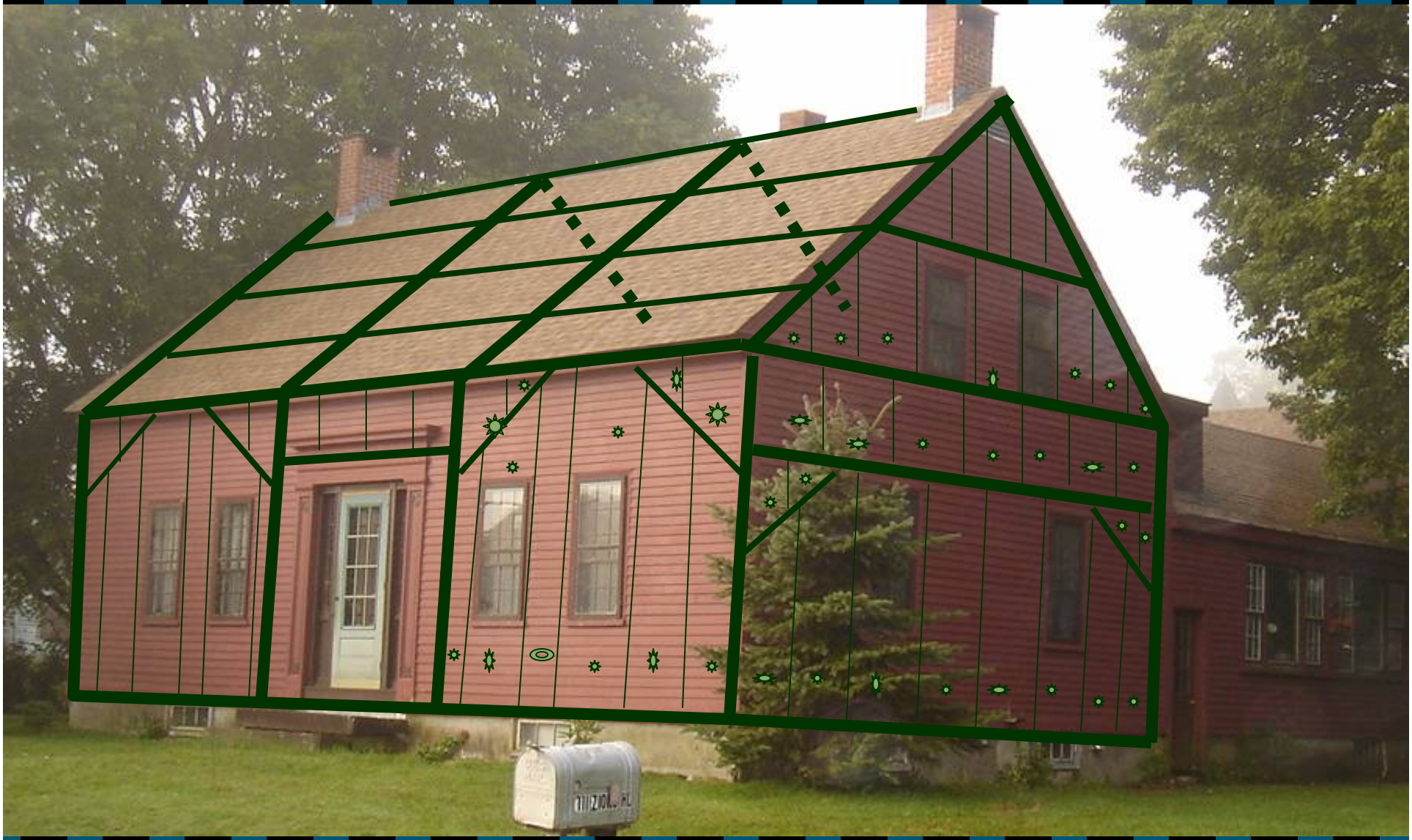
Post & Beam wall framing details

Gable end

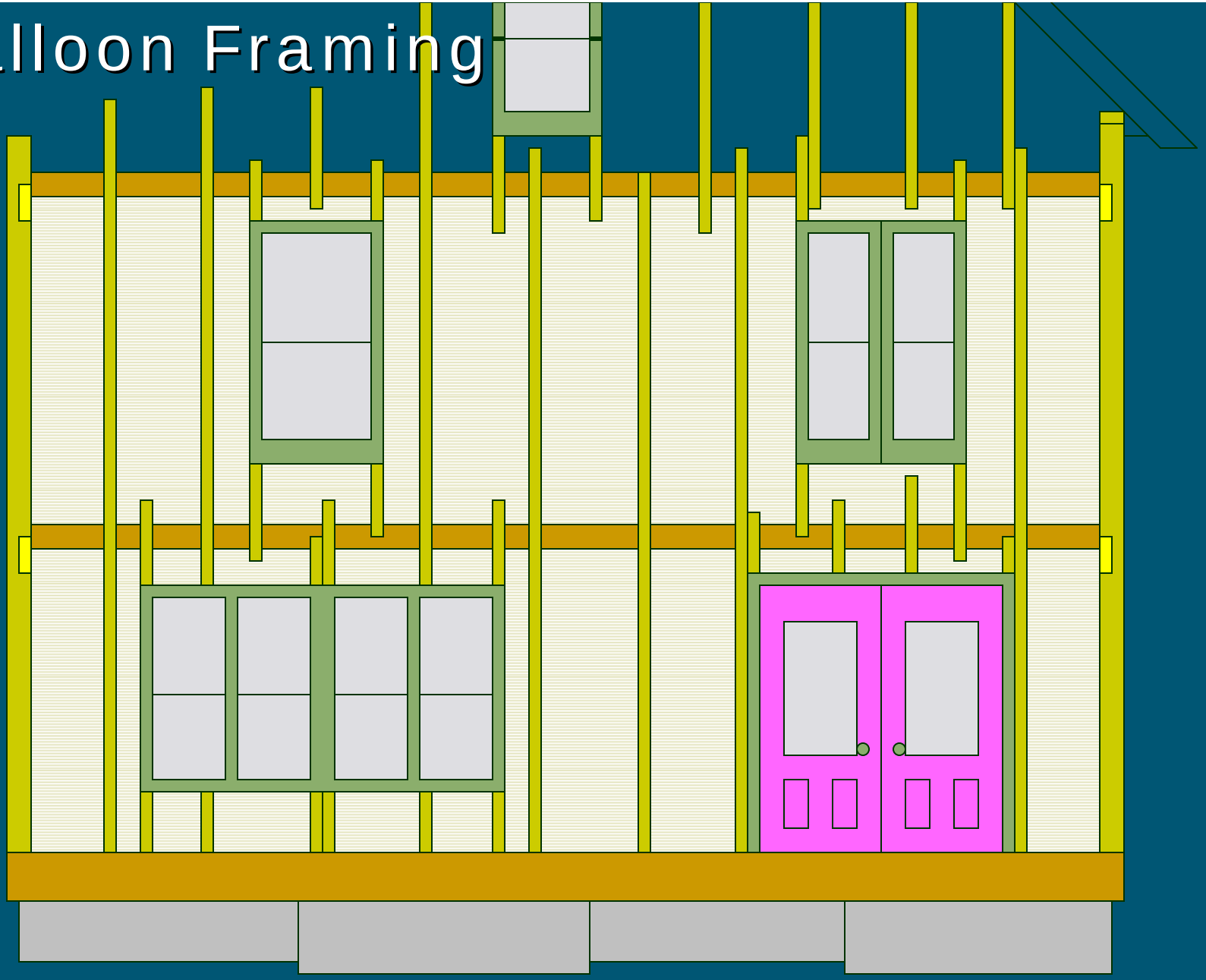
High-posted cape



Post & Beam drill pattern



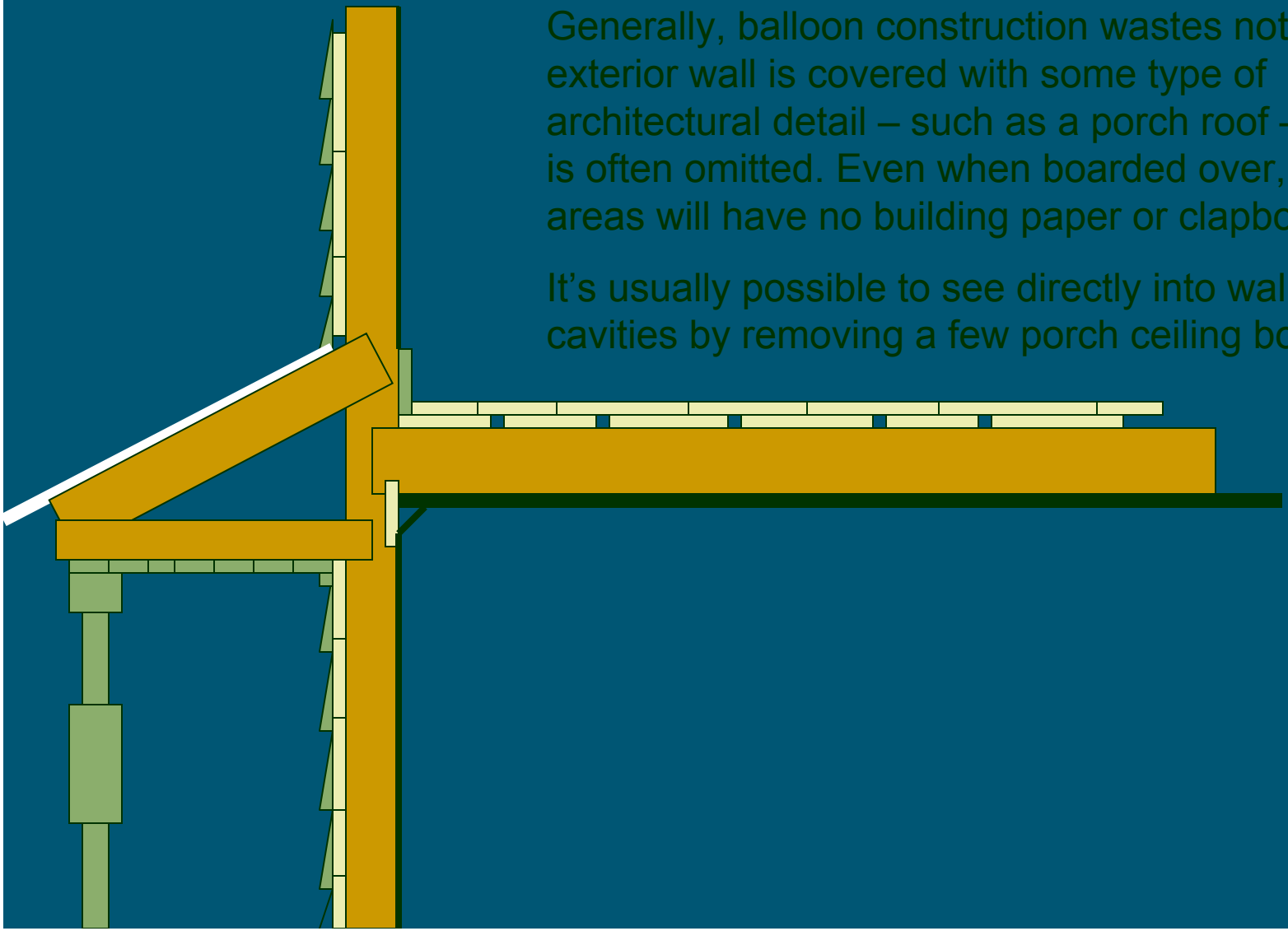
Balloon Framing



Because studs are arbitrarily placed wherever needed, all cavities must be probed left & right

Balloon Framing

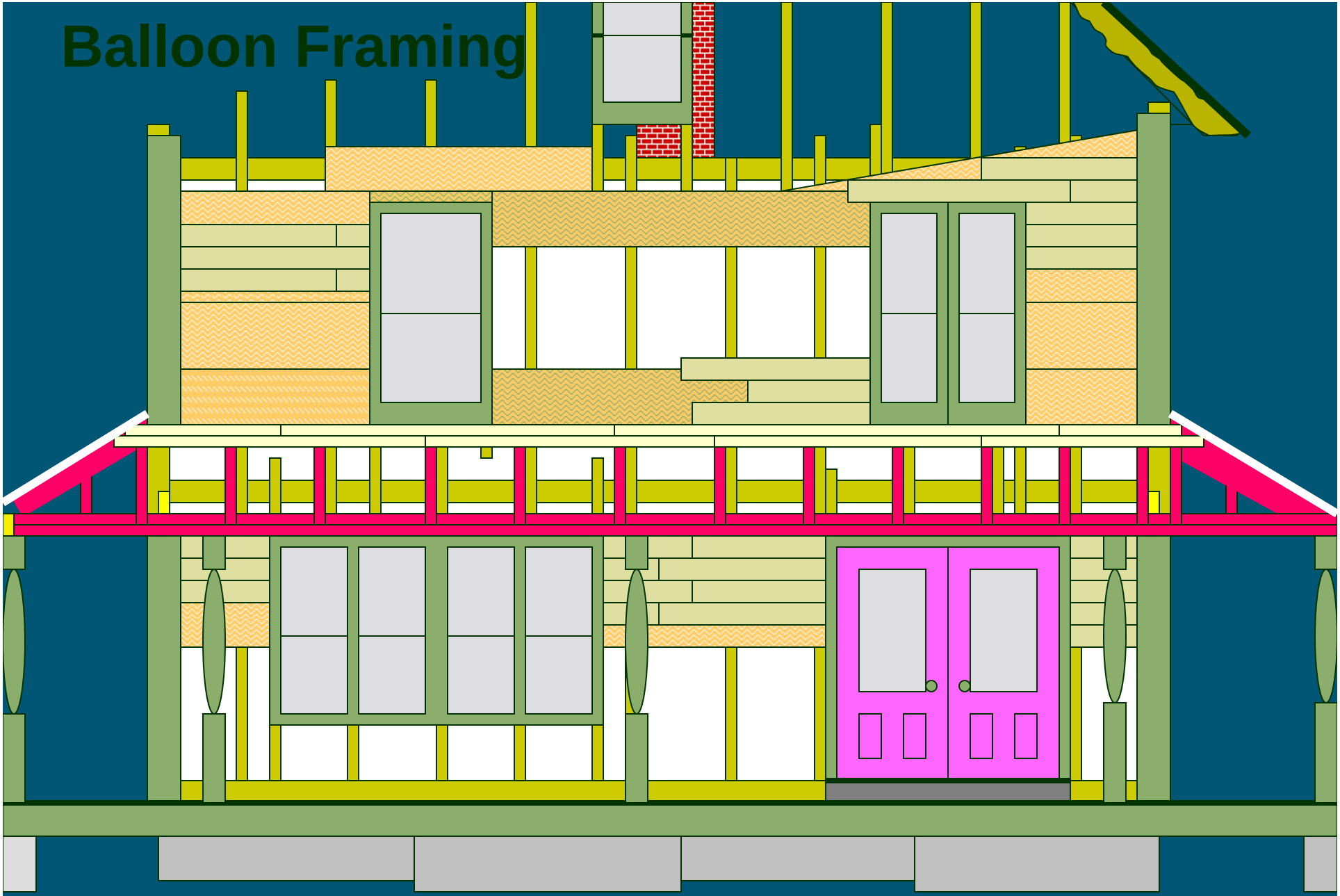
Typical porch or bay window detail



Generally, balloon construction wastes nothing. If an exterior wall is covered with some type of architectural detail – such as a porch roof – cladding is often omitted. Even when boarded over, these areas will have no building paper or clapboards.

It's usually possible to see directly into wall & floor cavities by removing a few porch ceiling boards.

