FOCUSED ENERGY. *For Life.*

Impact of Energy Codes on Exiting Homes

Improving Efficiency, Comfort, and Health

Mike Barcik, Southface

www.southface.org

Matt Belcher

MO Energy Code Support

Energy Code Resources

Technical assistance or training requests:

Matt Belcher, Energy Code Consultant
Matt@moenergycodesupport.org
314.749.4189

Energy Code Resources

Missouri Residential Building Energy Code Construction Practices Study:
https://energy.mo.gov/energy-codes/missouri-residential-building-codes-study
For additional information on other DOE Field Studies and participating states, please visit https://www.energycodes.gov/compliance/energy-code-field-studies.
Additional education resources are available at www.southfaceonlinetraining.org.

www.southface.org => Resources => GA Energy Code Resources

mikeb@southface.org

Ameren MISSOURI

Learning Objectives

- Quick Building Science review
- Safety issues:
  Asbestos, Lead, Mold & moisture, Combustion Safety, Radon
- Using the Code: Correctly Air sealing and Insulating the house
- Ductwork
- Lighting

Importance of Energy Codes

- **Saves energy** - Buildings consume 40% of energy in U.S.
- **Saves money** - Energy costs continue to escalate, and energy codes help keep money within local economy
- **Additional benefits:**
  - Increases comfort, health and durability of homes
  - Increases value of homes in local community
  - Reduces liability for builders and subcontractors

Ameren MISSOURI

Scope of Residential Energy Code

- Focus is on building thermal envelope
  - Ceilings, walls, windows, floors, and foundations
  - Sets insulation and fenestration levels, and solar heat gain coefficients
  - Infiltration control – caulk and seal to prevent air leaks, and test
- Ducts, air handlers, filter boxes – seal, insulate, and test
- Limited space heating, air conditioning, and water heating requirements
- Federal law sets most mechanical equipment efficiency levels, not the I-codes (similar for appliances)
- Lighting equipment – 90% of lamps to be high-efficacy lamps or 90% of lighting fixtures to have only high-efficacy lamps

Ameren MISSOURI

Residential Buildings

- New construction
- 1 and 2 family (R3)
- Multi-family, 3 stories and less (R2 and R4) – IECC 2015
- Additions, Alterations, Repairs

ALTERATION. Any construction, retrofit or renovation to an existing structure other than *repair* or *addition*. Also, a change in a building, electrical, gas, mechanical or plumbing system that involves an extension, addition or change to the arrangement, type or purpose of the original installation.

Exempt Buildings

- Low energy < 1 w/sq.ft.
- No conditioning
- Log homes – ICC400
- Historic buildings (501.6)

CONDITIONED SPACE. An area, room or space that is enclosed within the *building thermal envelope* and that is directly or indirectly heated or cooled. Spaces are indirectly heated or cooled where they communicate through openings with conditioned spaces, where they are separated from conditioned spaces by uninsulated walls, floors or ceilings, or where they contain uninsulated ducts, piping or other sources of heating or cooling.

Ameren MISSOURI

7

Building Science

Improving Efficiency, Comfort, and Health in Existing Homes

The house as a system

- A house is a system made up of interrelated parts:
  - Building thermal envelope
  - Space conditioning
  - Ventilation
  - Water heating & distribution
  - Lighting & appliances
- Building science represents a holistic view of a house and applies an understanding of the flow of:
  Heat, Air, and Moisture

Section R402 – Building Thermal Envelope

- The building thermal envelope is the barrier that separates conditioned space from unconditioned space

- The envelope should consist of a **continuous** thermal boundary (insulation) and a **continuous** air barrier that are in complete contact

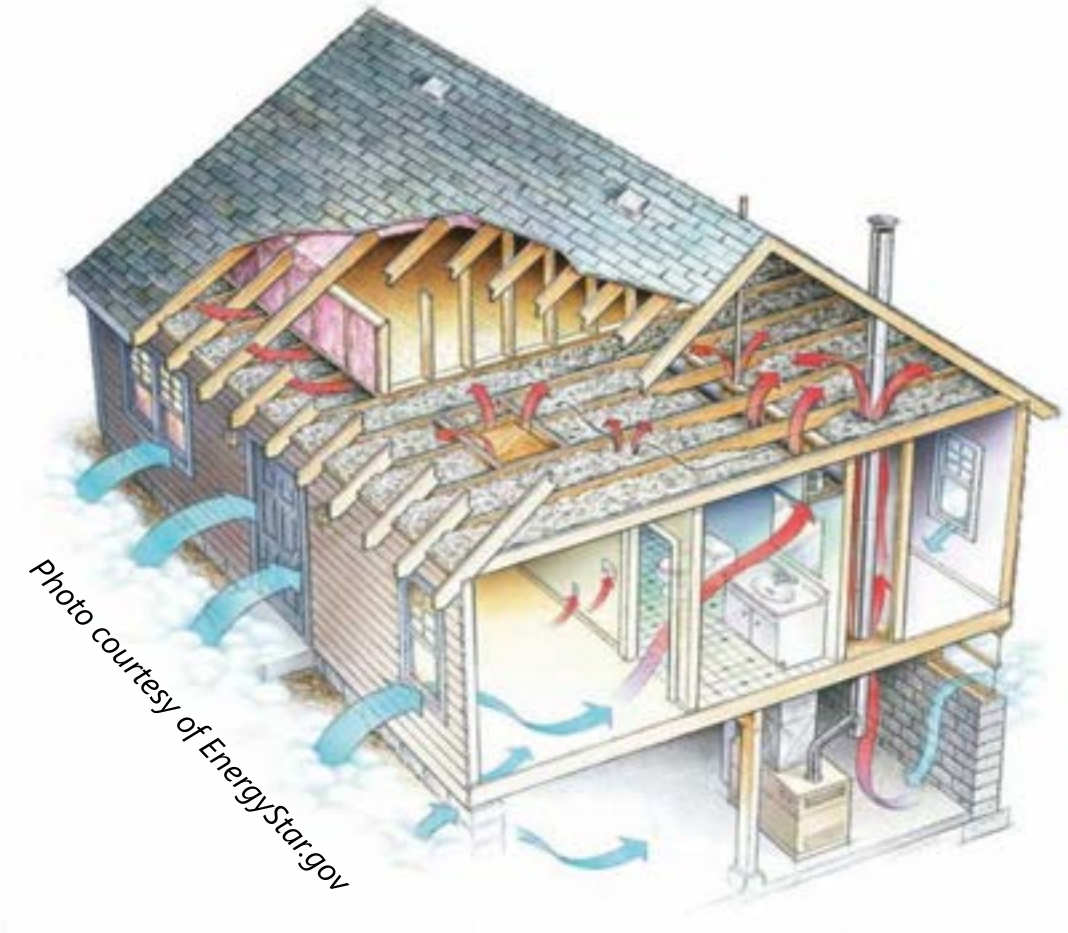
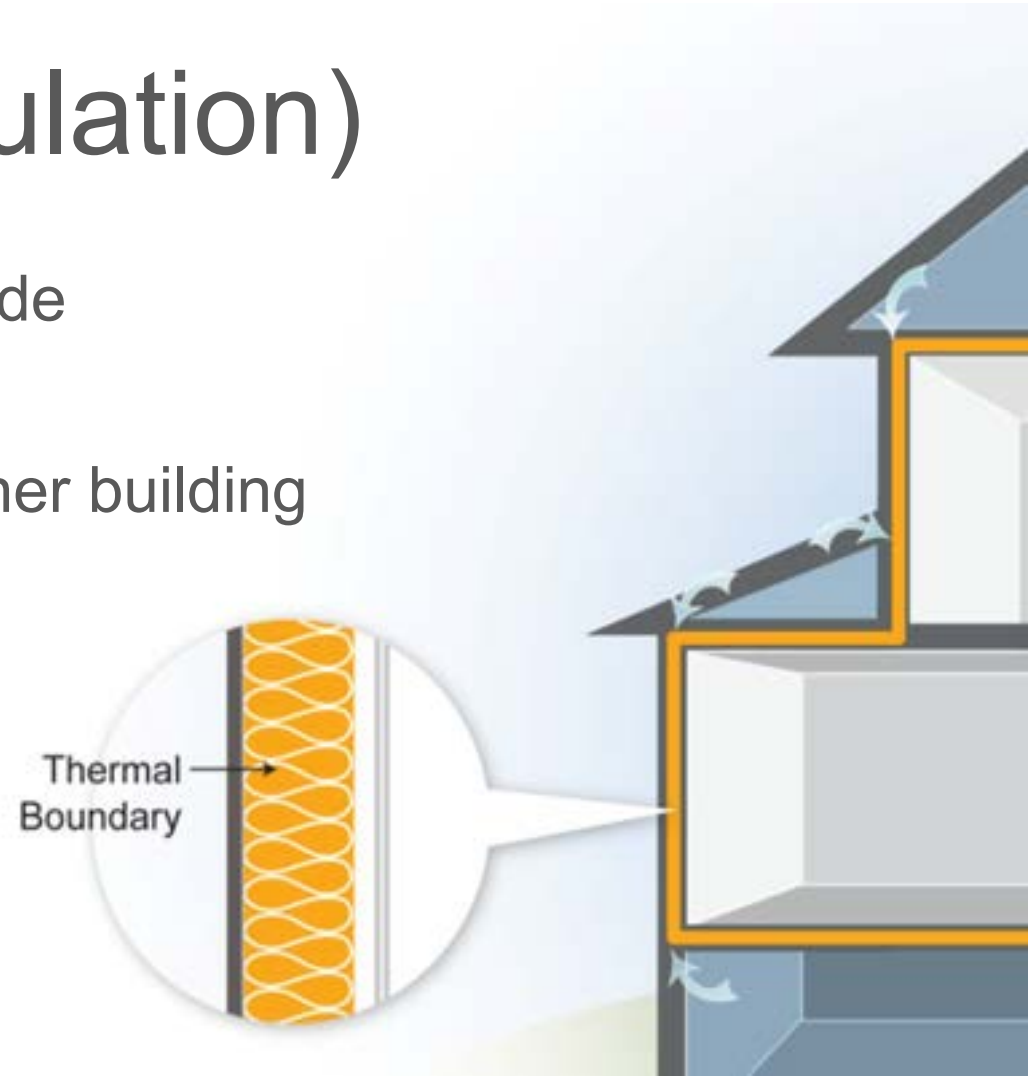