Balloon Framing

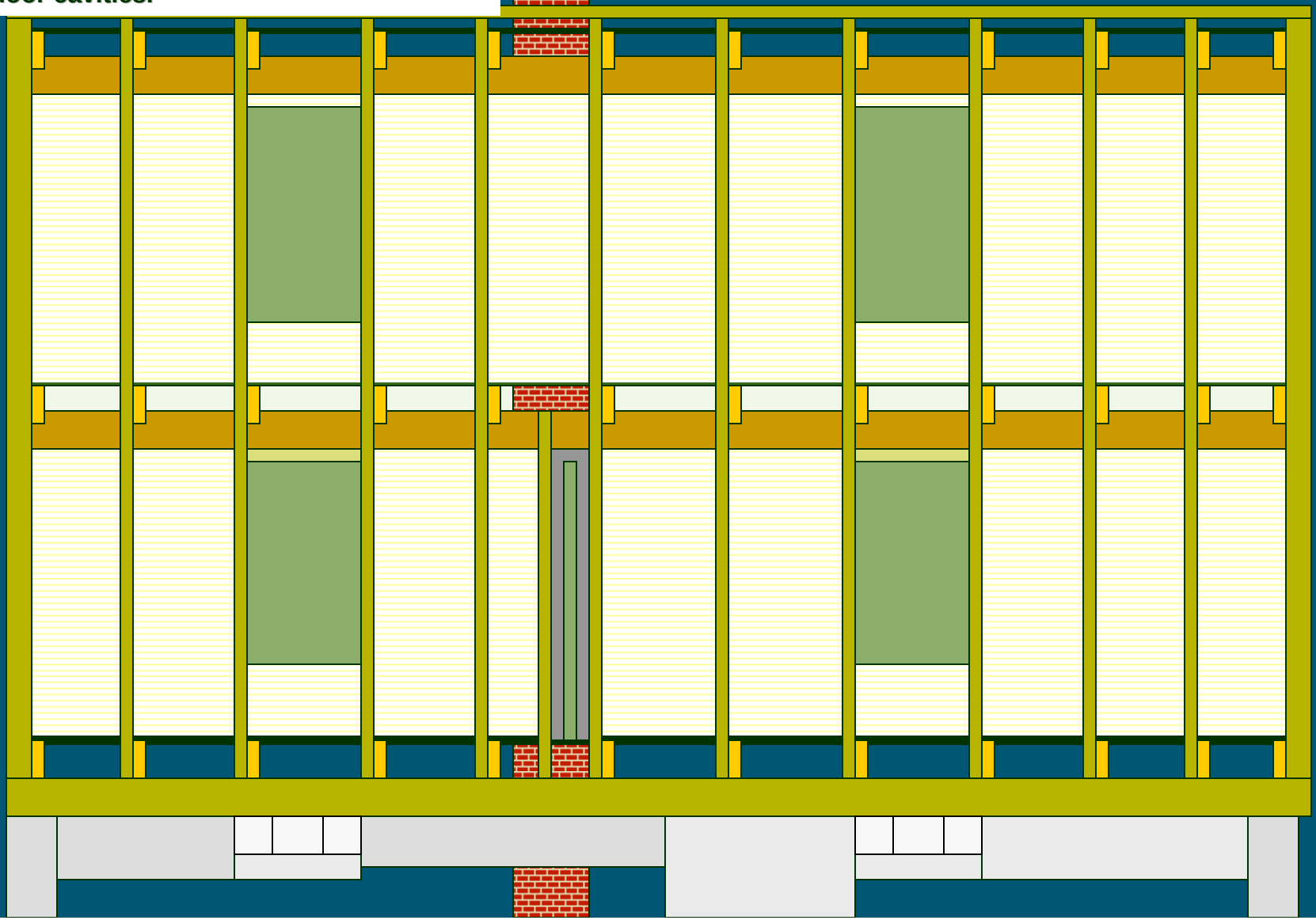


Air sealing walls over porches & bay windows is necessary.

Eaves wall of balloon framed building – cladding removed.

Usually it is possible to look into the floor cavity and see the opposite wall cladding.

Insulation blown into walls can fill ceilings, attics, basements, built-ins & pocket door cavities.



Balloon Framing – typical interior partition detail

Interior partitions generally align floor to floor.

Partition studs are generally nailed to the sides of floor stringers.

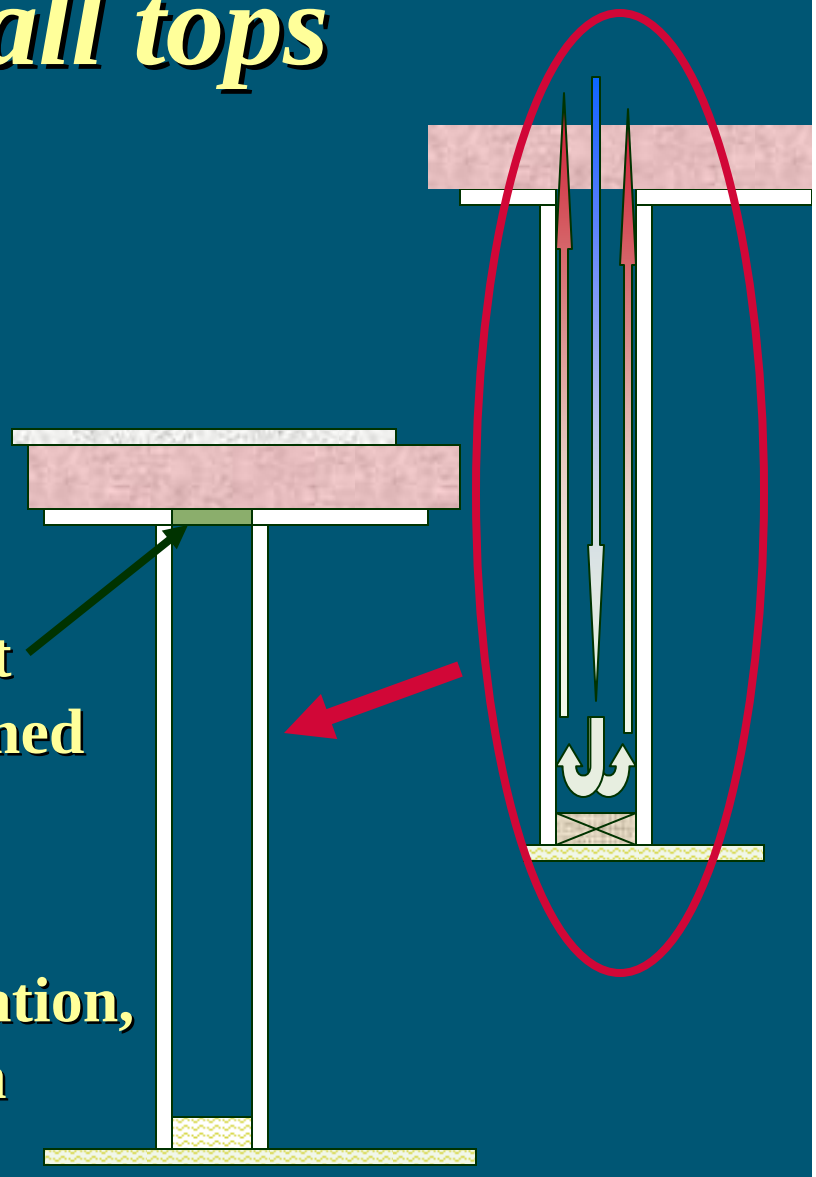
Partition stud cavities into the attic may or may not be floored over.

Lower floors may or may not be sub-floored between partition studs.

It is generally possible to drop an object from the attic to the first floor sub-flooring in the wall cavities.

Sealing the wall tops

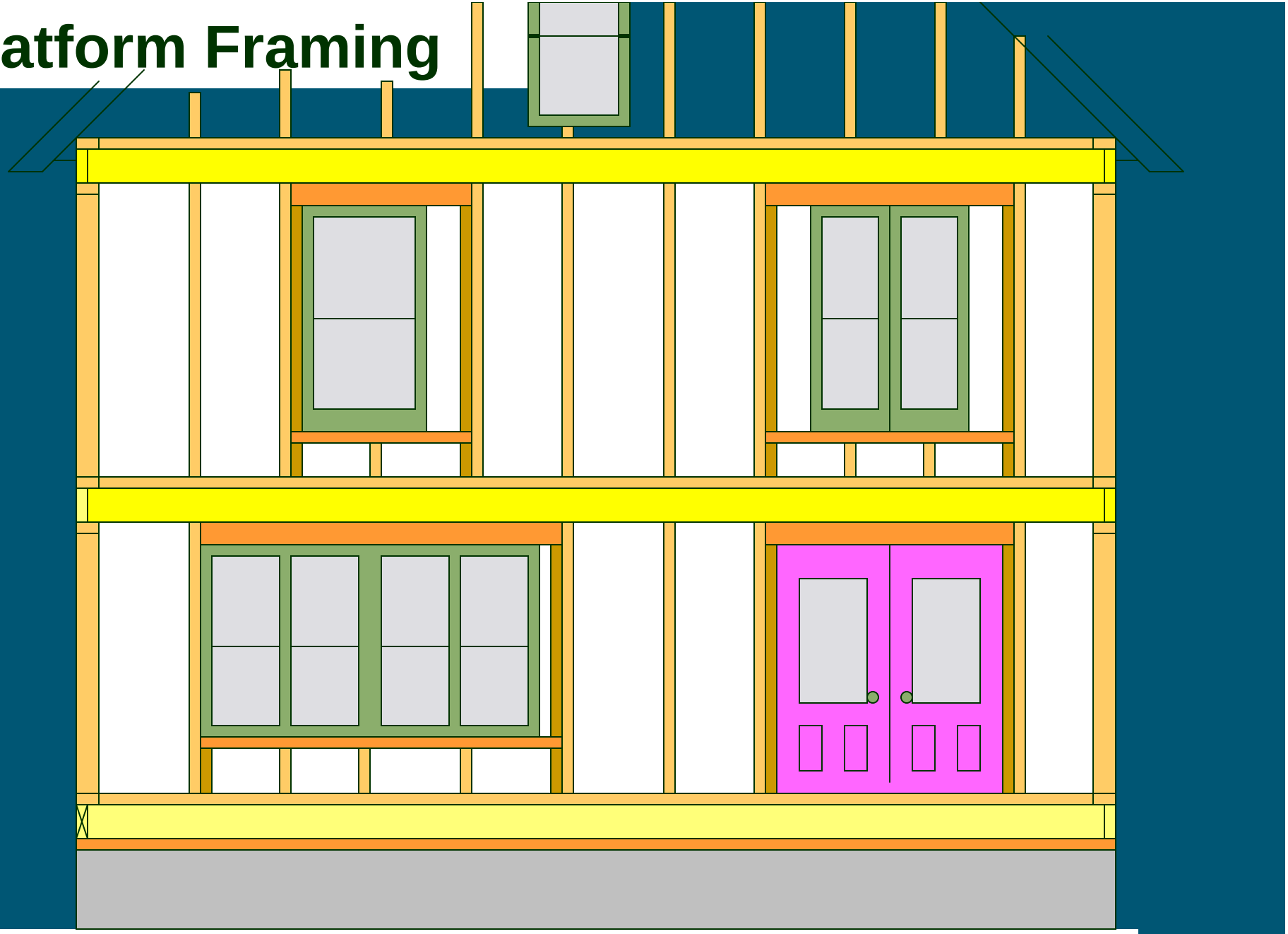
Balloon framed interior partitions are typically open to the attic. SO…



Install airtight blocking, foamed or caulked in place.

Replace insulation, dust over with cellulose.

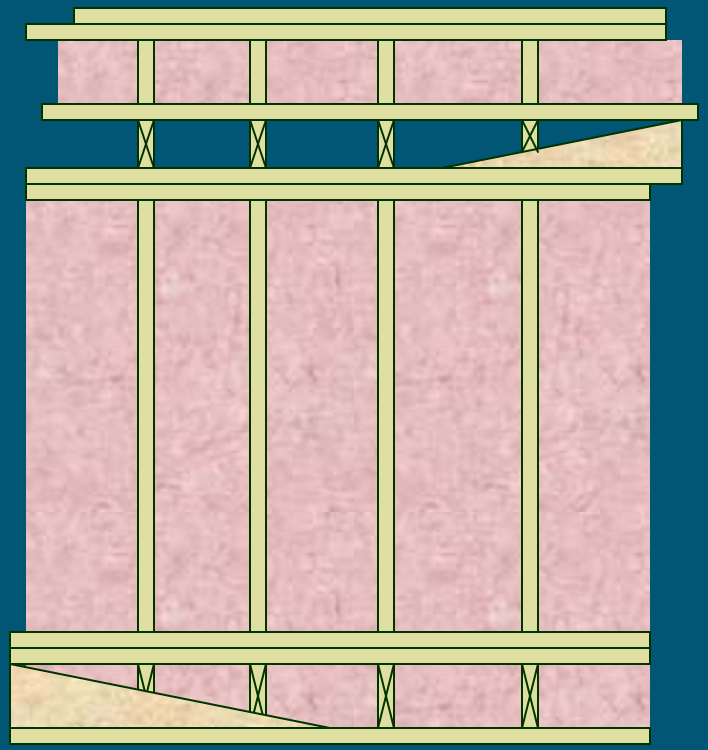
Platform Framing

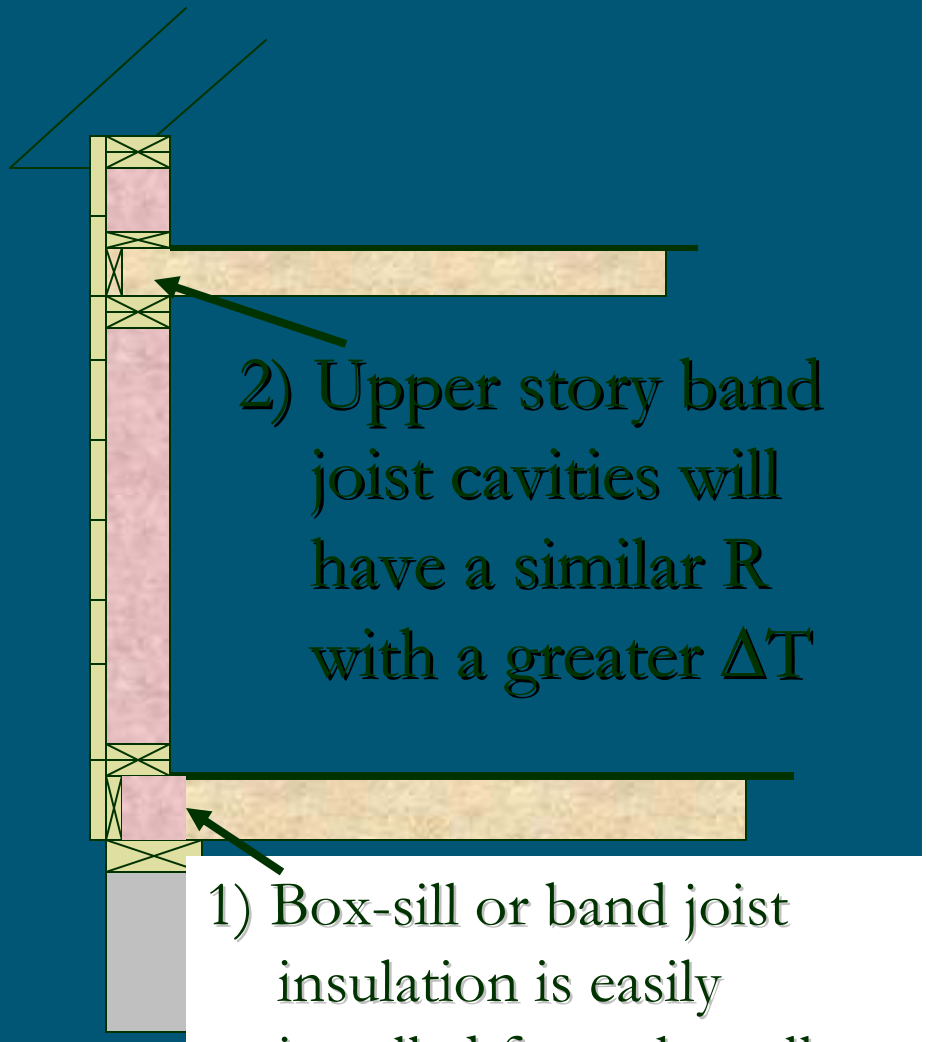


Typical gable end details – Eave side similar

Platform Framing

Upper story band joist or box sill issue





2) Upper story band joist cavities will have a similar R with a greater ΔT

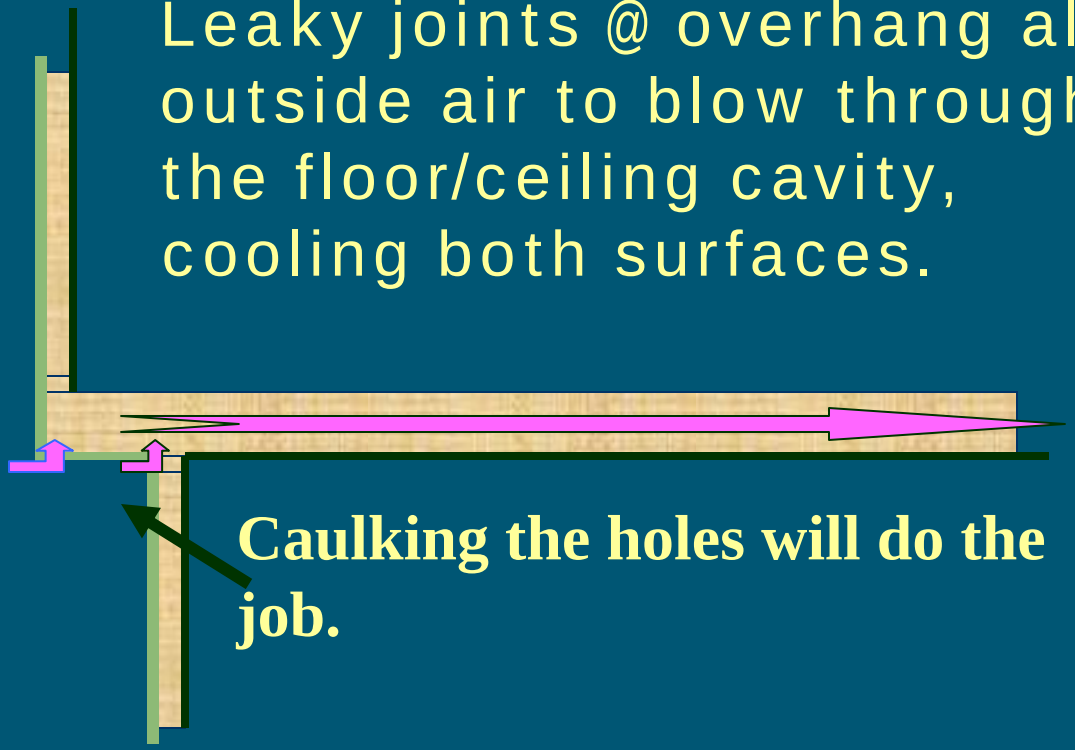
1) Box-sill or band joist insulation is easily installed from the cellar.