Photo courtesy of EnergyStar.gov

Thermal Boundary (Insulation)

- Limits heat flow between inside and outside
- Easy to identify by presence of insulation
- The location of insulation in relation to other building components is critical to its effectiveness
- Even small areas of missing insulation are critical
- Voids of 7% can reduce effective R-value by 50%

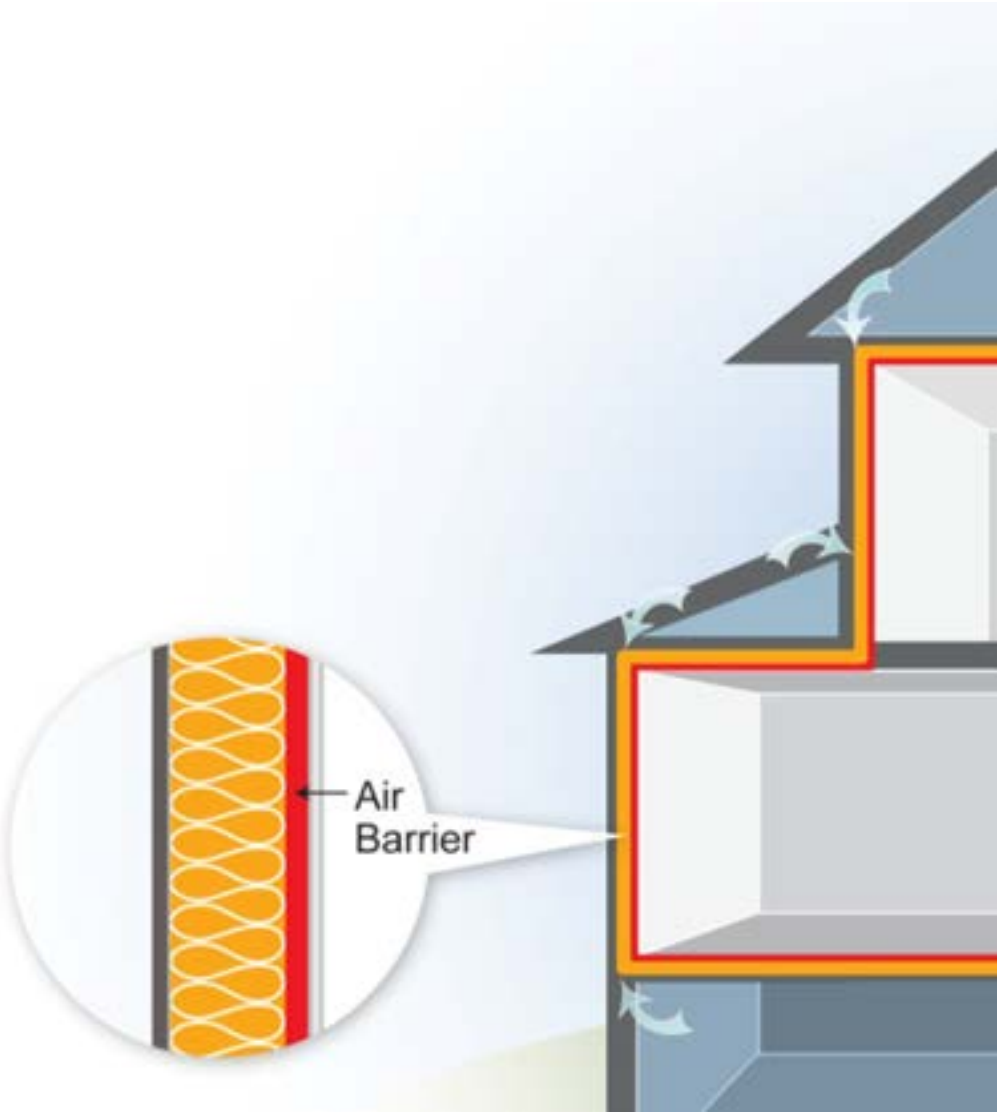


Graphic developed for the US DOE WAP Standardized Curricula

Ameren MISSOURI

Air Barrier

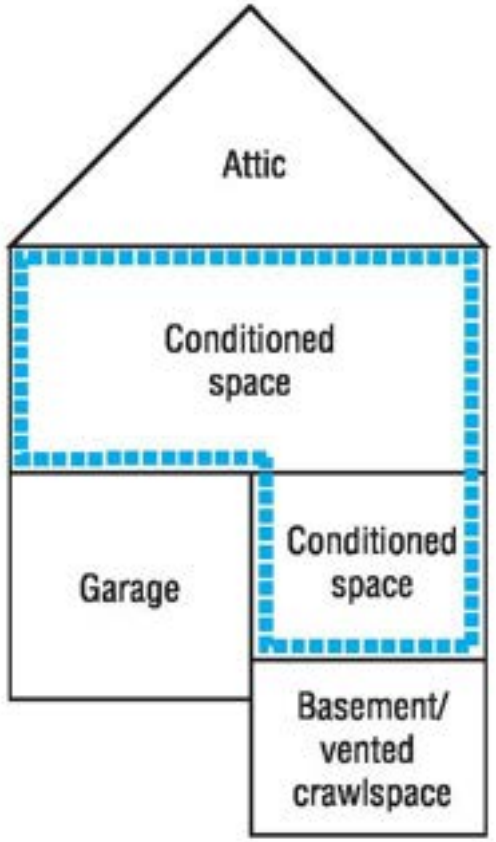
- Limits airflow between inside and outside
- More difficult to identify
- Not always where you think it is
- Must be co-located with the thermal boundary
- Must be continuous
- Blower door is used to locate & verify air barrier

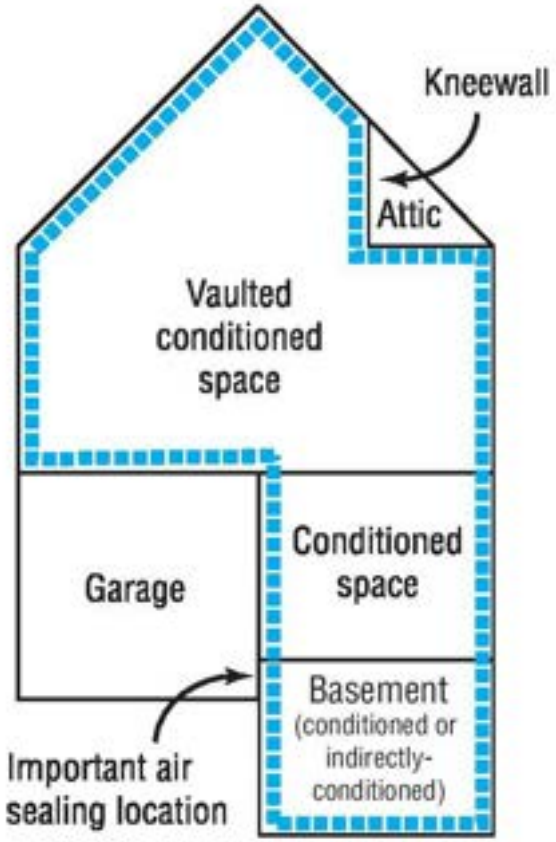


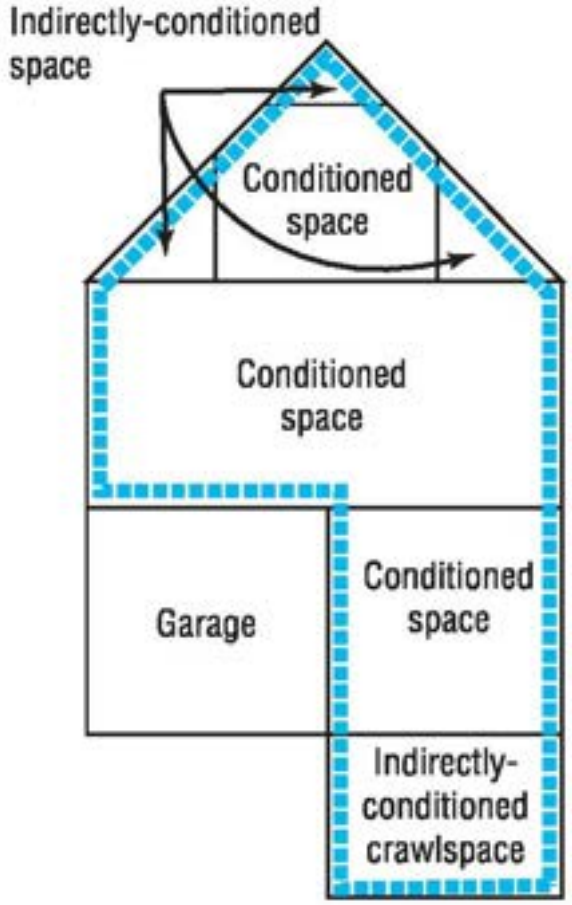
Graphic developed for the US DOE WAP Standardized Curricula

Ameren MISSOURI

Thermal Envelope Example







*Although these three homes look identical from the outside, each has defined the building thermal envelope differently

Ameren MISSOURI

Heat Transfer

- Heat is a form of energy
- Heat moves from hot to cold
- 3 methods of heat transfer:
  - Conduction – heat moves through a material
  - Convection – heat energy carried by a fluid (including air)
  - Radiation – heat “emits” from a hot surface to a cooler surface

Ameren MISSOURI

Radiation

Radiation is the movement of heat from a hot surface to a cold surface with nothing solid or opaque in between (low-emitting surfaces slow radiation)

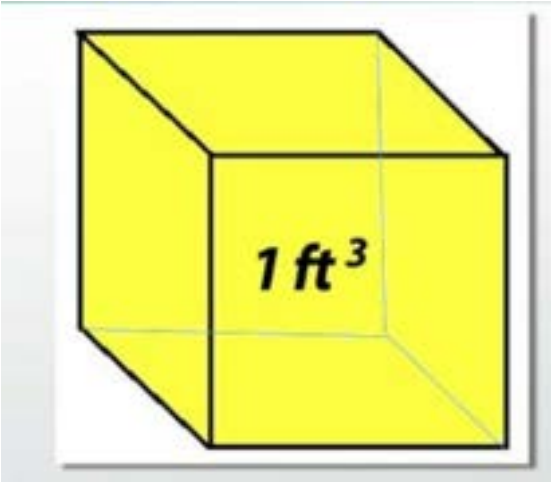
Convection

- Outdoor air of different temperature replacing indoor air
- Air moves from areas of higher pressure to areas of lower pressure
- Natural and man-made forces that can create pressure differences cause air to flow
- Whenever air moves out of a home, an equal amount of air enters the home

Conduction

- Heat moves through a material
- Insulation can slow down conduction
  - How well a material slows conduction is called resistance
  - Resistance is measure of R-value, inverse is U-value

Air Leakage

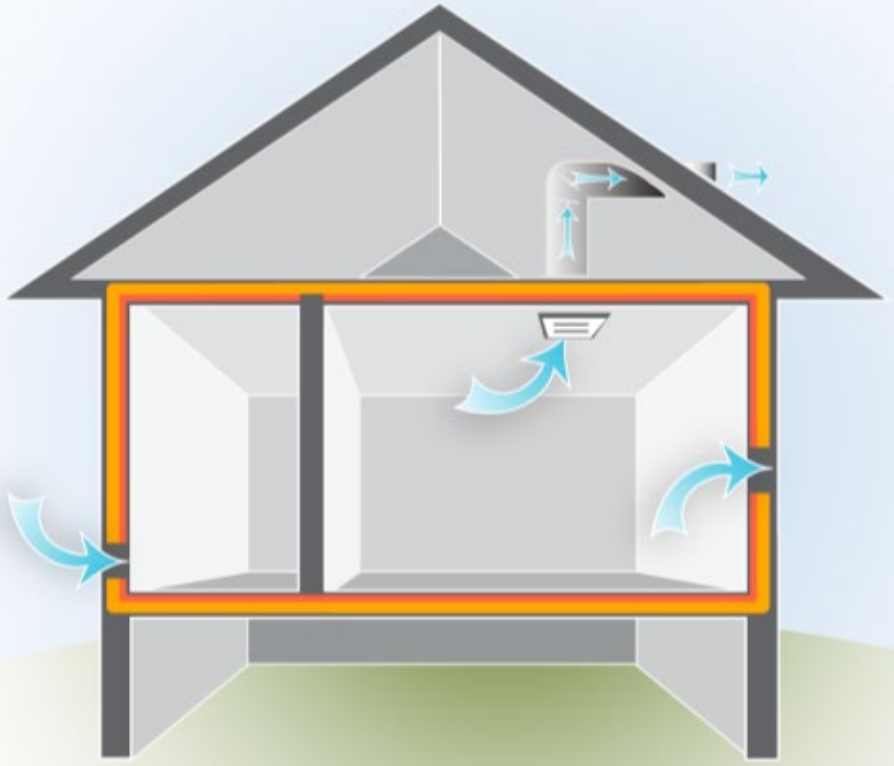


- Airflow is measured in cubic feet per minute, also written as ft^3/min, or CFM
- 1 CFM out = 1 CFM in
- Airflow takes the path of least resistance
- Air moves from high to low pressure areas
- Air usually moves from high to low temperature areas