Garrison Style

Problem?

Garrison style

Leaky joints @ overhang allow outside air to blow through the floor/ceiling cavity, cooling both surfaces.



Caulking the holes will do the job.

Basement box sill (band joist)

- **Sill plate must be sealed to the foundation:**
  - **Exterior or interior ok – do whichever is easiest.**
  - **One or two part foam.**
  - **Silicone caulk.**
- **Caulk or foam all holes.**
- **Insulate sill cavities with 2” foam board.**
  - **Airseal edges to framing with foam. (preferred method)**
  - **6” Fiberglass batts with backing caulked or foamed to framing is acceptable.**
- **Process can be reduced to one step if two part foam is used.**

Upper story band joist (platform)

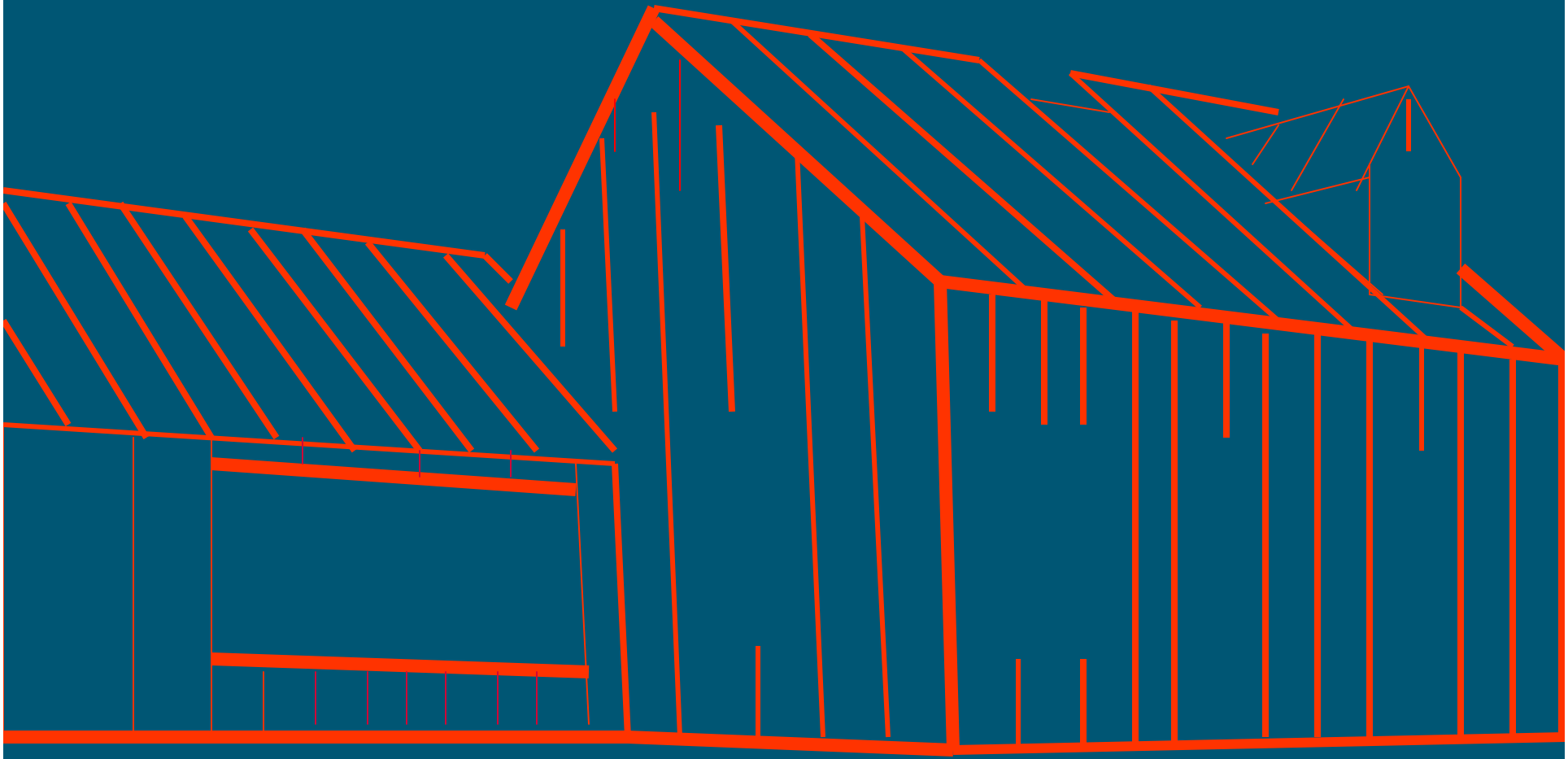
- **Same exposure/area as in basement.**
- **Greater temperature difference so greater heat loss.**
- **Harder to get to once drywall in place.**
- **Access by:**
  - **Removing trim (inside or outside).**
  - **Lifting carpet or inlay.**
  - **Removing clapboards or unzipping vinyl siding.**
- **Blow cellulose or foam into cavity.**

Upper story band joist (balloon)

- **Wall cavity connected to floor cavity.**
- **May be open to porch or addition roof.**
- **Seal & insulate by:**
  - **Removing exterior trim, ceiling or cladding**
  - **Blow cellulose at low pressure until dams**
  - **Use “bag trick”**

So what is it?

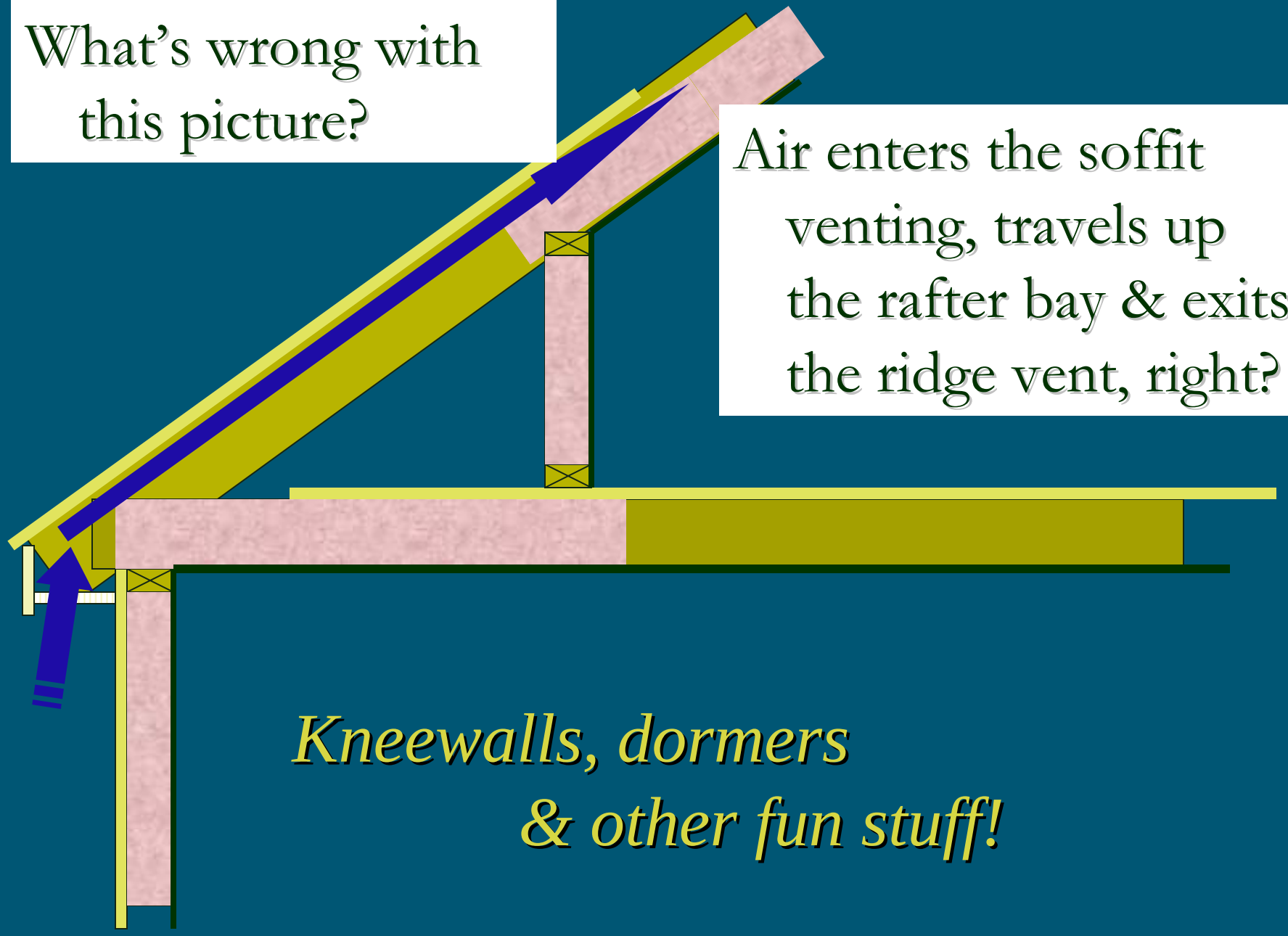
½ balloon & ½ platform !



IR of Ceiling below eaves

Infrared on windy day. Running a blower door would create the same picture.

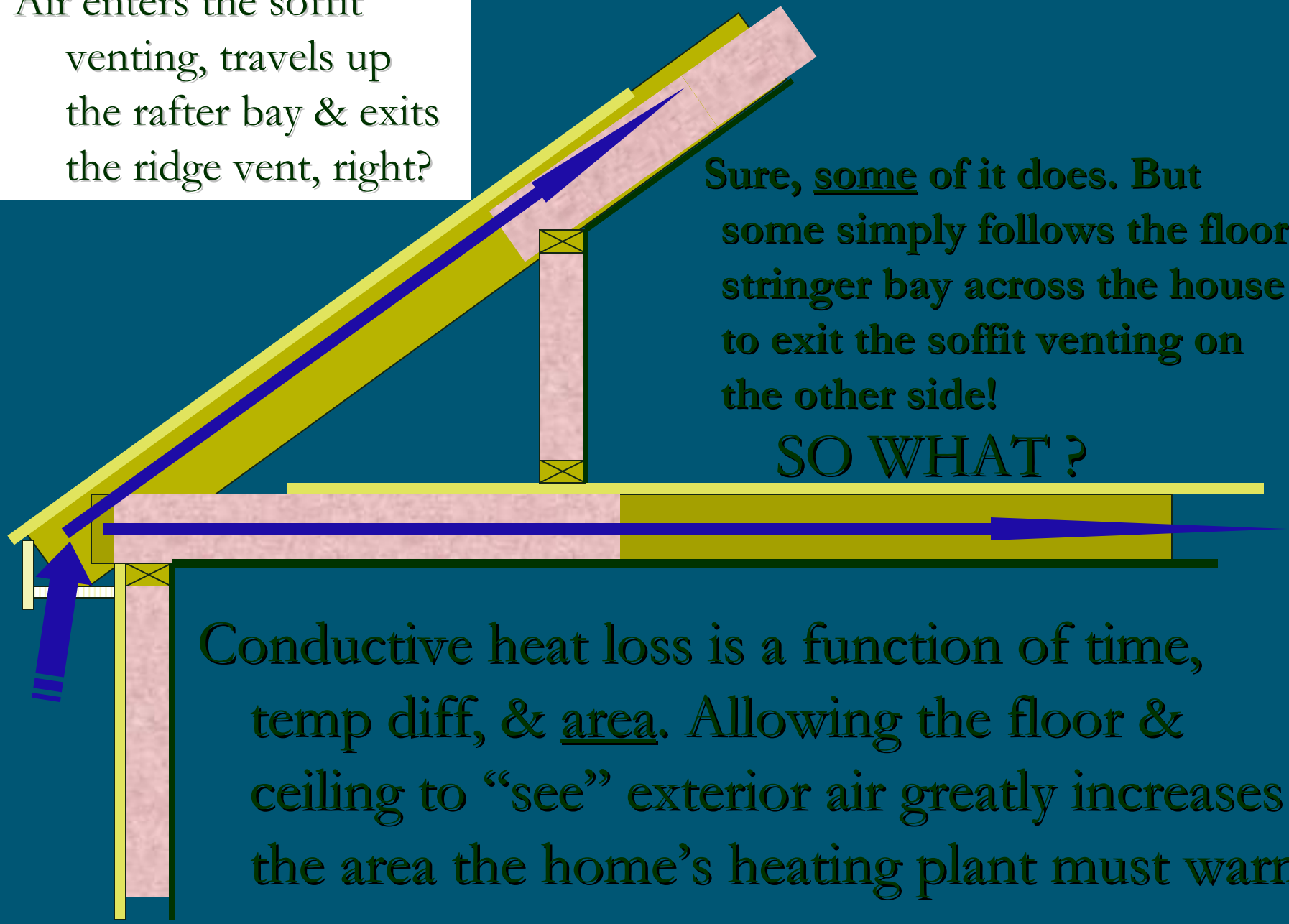
What's wrong with this picture?



Air enters the soffit venting, travels up the rafter bay & exits the ridge vent, right?

Kneewalls, dormers & other fun stuff!

Air enters the soffit venting, travels up the rafter bay & exits the ridge vent, right?



Sure, <u>some</u> of it does. But some simply follows the floor stringer bay across the house to exit the soffit venting on the other side!

SO WHAT ?

Conductive heat loss is a function of time, temp diff, & <u>area</u>. Allowing the floor & ceiling to "see" exterior air greatly increases the area the home's heating plant must warm.

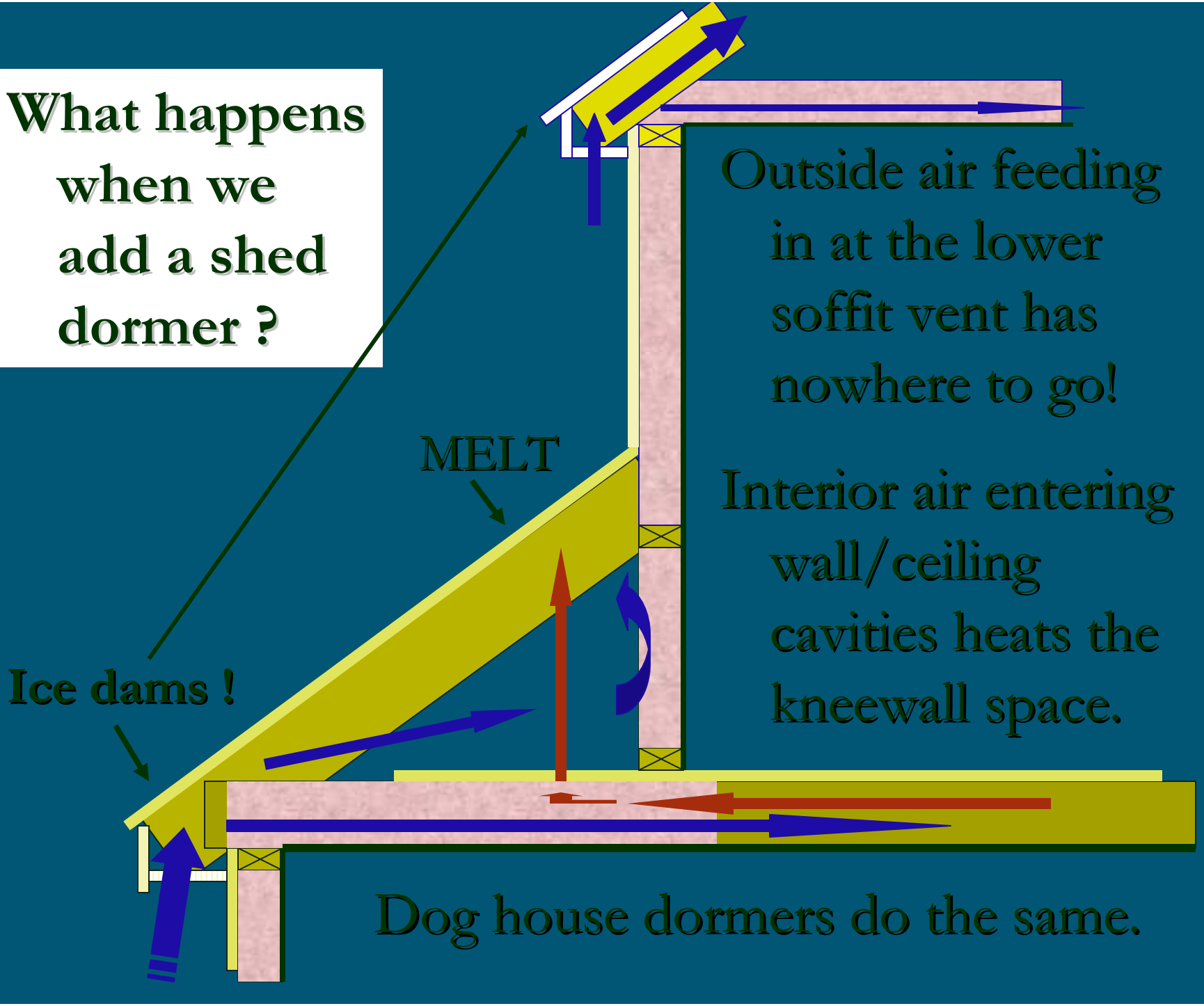
Seeing is believing!