Ameren MISSOURI

Air Leakage

Ventilation = Controlled air leakage

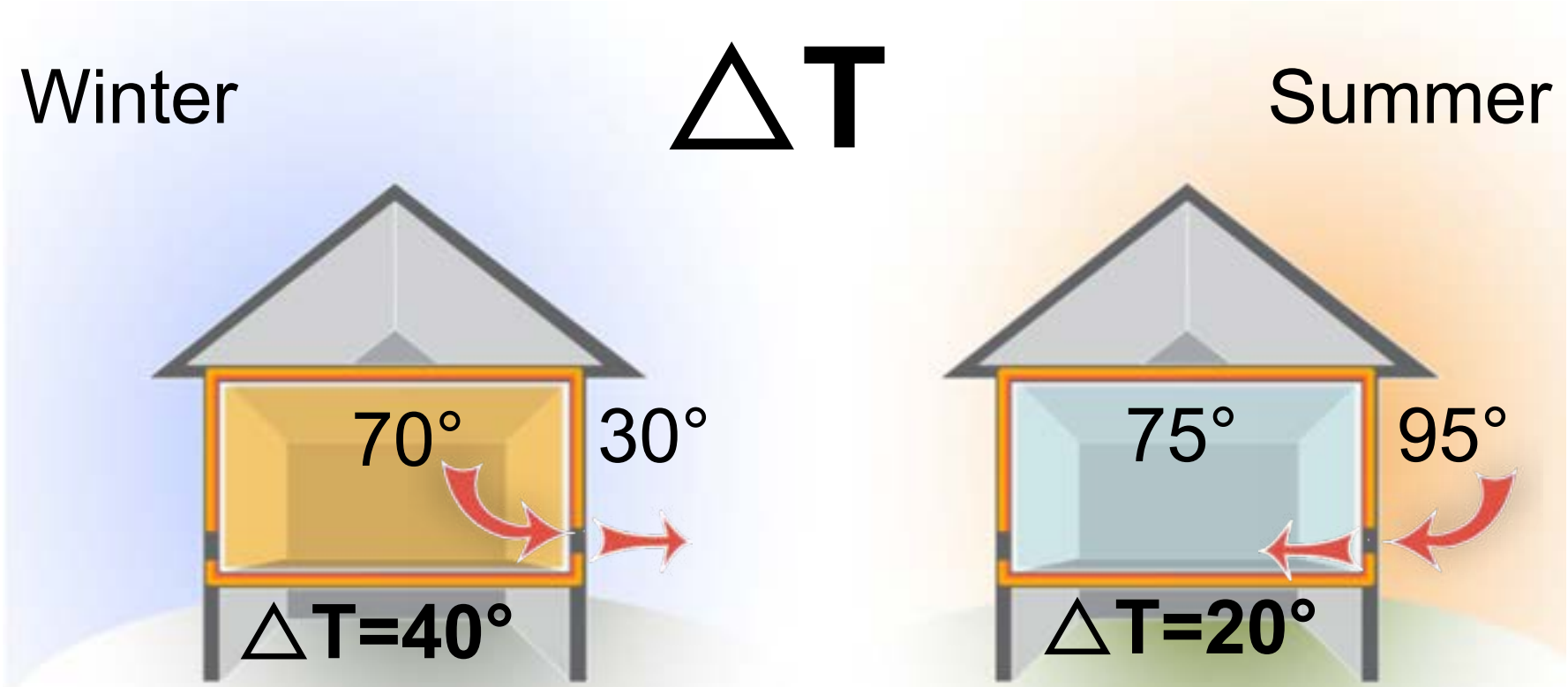


Infiltration =
Air leaking in

Exfiltration =
Air leaking out

Graphic developed for the US DOE WAP Standardized Curricula

Heat Flow: Temperature Difference



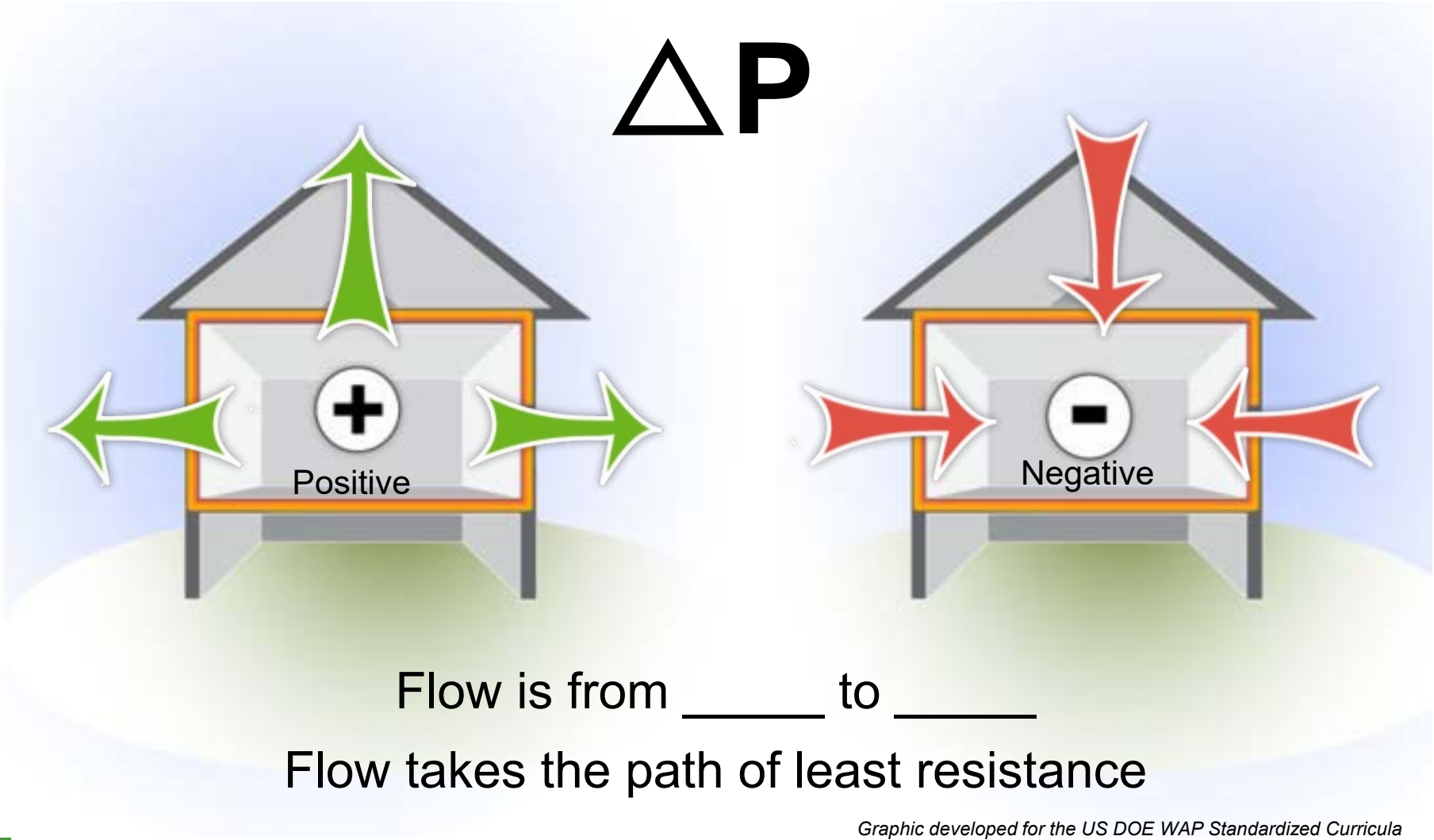
Heat Flow is from _____ to _____

The higher the △T, the more heat and air will move

Graphic developed for the US DOE WAP Standardized Curricula

Ameren MISSOURI

Air Leakage: Pressure



Flow is from _____ to _____

Flow takes the path of least resistance

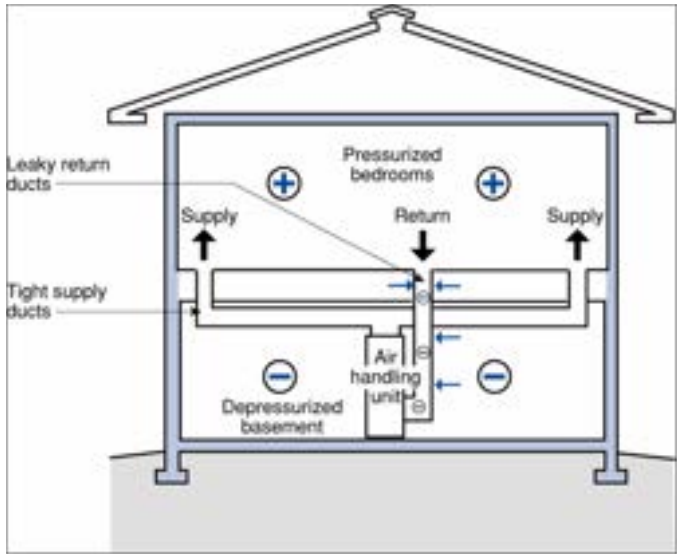
Graphic developed for the US DOE WAP Standardized Curricula

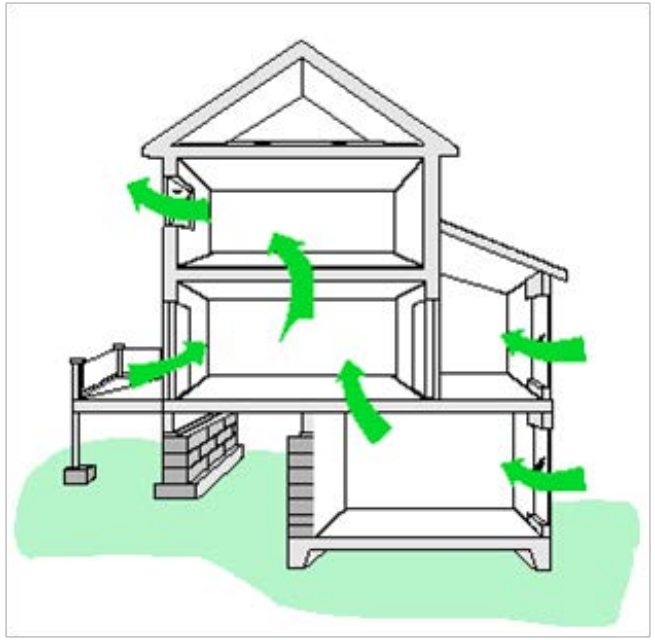
Ameren MISSOURI

Air Leakage: Driving Forces

Three forces create pressure differences in a home:

- Wind
- Stack Effect
- Mechanical Fans

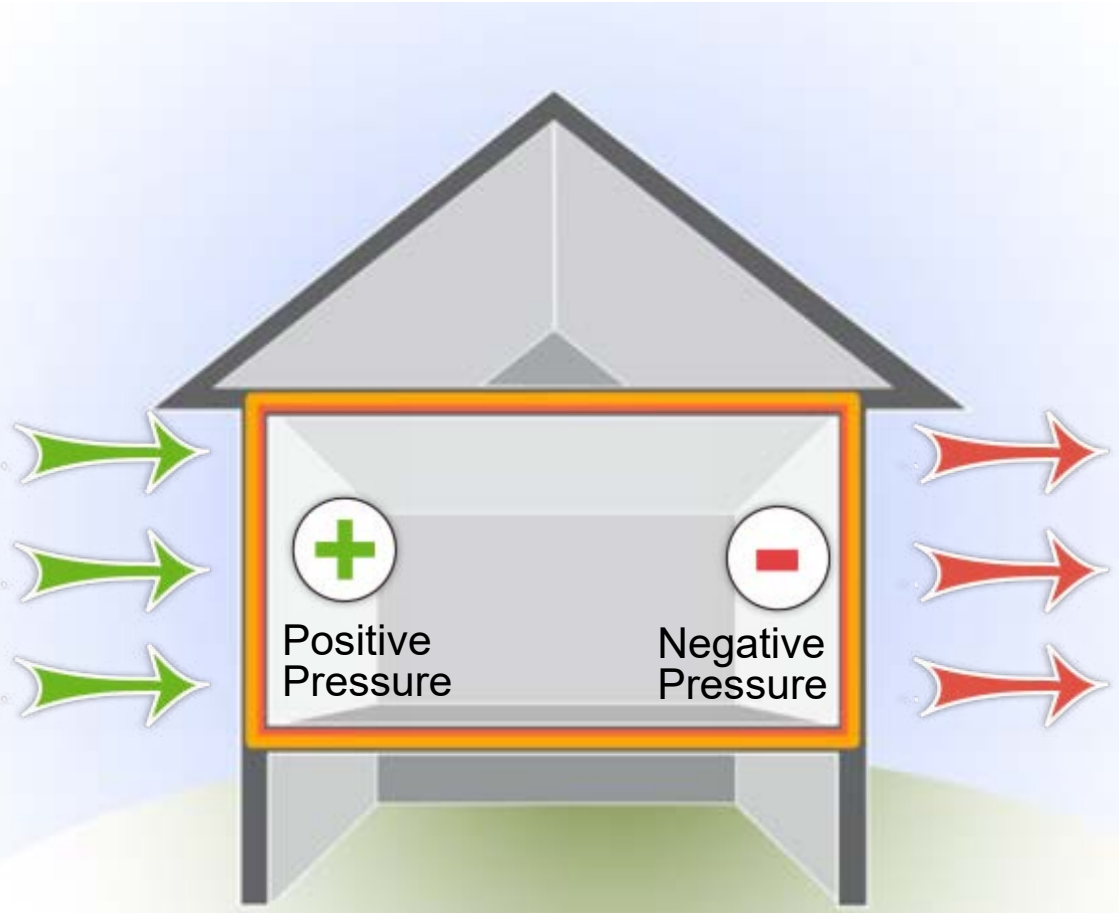




Ameren MISSOURI

Driving Forces: Wind Effect

Wind creates a positive pressure on the windward side of the building



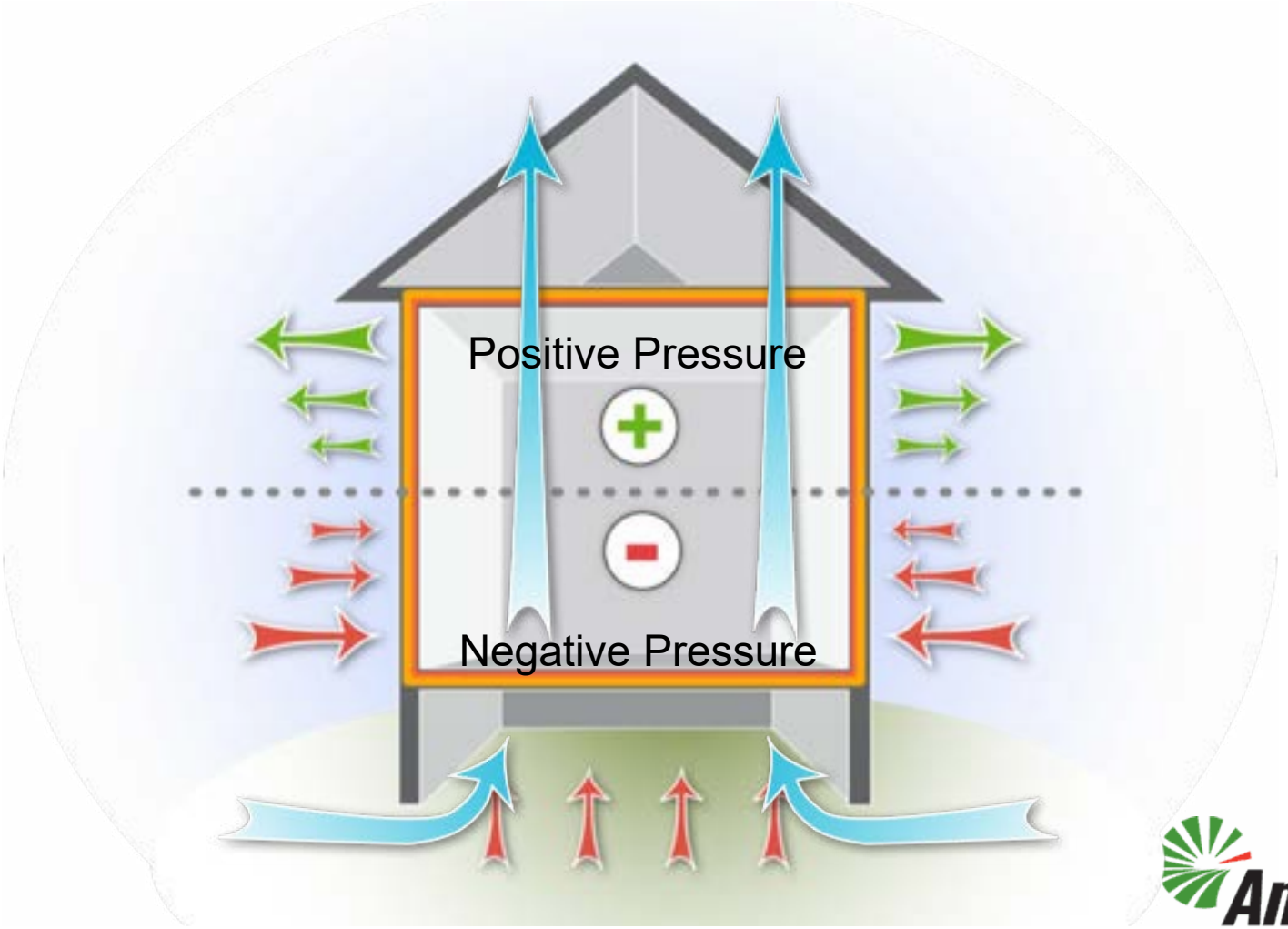
Which creates a negative pressure on the leeward side of the house

Graphic developed for the US DOE WAP Standardized Curricula

Driving Forces: Stack Effect

Warmer air rises and escapes out of the top of the house

Which creates a suction that pulls in outside air at the bottom of the house

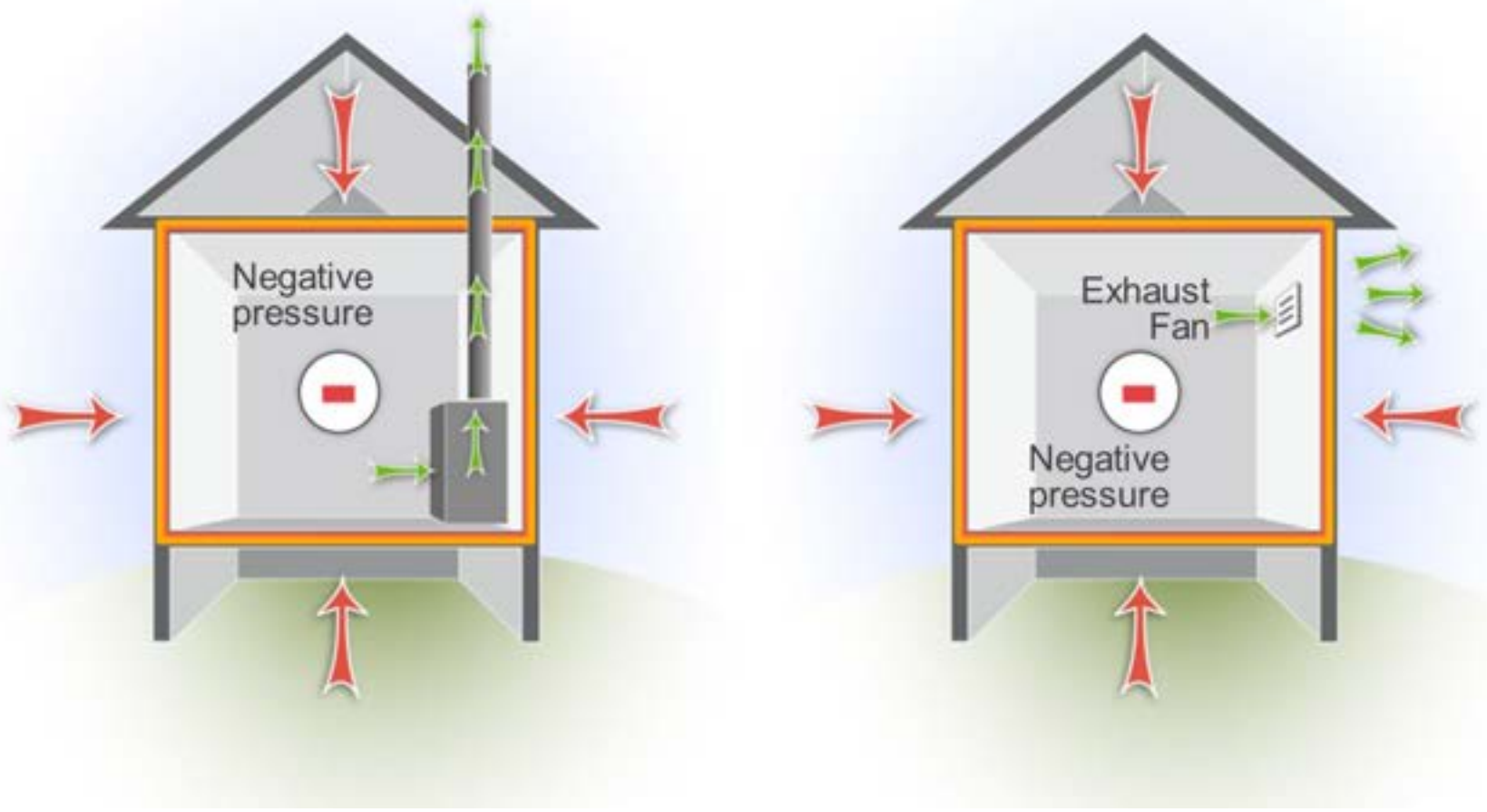


Graphic developed for the US DOE WAP Standardized Curricula

Ameren MISSOURI

Driving Forces: Mechanical Effect

Combustion Equipment & Exhaust Fans



Graphic developed for the US DOE WAP Standardized Curricula

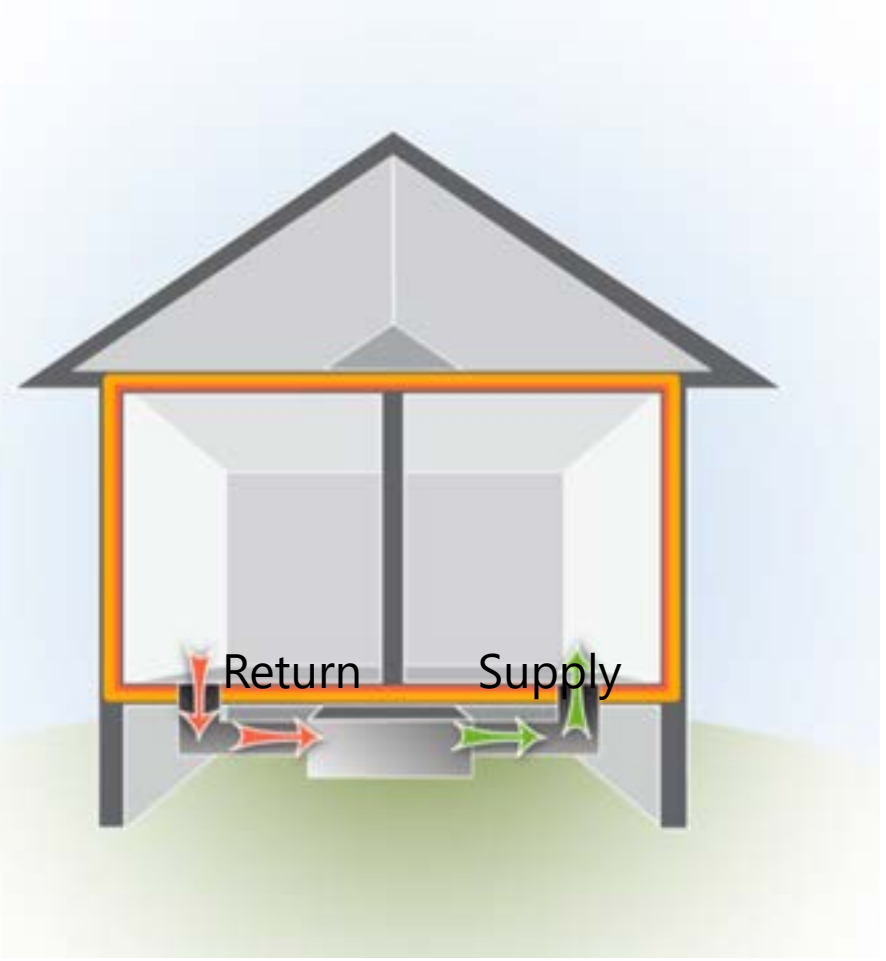
Ameren MISSOURI

Driving Forces: Mechanical Effect

Duct Leakage

Duct leakage can create positive and negative pressures in different areas of the house