Thanks to Chuck Prauza !

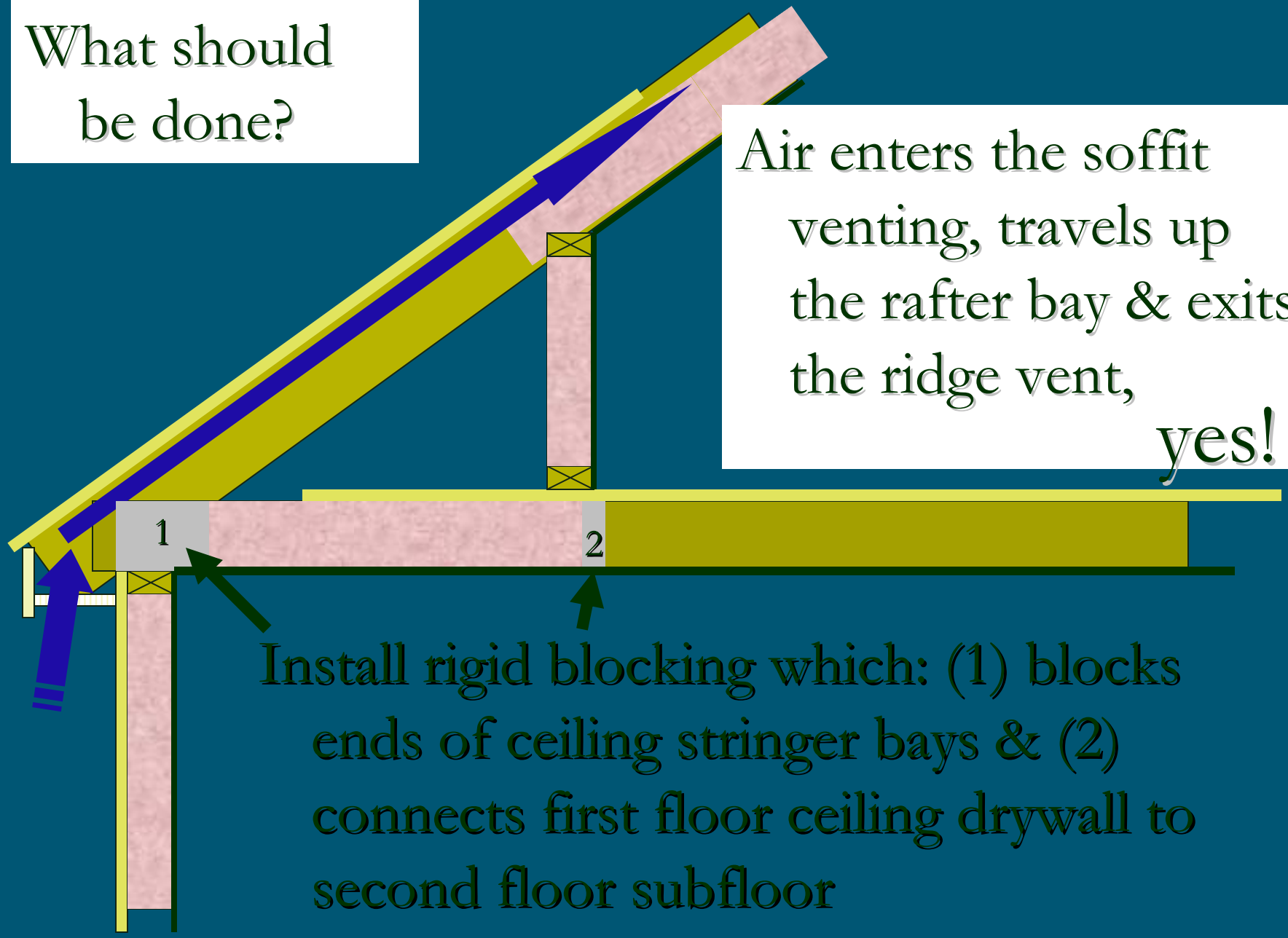
BREAK !

That's not all !

What happens when we add a shed dormer ?



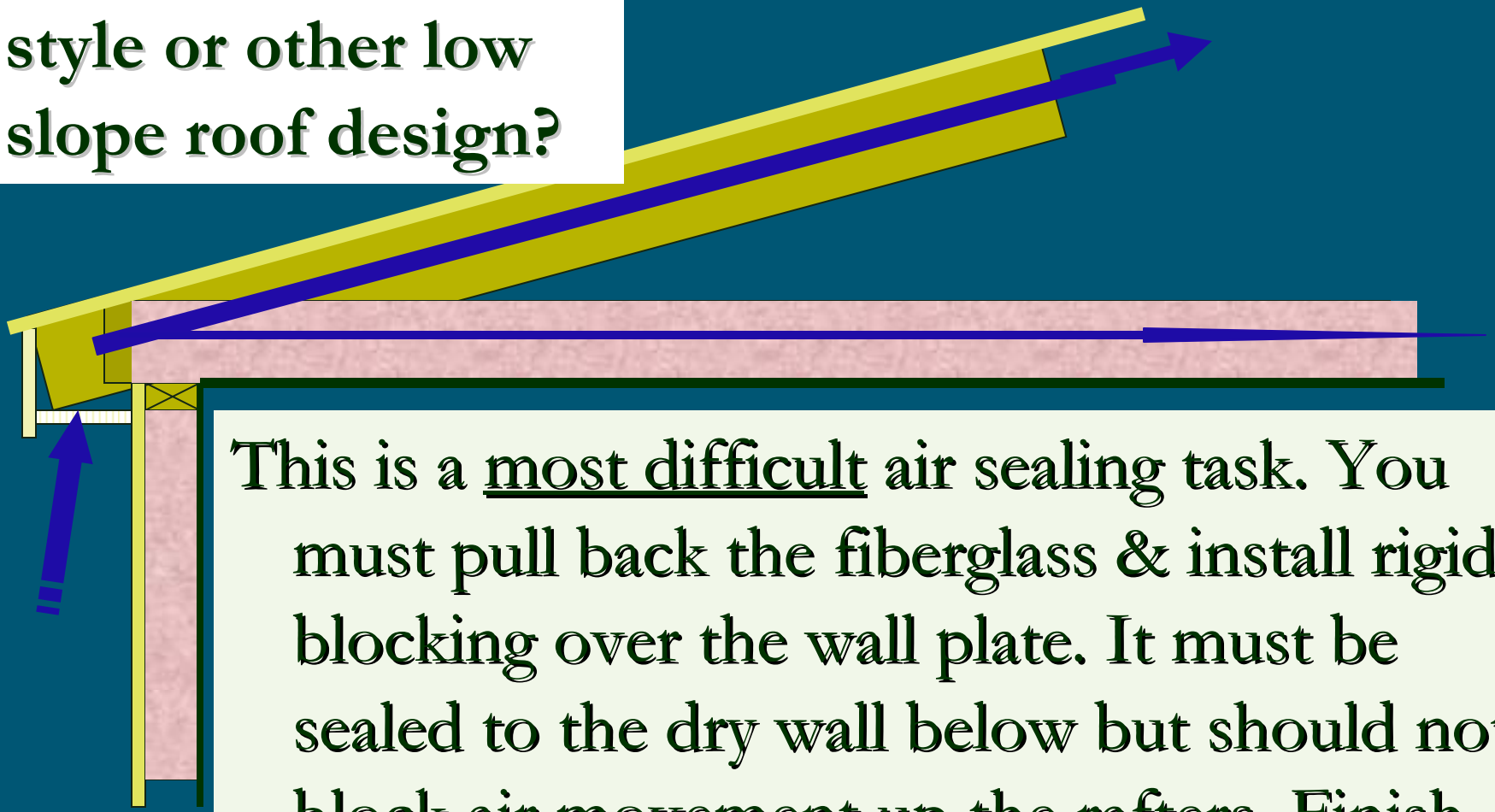
What should be done?



Air enters the soffit venting, travels up the rafter bay & exits the ridge vent, yes!

Install rigid blocking which: (1) blocks ends of ceiling stringer bays & (2) connects first floor ceiling drywall to second floor subfloor

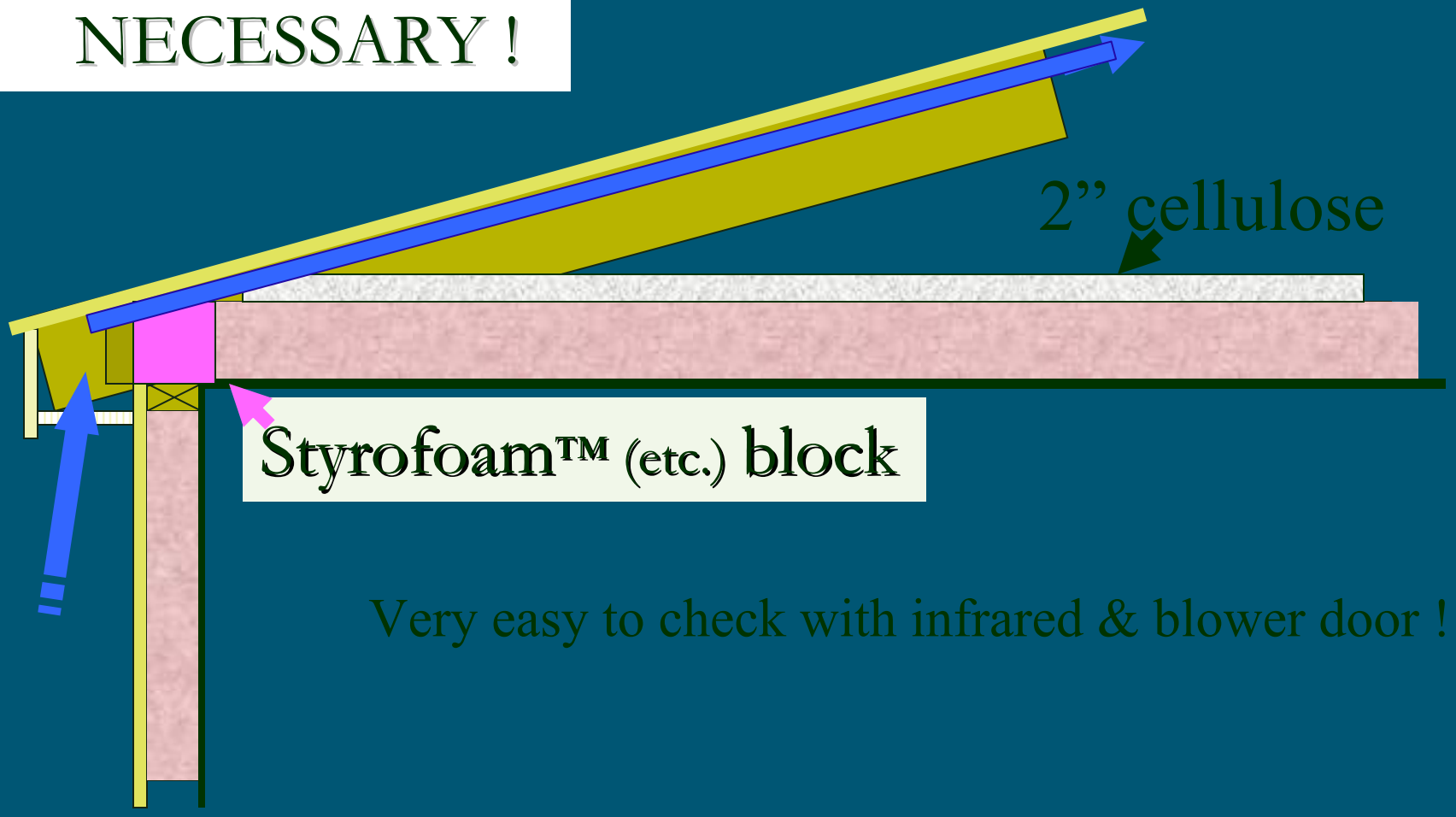
How about a ranch style or other low slope roof design?



This is a <u>most difficult</u> air sealing task. You must pull back the fiberglass & install rigid blocking over the wall plate. It must be sealed to the dry wall below but should not block air movement up the rafters. Finish by blowing ≈ 2" cellulose over all to prevent wind-washing.

Very difficult…

VERY NECESSARY !



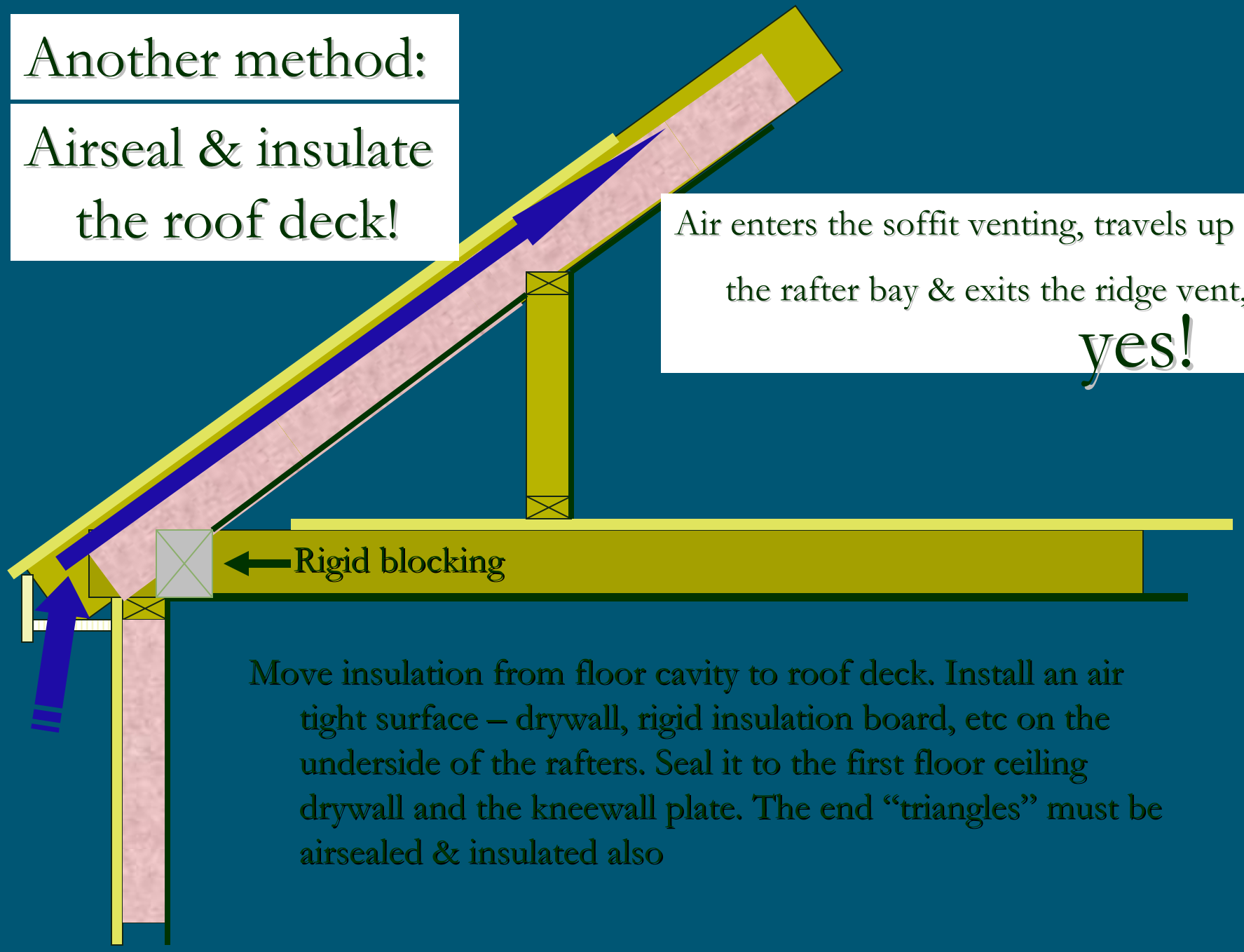
Very easy to check with infrared & blower door !

Tight fit !

Another method:

Airseal & insulate the roof deck!

Air enters the soffit venting, travels up the rafter bay & exits the ridge vent, yes!

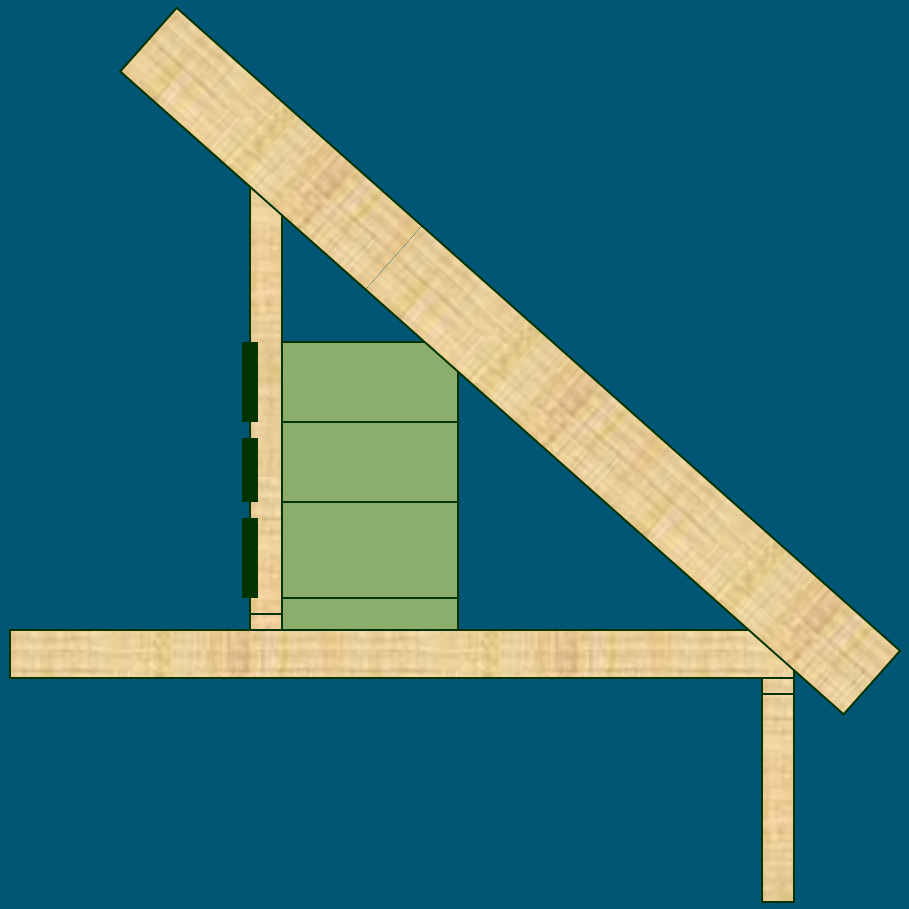


Move insulation from floor cavity to roof deck. Install an air tight surface – drywall, rigid insulation board, etc on the underside of the rafters. Seal it to the first floor ceiling drywall and the kneewall plate. The end "triangles" must be airsealed & insulated also

Built-ins can make your life miserable !

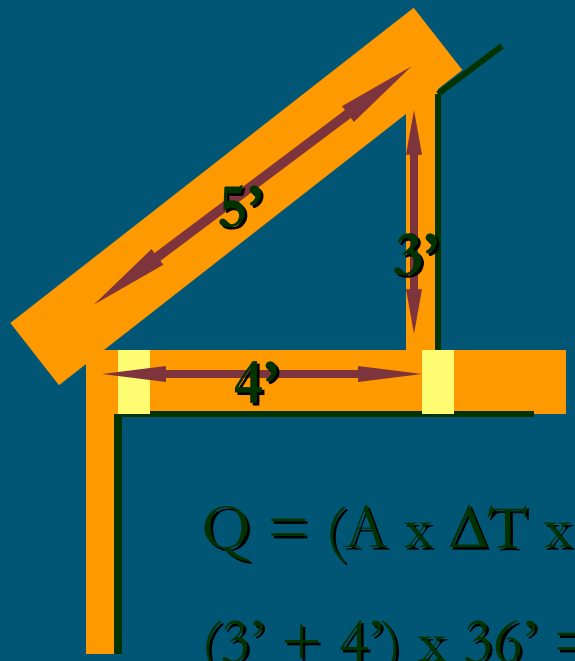
- Bureaus, cubbies recessed into knee walls
- Medicine cabinets
- Fold out ironing boards
- Dumbwaiters
- Heat ducts
- Plumbing chases
- Folding attic stairs

Insulate & air seal where ?



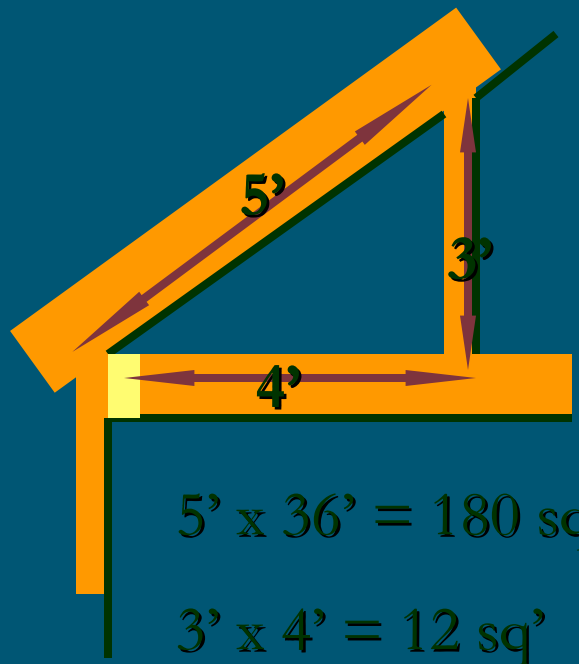
Which is preferred?

24’ x 36’ Cape



Q = (A x ΔT x t)/R

(3’ + 4’) x 36’ = 252 sq’



5’ x 36’ = 180 sq’

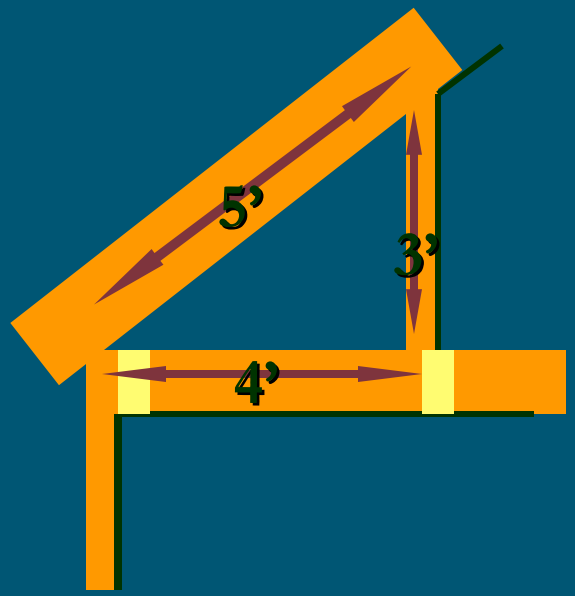
3’ x 4’ = 12 sq’

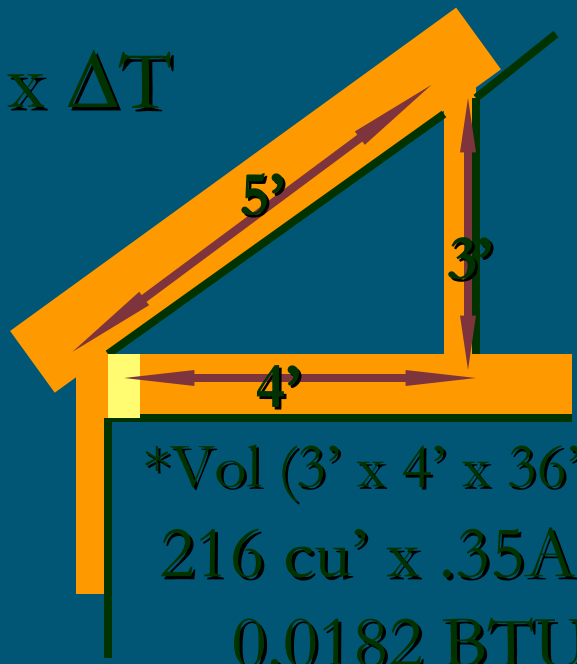
Total = 192 sq’

The conductive heat loss will be about 20% less doing the slope.

What about air transported heat loss?

*Vol x $\frac{AC}{H}$ x $\frac{0.0182\ BTU}{sq',°F}$ x ΔT





*Vol (3' x 4' x 36')/2 = 216 cu'

216 cu' x .35ACH x

0.0182 BTU/sq',hr x

7500 HDD x 24 hrs =

238,000 BTU/year

Given equal quality airsealing, the air transported heat loss attributable to the enlarged volume will be about $11/yr.

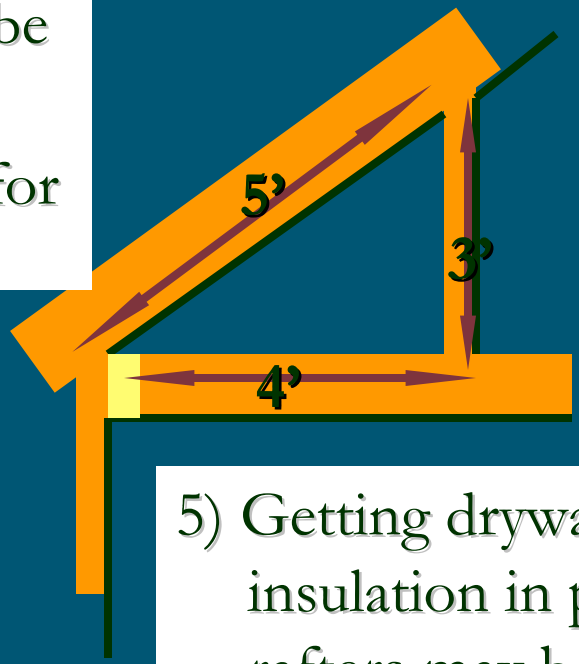
So…Which is preferred?

1) Insulation & air barrier must be in contact.

2) Blocking at eaves is required for both.

3) Connecting kneewall drywall to 1st floor ceiling drywall is often difficult.

4) Kneewall insulation voids are common



5) Getting drywall or rigid insulation in place on rafters may be difficult.

It Depends !

6) Pick the most advantageous method in each house.

CAZ test (before you leave EVERY day !)

- Combustion Appliance Zone
  - Room with any atmospheric combustion unit
- Depressurization Tightness Limit
  - (How tight can I make a house before I risk causing backdrafting?)
- Combustion Appliance Zone (CAZ) test

CAZ test

- Atmospheric (natural draft) chimneys operate by warm air rising.
- The buoyancy of heated air above the fire caries the smoke & combustion byproducts up the chimney.
- Draft strength depends on chimney height and the difference between stack & outside temps; the taller & hotter the chimney and colder the outdoors, the stronger the draft pressure.

Pressures

- Typically, draft is measured:
  1. Over the fire
  2. At the breech
- Manufacturer's specifications control.
- Most units require - 0.02" water (-10PA)
- Any natural draft appliance will back-draft if it is exposed to negative pressures exceeding the chimney's draft strength.
- < - 5PA CAZ to outside gives margin of safety

Combustion Appliance Zone Test

- Manometer set CAZ in reference to exterior
- House closed up
- All exhaust appliances running
- Open & close interior doors to determine greatest depressurization in CAZ.

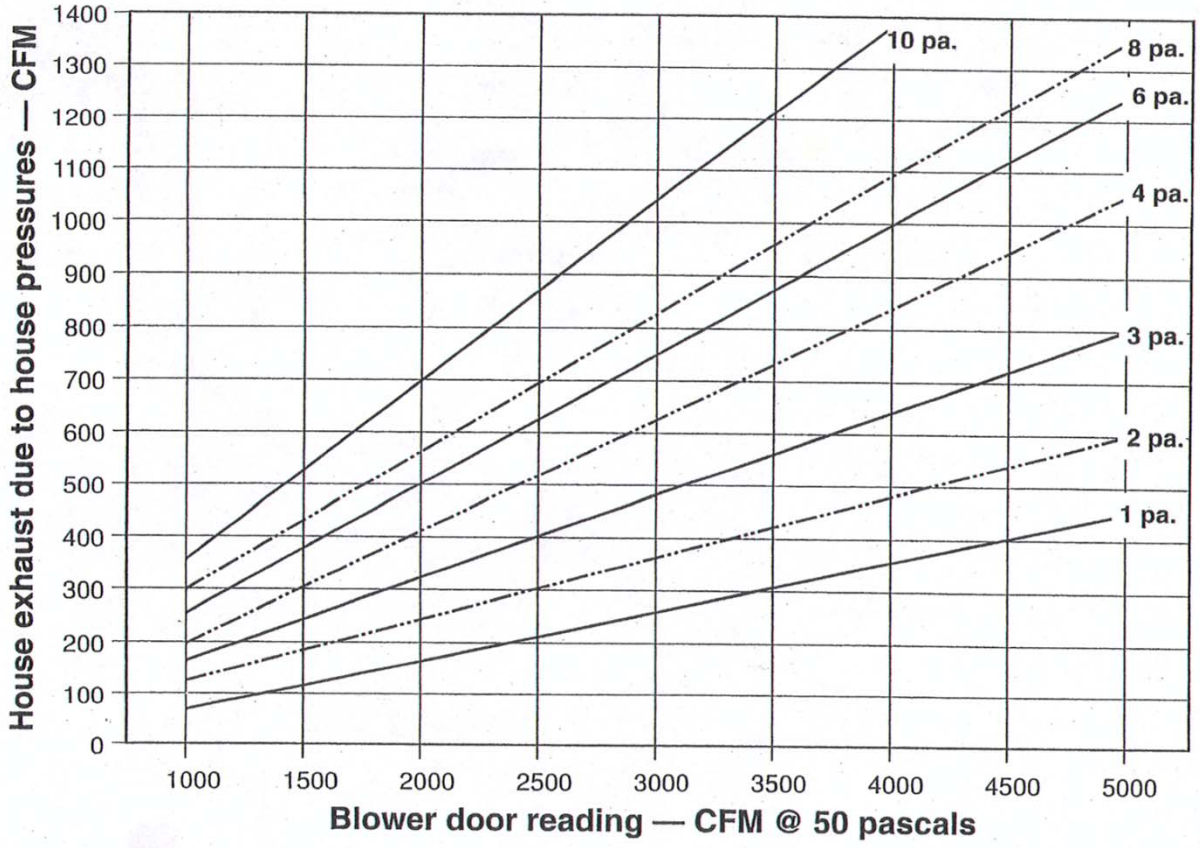
0-4PA  **5-9PA**  **10+PA** 

- Fire appliance & check for draft at barometric damper with smoke or wet hand.

Neil Moyer chart (PP 2-31 BA FG)

A-13 Air Leakage at Various House Pressures

The chart below is designed to estimate the air-leakage rate for houses under pressure from leaky ducts, unbalanced ducts, or other sources of house pressure. The diagonal lines represent airflows at various house pressures. When this page is turned 90°, the left-hand vertical axis gives leakage in CFM for the measured blower-door readings on the bottom horizontal axis. If you measure a house's CFM50 and its house pressure, you can estimate the air leakage caused by its house pressure using this chart.



Thanks to Neil Moyer

Part Five AGENDA:

- **Lead safe primer**
- **Insulation**
- **Blowing cellulose**
  - **Attics**
  - **Walls**
  - **Dense blow**

Review

- **Basic framing styles**
  - **Post & Beam**
  - **Balloon**
  - **Platform**
- **Looping & Windwashing**
- **Airsealing Detail**
- **CAZ Testing**

Lead safe overview

Lead-Based Paint Requirements for Wx Contractors & Auditors

- Weatherization-related work activities are not subject to licensing or work practice regulations. However, MaineHousing's Weatherization Program is federally funded, which requires all work that may impact a leaded surface to be performed using HUD's Lead-Safe Work Practice standards.

- Safe work practices prevent the creation of environmental lead hazards and the unintentional exposure of the public to lead hazards.

- If a contractor does not employ safe work practices, then the contractor can be held liable for the cost of clean-up of any environmental lead hazards, and can be subject to suit for causing lead poisoning.

Lead-Based Paint Requirements for Wx Contractors & Auditors

- Safe work practices for removal of lead-based paint are delineated in the HUD "Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing" and in the DEP's Lead Management Regulations.

- The DEP Lead Licensing Program (207) 287-2651) can provide you with the appropriate excerpts from both of these documents.

Lead-Based Paint Requirements for Wx Contractors & Auditors

- The Pre-Renovation Education Rule requires the Weatherization contractor to notify owners and tenants of pre-1978 housing of the presence of lead paint before the weatherization work is performed and provide them with the EPA pamphlet entitled "Protect Your Family From Lead in Your Home".
- OSHA regulations, including 29 CFR 1926.62 (interim final rule on lead in construction), apply to contractors who have employees. These regulations are designed only to protect worker health and safety; they do not prevent exposure to others or contamination of the environment.

Lead-Safe Work Practice Standards

- When you are performing an activity that disturbs lead, you must follow these safeguards to prevent lead dust from spreading throughout your clients home. You should also make sure that any outside contractor performing maintenance activities in your day-care facility follows these safe work practices.

  - **Create as little dust as possible. Avoid using power tools, particularly sanders.**
  - If the work releases any dust, keep it damp. Mist work surfaces as you scrape.
  - Keep the dust contained. Keep doors and windows closed. Work over a plastic drop cloth.
  - Clean up each room or area as you work.
  - Keep all children and pets out of the work area.