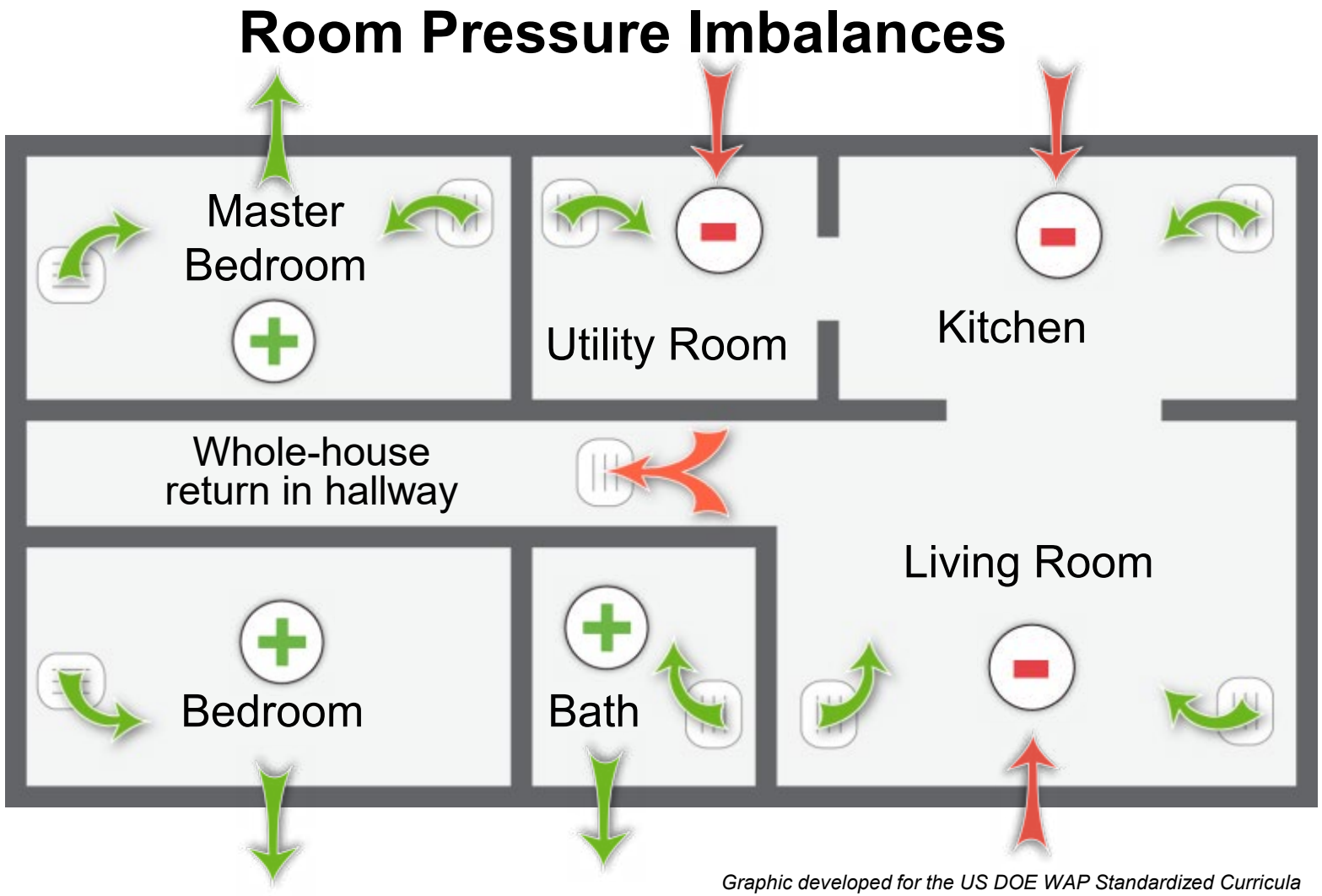
The pressures associated with duct leaks can be larger and more significant because the driving force is stronger



Graphic developed for the US DOE WAP Standardized Curricula

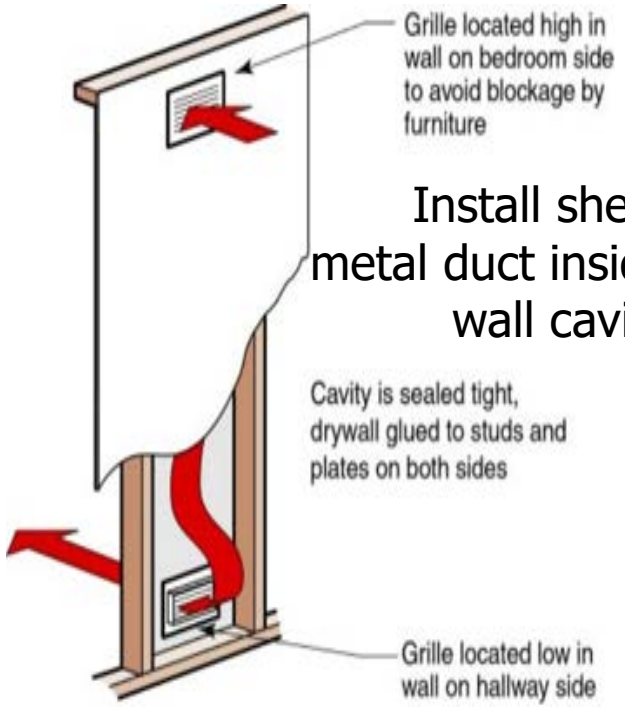
Ameren MISSOURI

Driving Forces: Mechanical effect

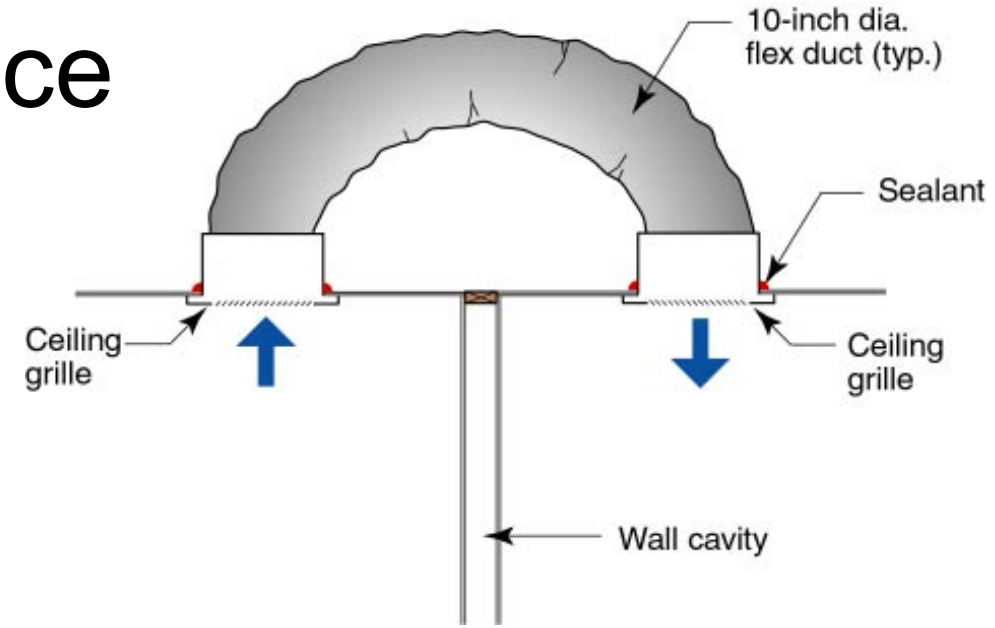


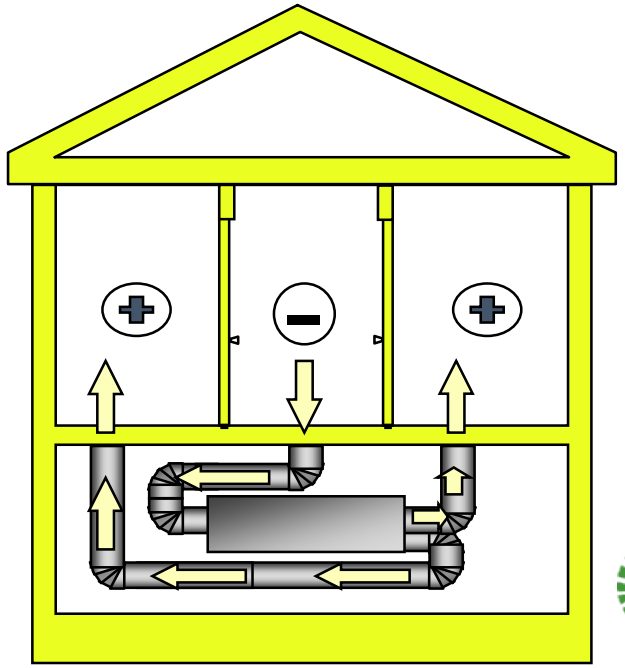
Graphic developed for the US DOE WAP Standardized Curricula