Exterior Lead-Safe Work Practices

- Cover the ground and any flowers or plants with plastic sheeting to catch dust and trash. It should extend at least 10 feet from the base of your house for work on the first story, and an additional 5 feet for each additional story. Use bricks or rocks to hold the edges of the plastic sheeting in place.
- Cover sandboxes and all other bare soil play areas with the plastic sheeting. If possible, move play equipment at least 20 feet away from the work area.
- Close all windows, including windows in adjacent dwellings, within 20 feet of the work area. If dust gets inside, use wet mops and rags to clean it up.
- Anchor ladders securely to the ground. Never put a leaning ladder on the plastic sheeting. Cut through the plastic for ladder feet, and then patch the holes with duct tape.
- Avoid working in windy conditions. Strong winds can blow lead dust to areas that are not covered. If the chips and dust are blowing off the plastic sheeting, set up a barrier to block the wind or do the work another day.

Insulation R values per inch

- Cellulose: 3.0 (densepack) to 3.5 (open)
- Fiberglass: 3.5 (regular density)
- Foam boards (i.e. Styrofoam™): 5
- Two part foam: 5 to 7
- Foam board with reflective coating: 7

- Glass: R-1 per layer
- Concrete: R-1 per 8” thickness

Insulating Floors

- **If possible, install a membrane on the underside of the floor stringers and dense blow the resulting cavities with cellulose.**
- **If fiberglass batts are used, the insulation must be in contact with the underside of the floor above.**
- **Use a durable fastening system – "lightening rods", Gro-Net™, chicken wire, etc.**

Installing fiberglass

- Friction fit batts are preferable to the foil or paper backed product.
  - Slightly higher “R” per inch
  - Faster installation
  - Backing contributes nothing
- Must be in contact with winter-warm surface.
- Poor choice for open floor attics:
  - Expensive per “R”
  - Allows windwashing
  - Takes longer to insulate same area.
- Can “hang up” if blown into a closed cavity.

Insulation blower operation…

- Insure adequate amperage at machine
- Clamp all hose connections
- Reduce hose/nozzle diameter gradually
- Use shortest hose practical
- “Tune” machine to job
  - Max pressure/product w/o building damage

Insulation blower safety…

- Be certain machine is on a solid footing
- Check all cords for wear &/or breakage
- Do not operate unless all guards are in place
- If the machine jambs or the hose plugs:
  - SHUT IT OFF!
  - NEVER insert ANYTHING into the hopper when the agitator is running
  - You may reverse the hose to use the machine to clear a hose plug

Ideal blower specifications…

- Positive displacement, air-lock blowing machine capable of dense packing walls with cellulose to a density of at least 3.25 pounds per square foot.
- Flip-top hopper of at least 16 cubic feet.
- Adjustable speed operation.
- Stainless steel agitators, at least four.
- Two insulation blowers.
  - 12 amp, three-stage.
- Accommodates cellulose and fiberglass insulation.
- Adjustable slide gate for material feed.
- 16 inch airlock.
- Insulation shredder system.
- Adaptable to wet spay use.
- Multiple blower capacity with single material output.
  - Three-stage blowers.
  - Capacity of at least 2.8 psi of air pressure at machine hose takeoff.
  - Output capacity.
    - Cellulose, 2400 pounds per hour.
    - Fiberglass, 700 pounds per hour.
- Safety guards must cover all moving parts.
- 3” x 50’ blowing hose
- Standard wheel kit
- Hose reel
- Reducer tube 3” to 2”
- Nozzle reducer 2” to 1” steel
- ***Electrical***
- Single-phase power, 240 volts.
- Pre-alarm buzzer (alerts operator before machine stats).
- Main disconnect/power interruption shutdown (disconnects power to panel before allowing access or manual restart).
- Emergency kill switch.
- Manual override at machine.
- At least 150 feet of remote control cord with three-position switch.
- Voltmeter.
- At least two auxiliary 120 volt outlets.
- Overload protection on transformer and all motors.

Dense pack cellulose

- Drill 3” hole about 2 feet from bottom of cavity.
- Insert hose in wall to top of cavity.
- “Tune” machine settings to cavity by watching inside wall and running maximum allowable air pressure. Set product just below hose blockage.
- “Snow” cellulose into cavity until loosely filled.
- Dense pack cellulose by slowly pulling hose from wall. Set removal speed by sound & feel.
- Push hose to bottom of cavity & dense pack.
- Insulation should achieve 3.5 lbs per cubic foot.

Insulation Blowing Demo Tape

BREAK !

Attic before & after

Two hole method (Not allowed)

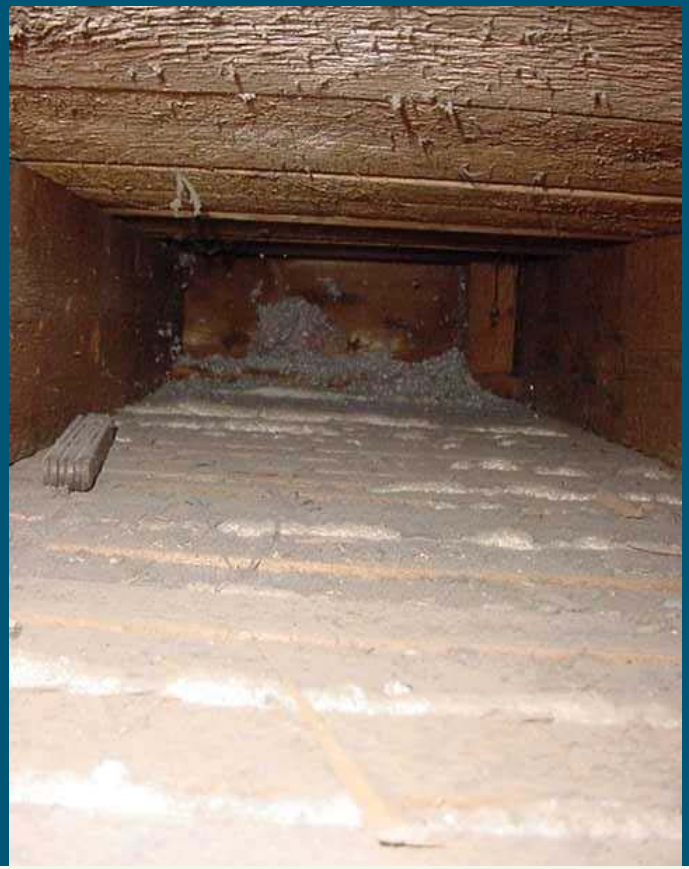
Dense blow cellulose

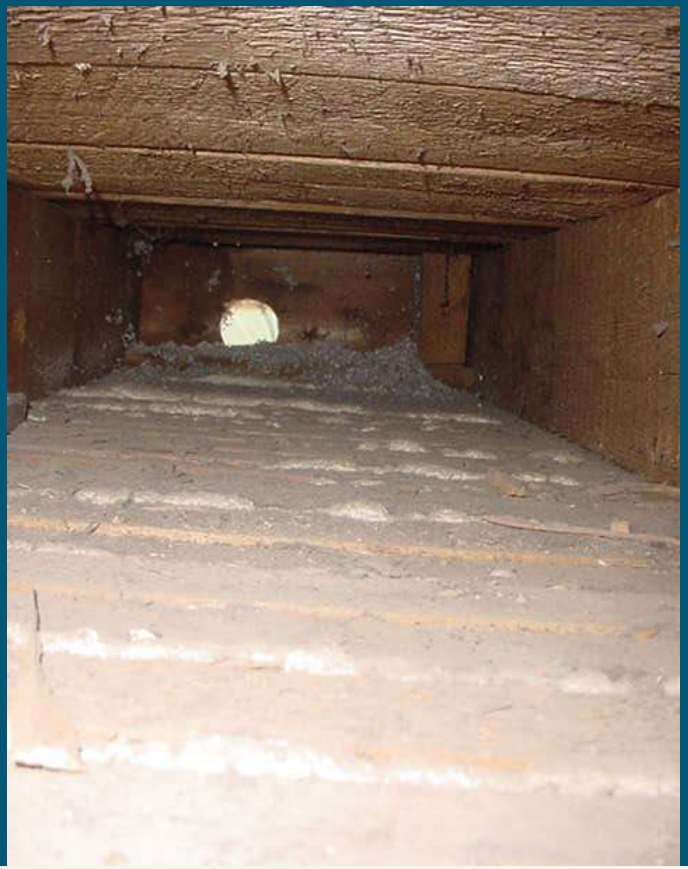
“Snowing” & start of packing

Packing….

The Bag Trick !

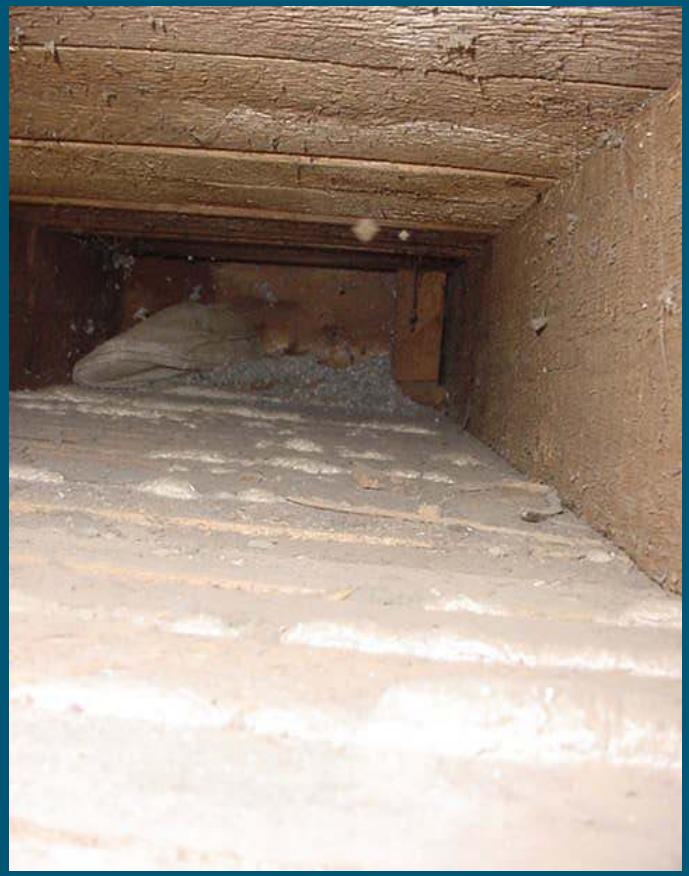
THE BAG TRICK !





All pictures taken through removed floor register

THE BAG TRICK !



THE BAG TRICK !

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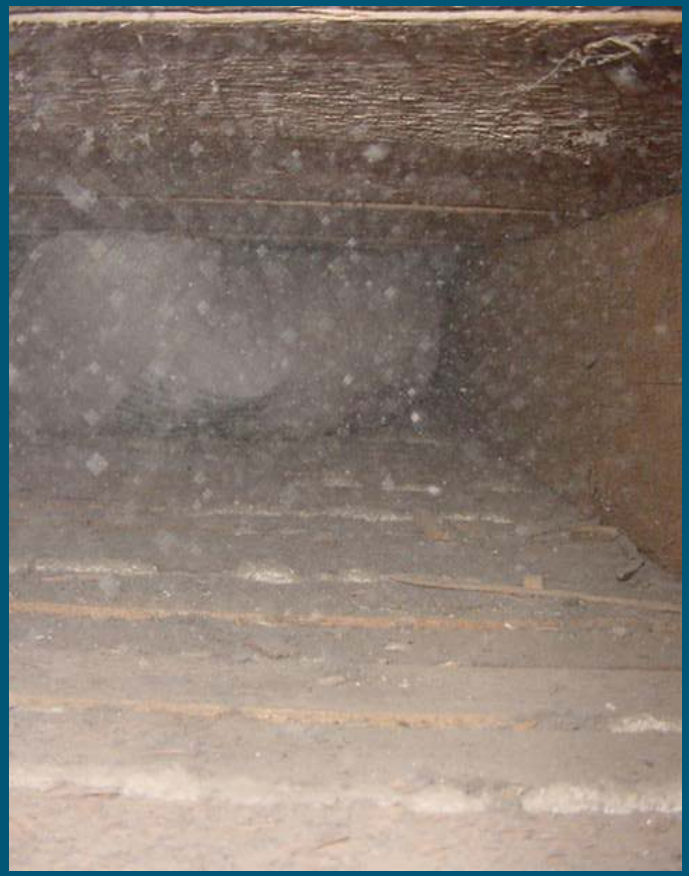

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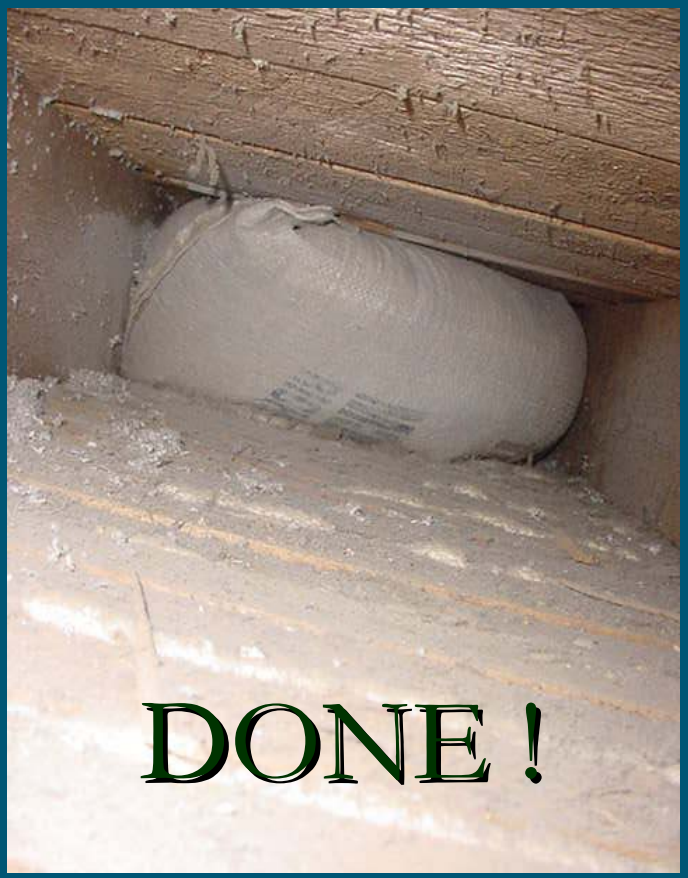


Program requirements

- Fill all closed cavities (walls & floored attics).
- Insulate open attics to R-38/40.
- Cellulose: dense pack all closed cavities to 3.5 lb/cu ft.
- Always use one-hole hose insertion dense pack method. The two hole nozzle method is no longer acceptable.
- Completely airseal attics before installing any insulation.
- Either be sure that "buried" K&T electrical circuits are not - & can not be – overloaded, eliminate them or dam insulation away from them.
- "Tag" any buried electrical junction boxes.
- Dam all insulation away from chimneys & recessed lights.
- Dam the attic hatch to prevent insulation from falling into the living space when opened.

Equipment

Two part foam set-up

Part Six AGENDA:

- **Mobile Home Weatherization**
- **Quality Control**

Review

- **Lead awareness**
- **Dense blowing cellulose**
- **CAZ testing**

Mobile Home Weatherization

- Air seal
- Seal ducts
- Insulate ceilings
- Insulate walls
- Typical savings 30%

Mobile home weatherization

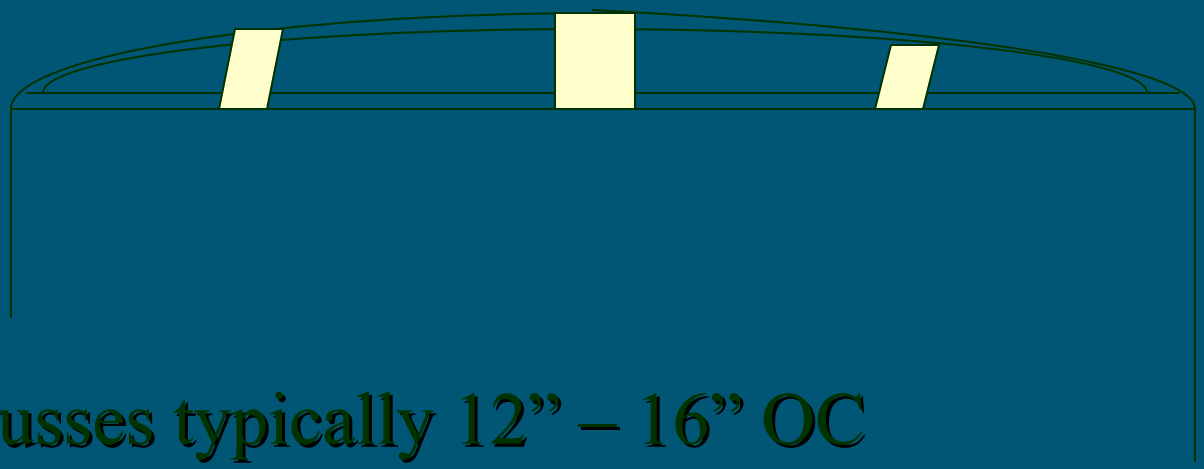
- **Long fiber (Insulsafe III) fiberglass preferred:**
  - **Lighter per cubic foot.**
  - **Won't absorb water.**
  - **No galvanic reaction.**
- **Heat duct sealing is a priority:**
  - **Heat ducts are outside the air barrier.**
  - **Typically poorly installed**
  - **Often damaged in transit.**
  - **All heat duct joints important.**
- **Eliminate factory floor return systems:**
  - **Plug all return floor register openings.**
  - **Undercut interior doors for free return air flow.**
  - **Install louver door on furnace closet.**

Mobile Home Weatherization

Mobile Home Weatherization

Typical older roof details

- Minimal strength bow trusses, usually constructed of scrap material.
- One piece insulation blanket laid on ceiling before trusses installed.