Correcting Pressure Imbalance with a Proper Return Path



Install sheet metal duct inside wall cavity

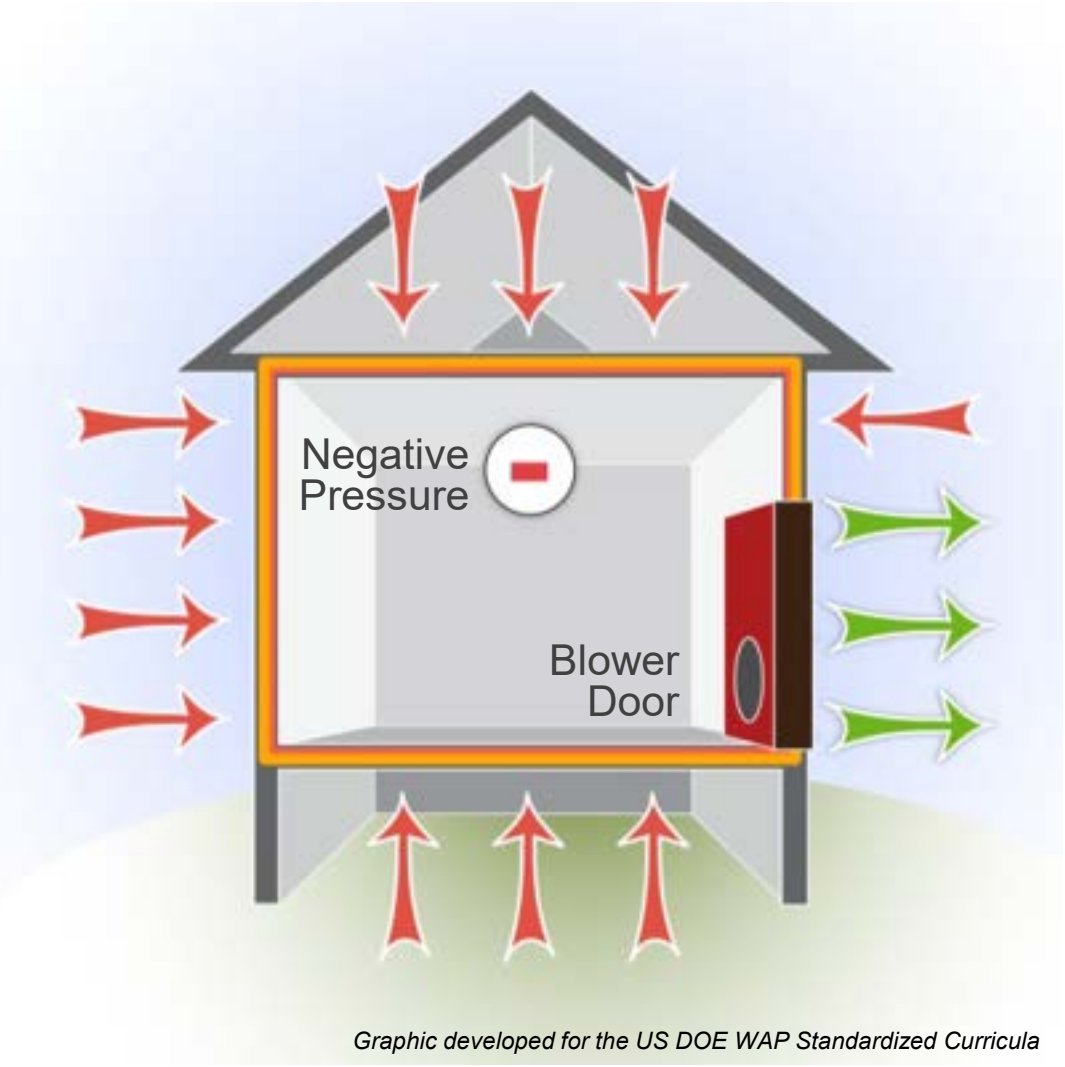




Driving Forces: Mechanical Effect

Use a Blower Door as a Controlled Driving Force

Using the blower door depressurizes the house, drawing air through all the holes between inside and outside



Graphic developed for the US DOE WAP Standardized Curricula

Ameren MISSOURI

MOISTURE TRANSPORT

Moisture moves…

…from wet to dry

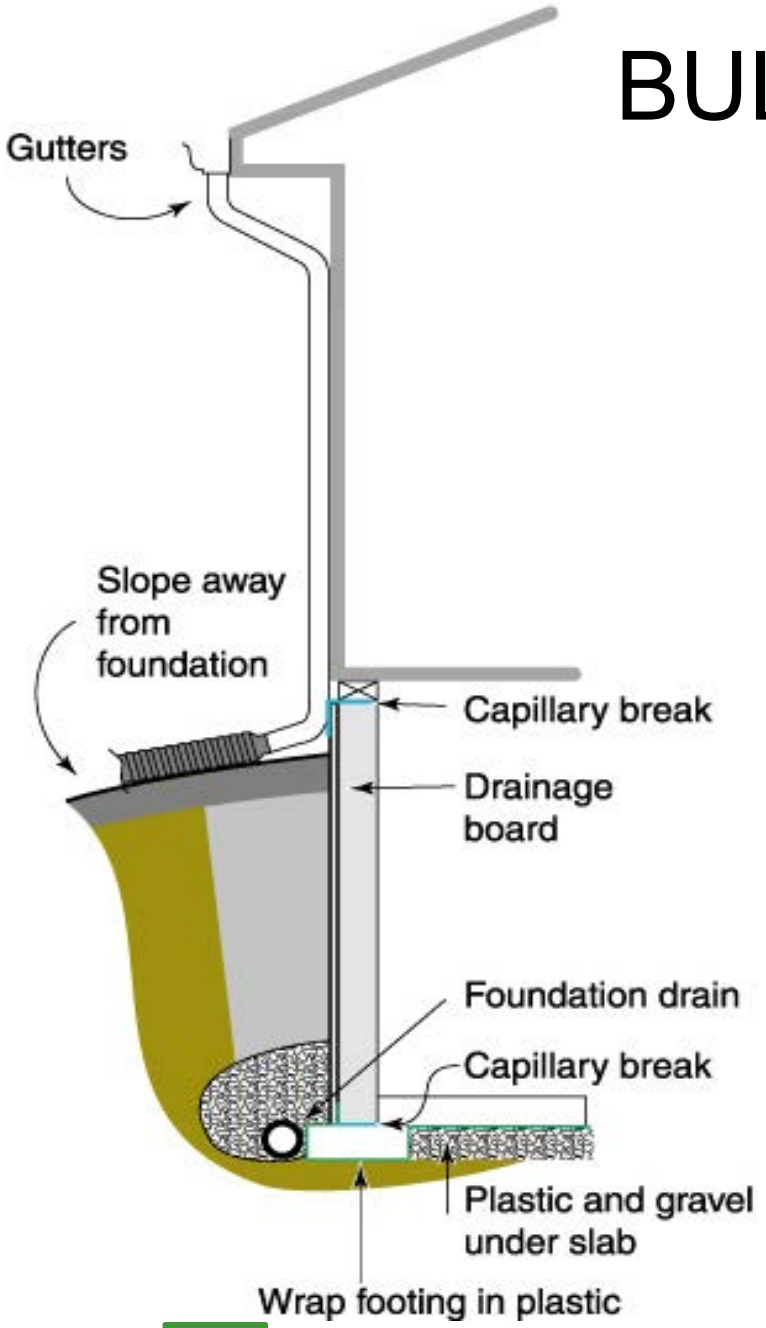
- **Liquid** Water
  - Bulk (rain/drainage, plumbing)
  - Capillarity (wicking)
- Water **Vapor**
  - Diffusion (molecular)
  - Air Leakage (infiltration)

Geography matters!
What works in one region may not work in another

Appropriate measures for moisture control are essential!