- Trusses typically 12” – 16” OC
- Ceiling usually has poly vapor retarder.

Insulating the roof

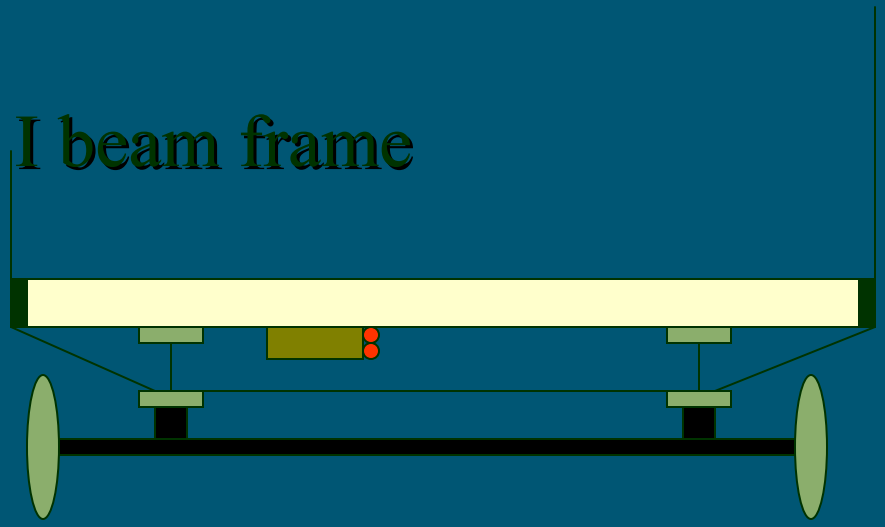
Insulating the roof

Bending Lexan™ for wall stuffer

Using Lexan™ wall stuffer

Typical floor details

- Steel I beam frame



- Side to side floor stringers
- Heat duct fastened to under side of floor stringers
- Water pipes beside heat duct

Blowing belly

Multi-Family Weatherization

- Insulate & airseal attics.
- Insulate walls.
- Minimize stack effect.
- Evaluate indoor air quality.

BREAK !

Quality Control

- Blower door
- Infrared
- Digital camera
- Core sampling

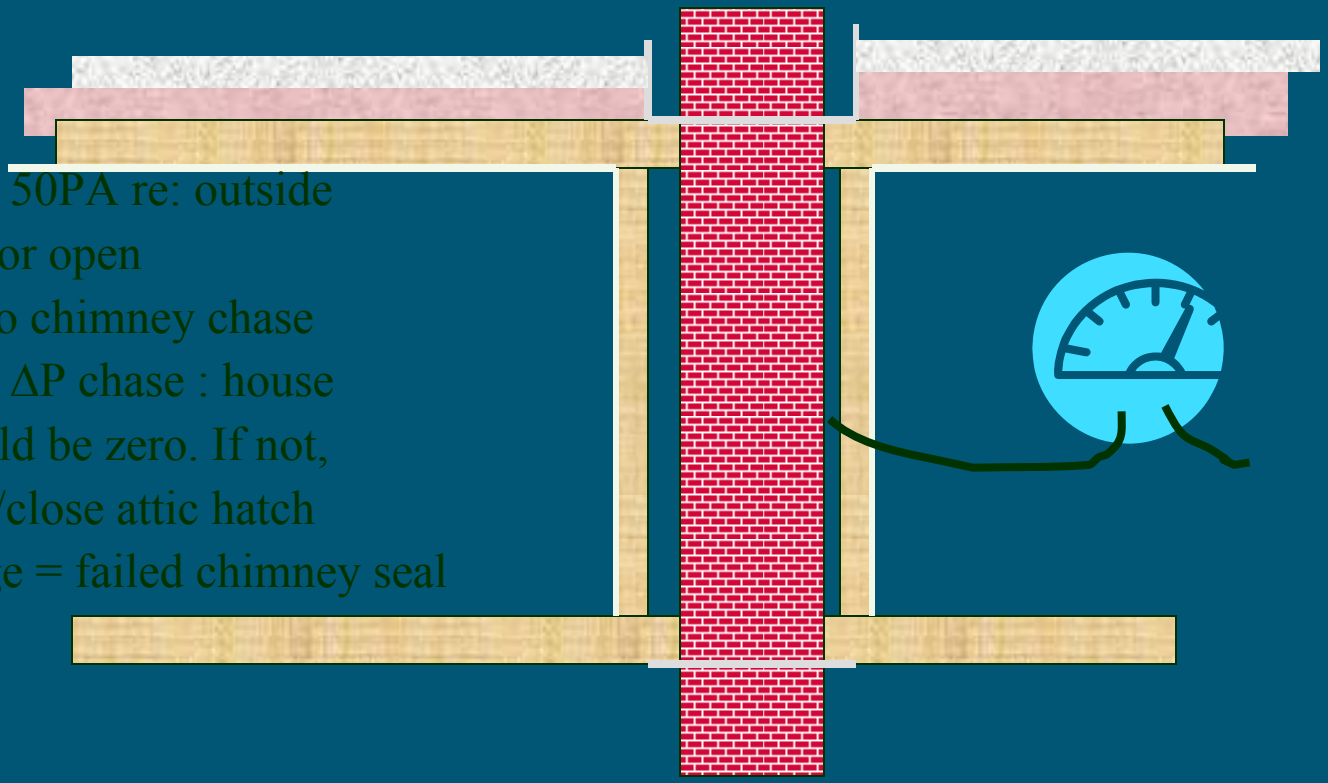
Blower door

- Creates pressure across the building envelope – generally test @ 50 Pascal
- Very accurate measure of envelope hole size
- Smoke will locate holes
- “Two finger” test
- Finding holes in attics

Quality control w blower door

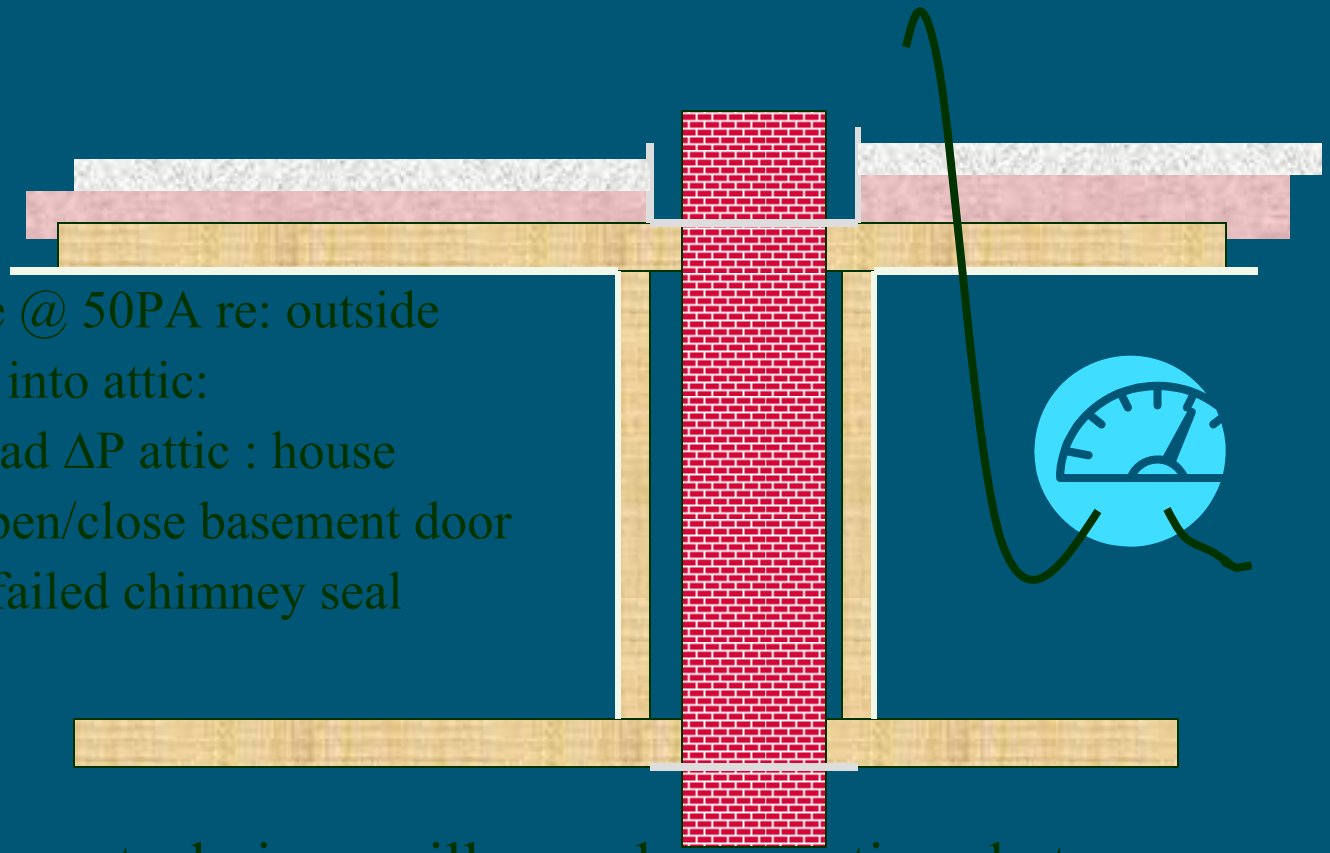
Check chimney seal

House @ 50PA re: outside
Cellar door open
Probe into chimney chase
(1) Read ΔP chase : house
(2) Should be zero. If not,
(3) open/close attic hatch
ΔP change = failed chimney seal



This works for any chase; not just chimneys !

What if we can't probe the chase ?

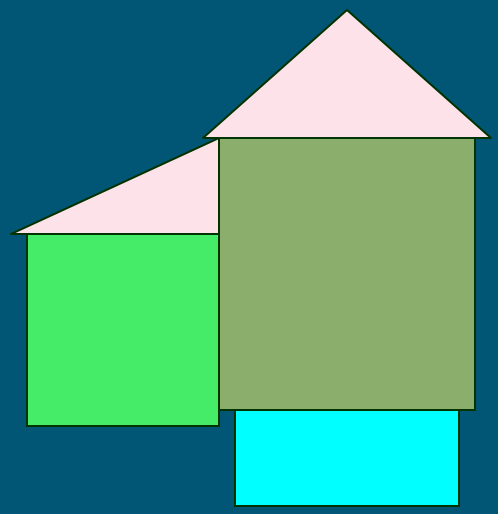


House @ 50PA re: outside
Probe into attic:
(1) read ΔP attic : house
(3) open/close basement door
ΔP = failed chimney seal

The same technique will reveal connections between attic & cellar or kneewall spaces space & attics, etc.

Then there's Pressure Diagnostics

- With a blower door & charts the amount of hole in almost any surface can be measured.
- In minutes, you can determine how well the attic, garage or basement are cut off from the main living space.



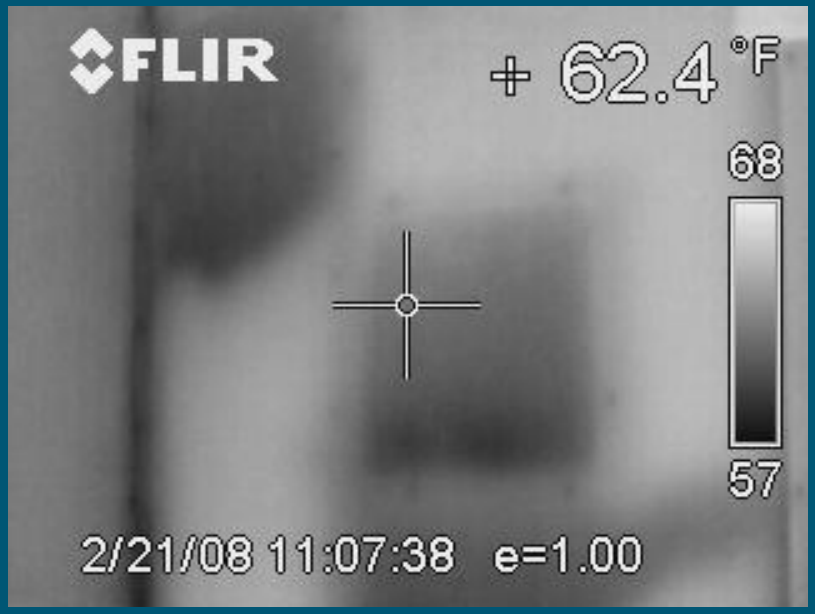
& Infrared

Infrared (IR)

- Sees surface temperature only
  - Can't see through anything.
- Very powerful when used with the blower door
  - IR alone followed by IR with BD.
  - First IR establishes normal condition air leakage pattern, second IR with blower door shows what happens under artificial air pressure.
  - Interpretation is key
- Used by fire departments to locate hotspots

Infrared

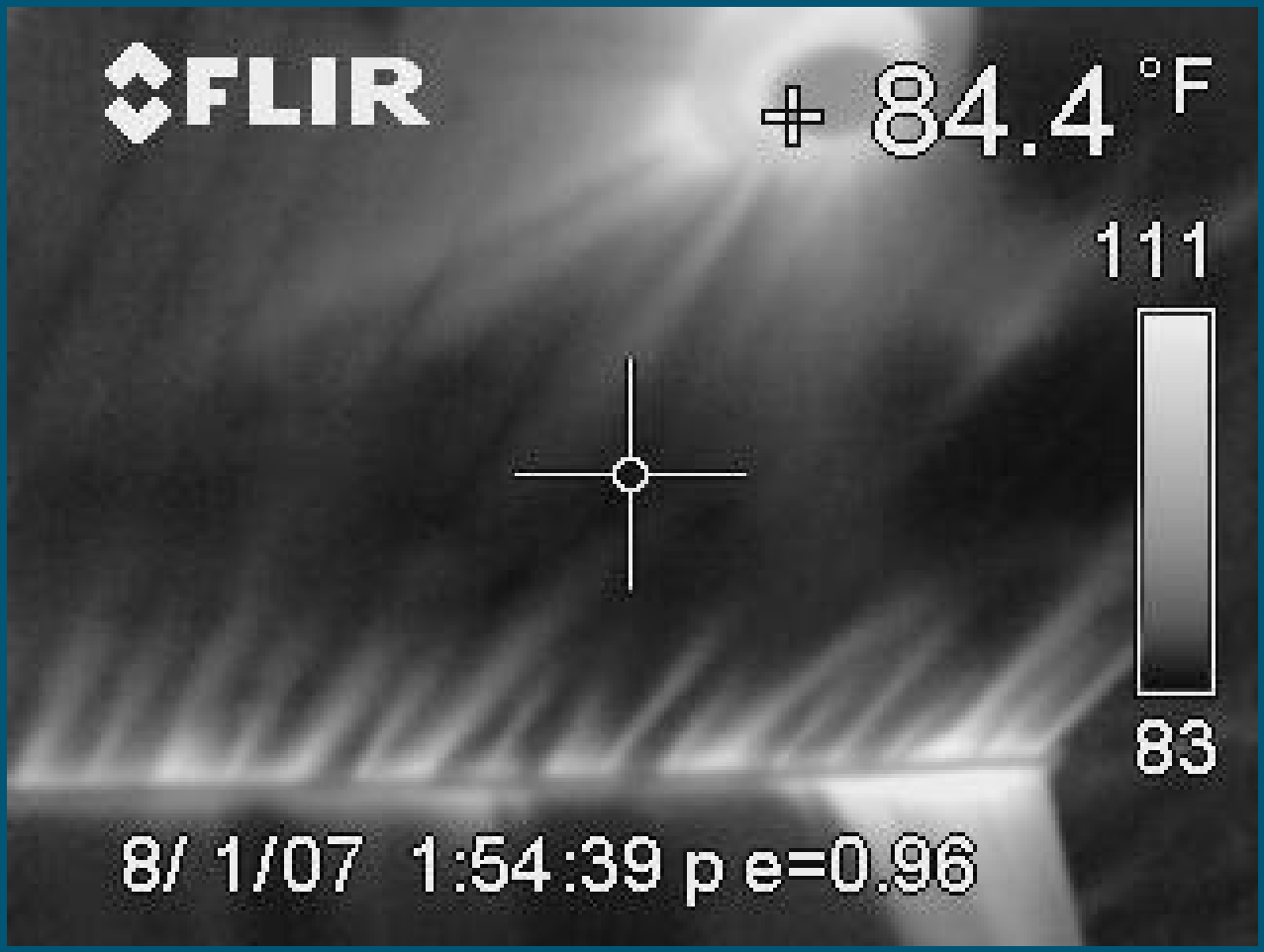
- Sees surface temperatures only
- Requires trained operator
- Very powerful when used with blower door



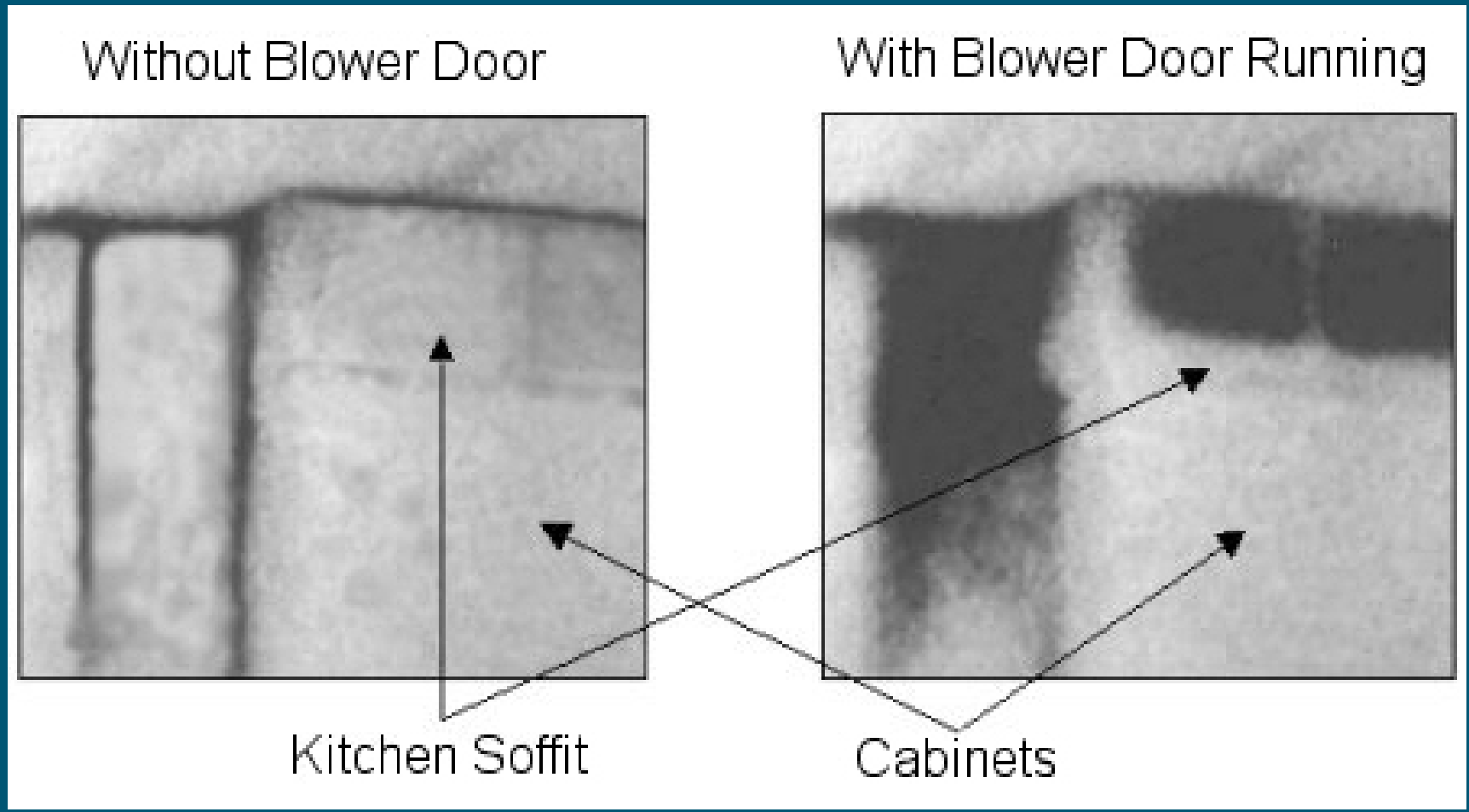
Poor density & voids

IR & the Blower Door

IR & Blower Door



IR & the Blower Door



Soffits

Missing fiberglass batt

- The dark areas are ceiling discoloration caused by condensation on a cold surface.
- There is one missing fiberglass batt in the attic.

Digital camera at arm's length !

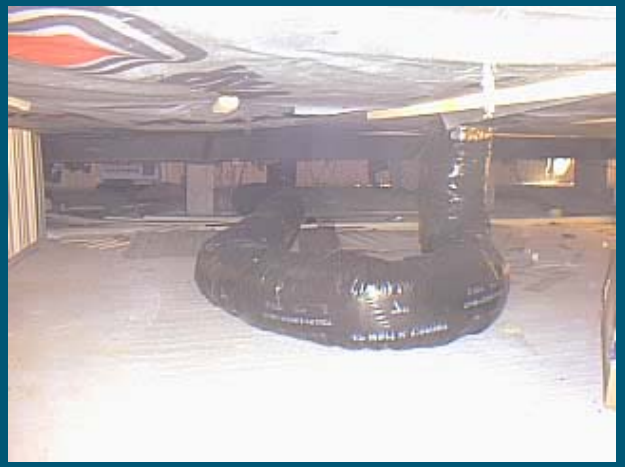
Core Sampling

- Dense pack cellulose = 3.5 lb/cu’
- Drill 2” hole *just through* siding, EITHER

1. Using sharpened section of 2” copper pipe carefully cut sample from wall.
2. Measure depth of wall cavity
3. Using $V = \pi r^2 \times h$, calculate volume of sample.
4. Weigh sample. Convert results to lbs/cu’ OR…

- Attempt to depress cellulose with the flat of your thumb. Any significant compression = failure.

Common Sense!



Common Sense!

Part Seven AGENDA:

- **Part six review**
- **Course review**
- **Break**

- **Written test**

Part 6 Review

- Mobile Home Weatherization
- Quality Control
  - Infrared
  - Blower door

Heat Movement Review

- **Three major mechanisms move heat:**
  - **Conduction**
  - **Convection**
  - **Radiation**
- **Insulation reduces conduction & radiation.**
- **Air sealing reduces convection (air leakage).**
- **Heat uses whatever mechanism is available at any point in time to escape.**

Insulation Review

- **Works by trapping air tiny pockets**
- **Typically insulation doesn't air seal**
  - **Exceptions:**
    - **Dense pack cellulose @ 3.5lbs per cubic foot. (remember: an open attic can not be dense packed even with cellulose.)**
    - **Foam board products with joints sealed**
    - **Sprayed in place foams (1 or 2 part)**
- **Must be installed in actual contact with air & moisture retarders/barriers to create the building envelope.**

Building Envelope Review

- **Consists of:**
  - **Insulation (thermal boundary)**
  - **Air barrier (pressure boundary)**
  - **Vapor retarder. (moisture or vapor boundary)**
  - **All must be at the same surface & in contact with each other.**
- **Should be as simple as possible:**
  - **Least area heat exposed to cold.**
  - **Smallest volume of heated space.**
  - **Fewest & least difficult joints.**
- **Weigh options:**
  - **Build hatch at top of attic stair instead of insulating stairwell walls & stair treads.**
  - **Insulate slope & end walls in kneewall crawl space instead of doing floor & back of kneewall.**

Air Leakage Reduction Review

- **Intended to:**
  - **Stop moisture (99% of moisture is air carried)**
  - **Allow insulation – particularly fiberglass – to function as rated**
  - **Make home less drafty**
  - **Save energy**
- **Requires attention to detail**
- **Most easily done during construction**
- **Must be done on “winter warm” surface**

Insulation alone will not reduce air leakage!

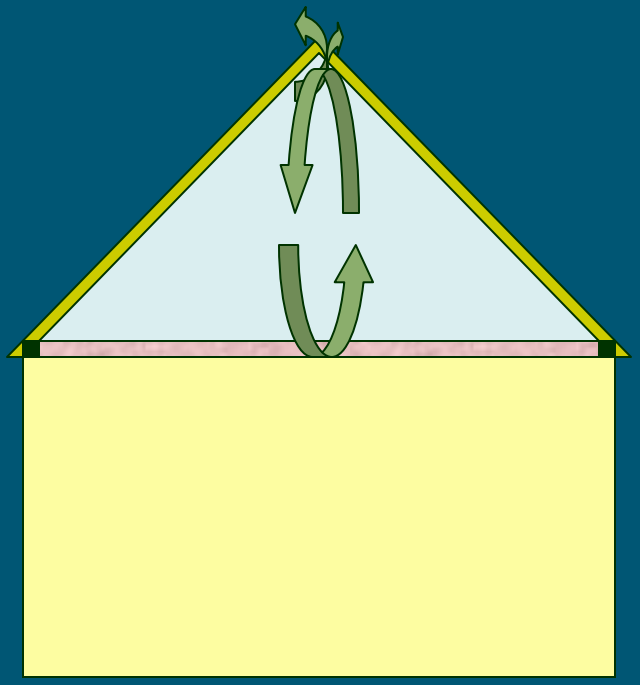
Structural Details Review

- **Post & beam buildings can have irregular nailers & hurricane bracing that create strangely shaped wall cavities.**
- **Balloon buildings have interconnected wall & ceiling cavities everywhere. Gable end stud patterns can be quite irregular.**
- **Platform buildings will have a band joist at each level.**
- **Split level buildings can have open wall cavities into unheated areas similar to balloon framing.**
- **Both balloon and platform framed buildings can have irregular fire stopping.**

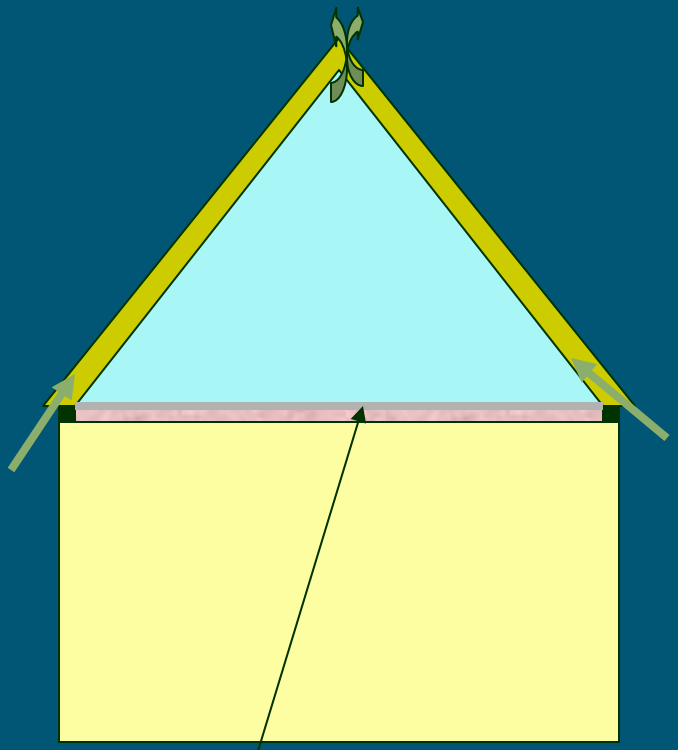
Upper story band joist

- 2” framing member, cladding & siding ≈ R-3
- Usually band joist “talks” to entire floor cavity
- Access to cavity is the key
  - Unzip siding
  - Remove baseboard or cove molding
  - Lift carpet or inlay
- Dam if possible
  - Bag trick
  - Run low air until bay blocks, then dense-pack
  - Two part foam

Looping

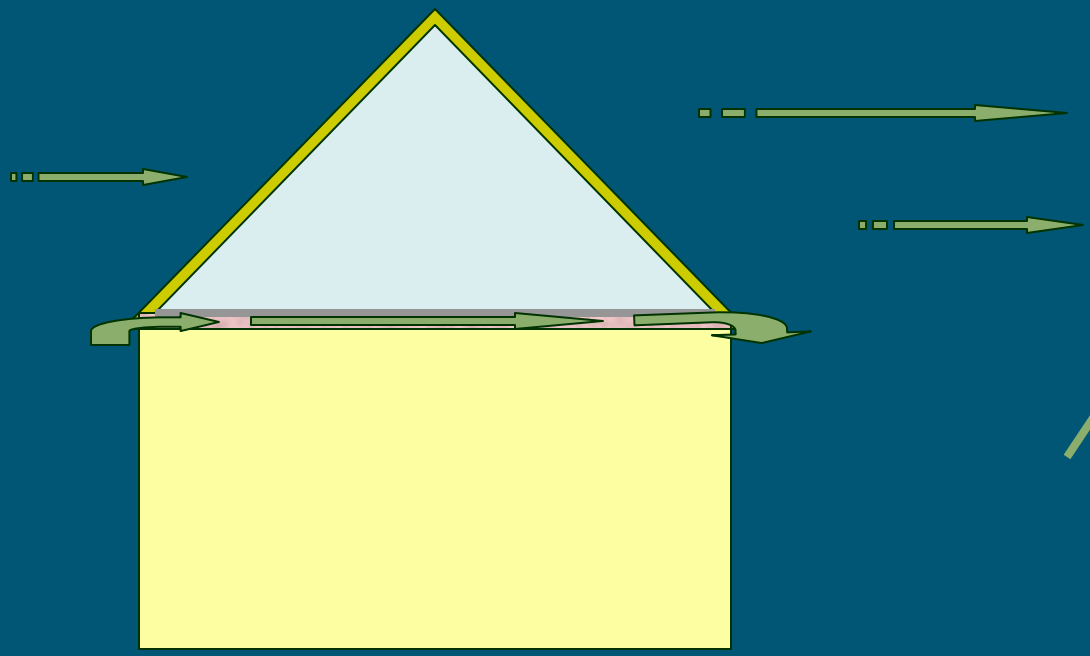


Warm air rising constantly “loops” through the insulation, picking up heat & bringing it up to where it can exit through the ridge venting.

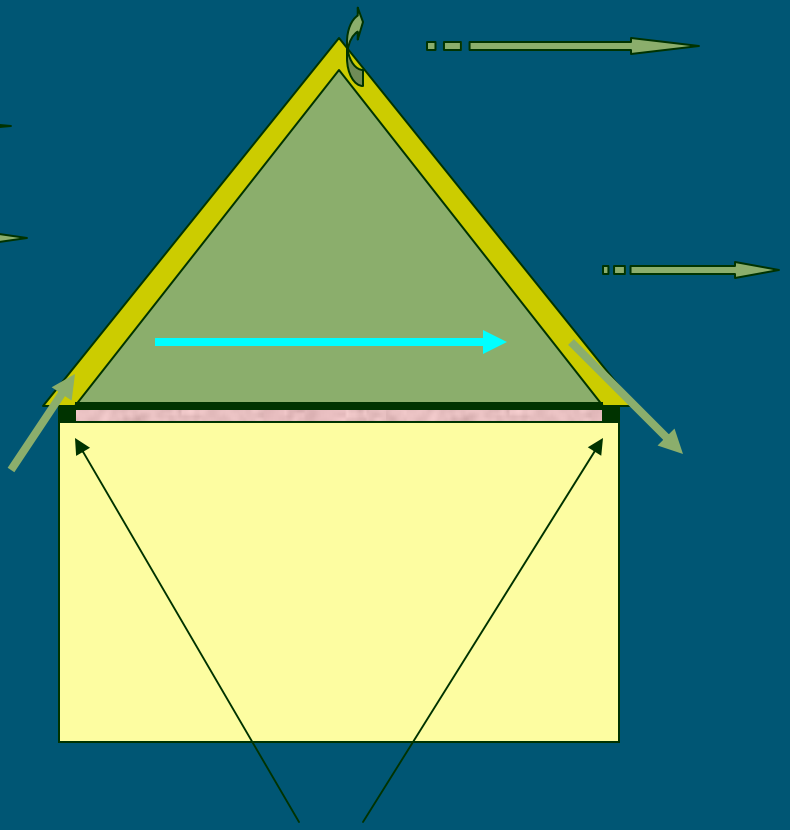


Dust 2 or 3 inches of cellulose over the batt insulation to reduce air intrusion & looping

Wind-washing



Wind will also blow <u>through</u> insulation, picking up heat as it goes.



Install solid blocks foamed or caulked to sides of ceiling stringers & top of ceiling below to block air from insulation.

Fiberglass vs. cellulose

- Fiberglass does not absorb water, cellulose does.
- Fiberglass is lighter than cellulose.
- Fiberglass does not react with metal, cellulose can. (galvanic reaction)
- Fiberglass allows air movement, dense packed cellulose (properly installed) prevents it.
- Fiberglass may be carcinogenic, cellulose isn't.
- Fiberglass can't be densepacked, cellulose can.

The blower door

- Makes air-tightness testing possible.
- Measures the volume of air moved out of the house under a known pressure, usually 50 PA.
- Only way to accurately measure house “leakiness.”
- Feeling for moving air will locate leaks.
- Pascal equals 1/250th of an inch of water.
- The blower door rings concentrate air flow by the venturi ports for testing tight (low flow) houses.
- Removing rings allows greater air flow and higher house pressures. It is done in leaky houses.

Attics revisited *(One last time!)*

The vast majority of air moving through Maine houses during the heating season is driven by stack effect.

Insulating an attic without airsealing it will not reduce the volume of air moved into the attic by stack effect.

Insulating the attic will lower the attic temperature causing condensation on surfaces which previously remained above the dew point.

Adding attic venting will most likely cause even more condensation in the attic as the “relief” at the top will pull harder on the house, moving more house air up.

The ONLY reliable “fix” is air sealing.

BREAK !

Written Test