Ameren MISSOURI

BULK MOISTURE CONTROL

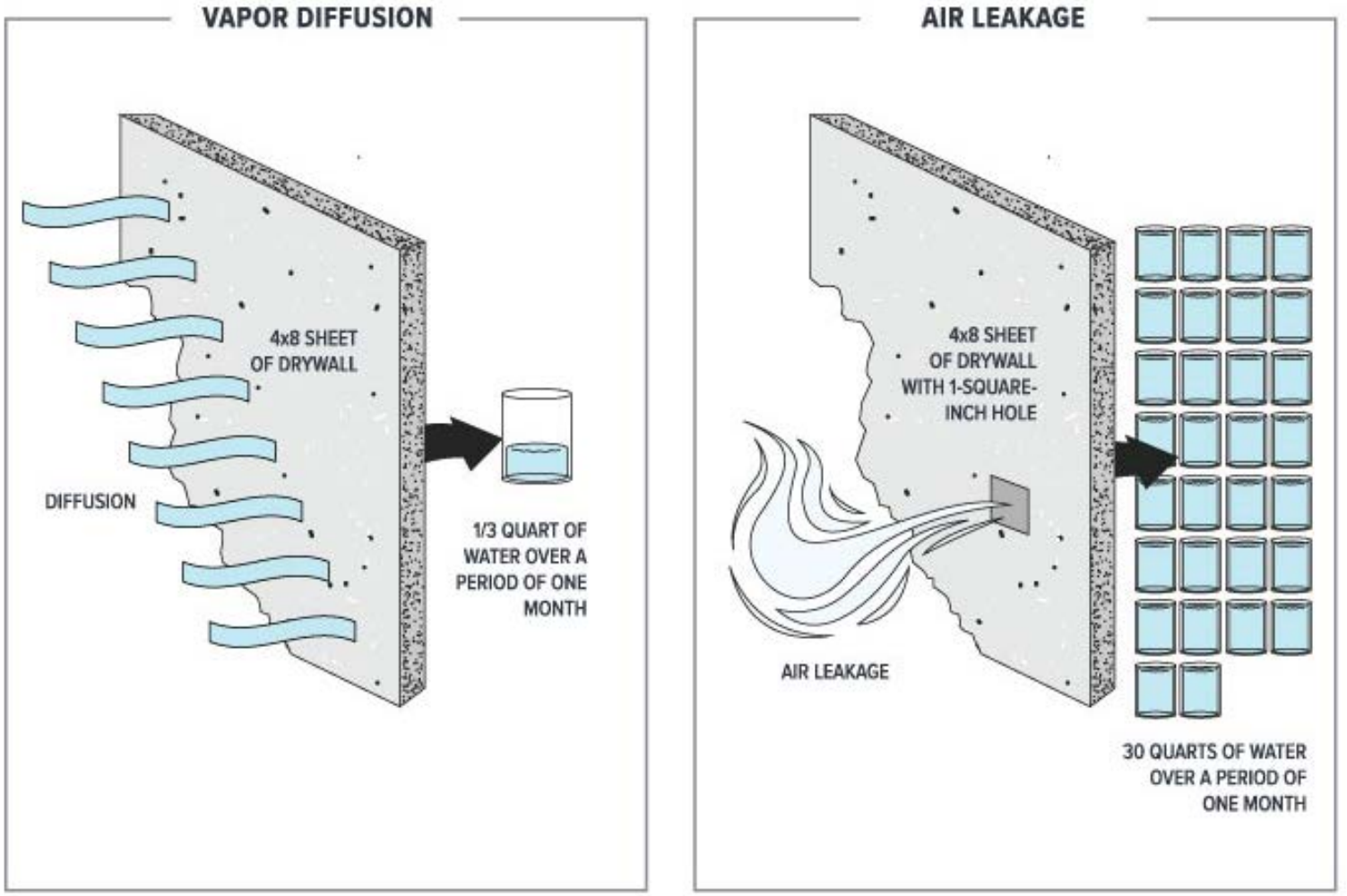


- Proper site drainage
- Foundation waterproofing
- Plastic ground cover
- Gutters channel water away from foundation

Ameren MISSOURI

Moisture Vapor

Another reason to limit air flow in a home is to reduce moisture intrusion. Even a small hole can allow a large amount of water into the building.



VAPOR DIFFUSION VS. AIR LEAKAGE

INTERIOR TEMPERATURE = 70° F
RELATIVE HUMIDITY = 40%

Ameren MISSOURI

Safety

Improving Efficiency, Comfort, and Health in Existing Homes

Asbestos

Asbestos can be located in:

- Siding, walls, ceilings, etc.
- Vermiculite insulation
- On pipes, furnaces, and other small covered surfaces

This scanning electron micrograph of asbestos shows the tiny, glass-like fibers that make asbestos so dangerous. These miniscule fibers become lodged in the lungs and can cause mesothelioma or other cancers.

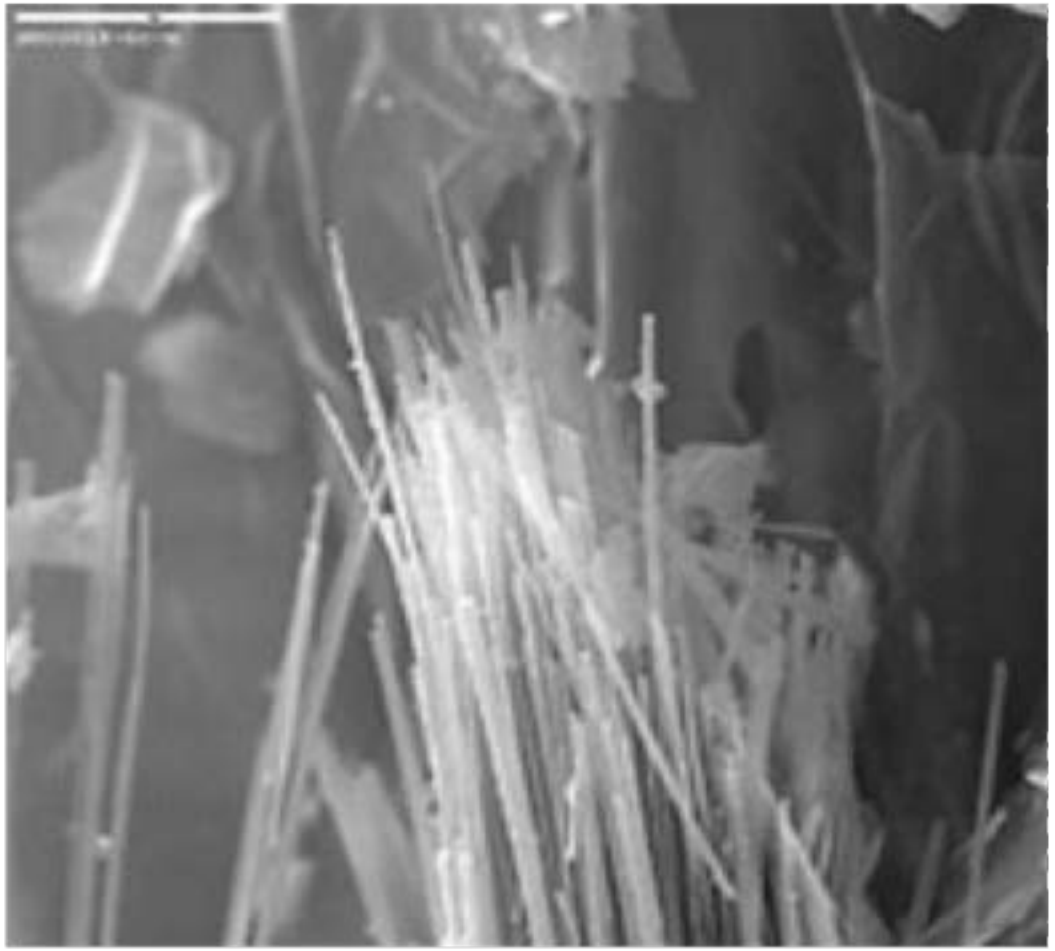


Photo courtesy of U.S. EPA

Ameren MISSOURI

Asbestos


Photo source: U.S. Dept. of Energy


Photo source: U.S. Environmental Protection Agency


Photo courtesy of Hub Testing Laboratory, Inc.

Ameren MISSOURI

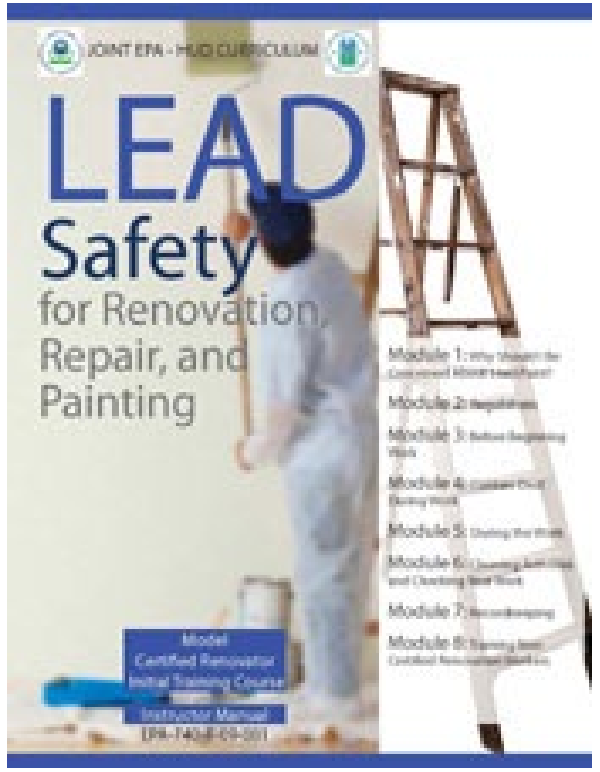
Lead-Based Paint

- Assume presence of lead in pre-1978 housing stock
- Lead-based paint is the primary source of lead-contaminated dust in housing
- Lead dust can harm everyone
  The most vulnerable are:
  - Babies/Children
  - Pregnant women
  - You!

Renovation, Repair and Painting (RRP)

- ALL paid contractors who work in pre-1978 housing where there's a risk that lead-based paint will be disturbed, or lead-based paint dust will be created, must comply with the EPA's Renovation, Repair and Painting (RRP) Rule or HUD's Lead Safe Housing Rule

- Consult your state environmental protection office or local jurisdiction for info on training requirements. Initial trainings are usually required with refreshers every 3-5 years



Ameren MISSOURI

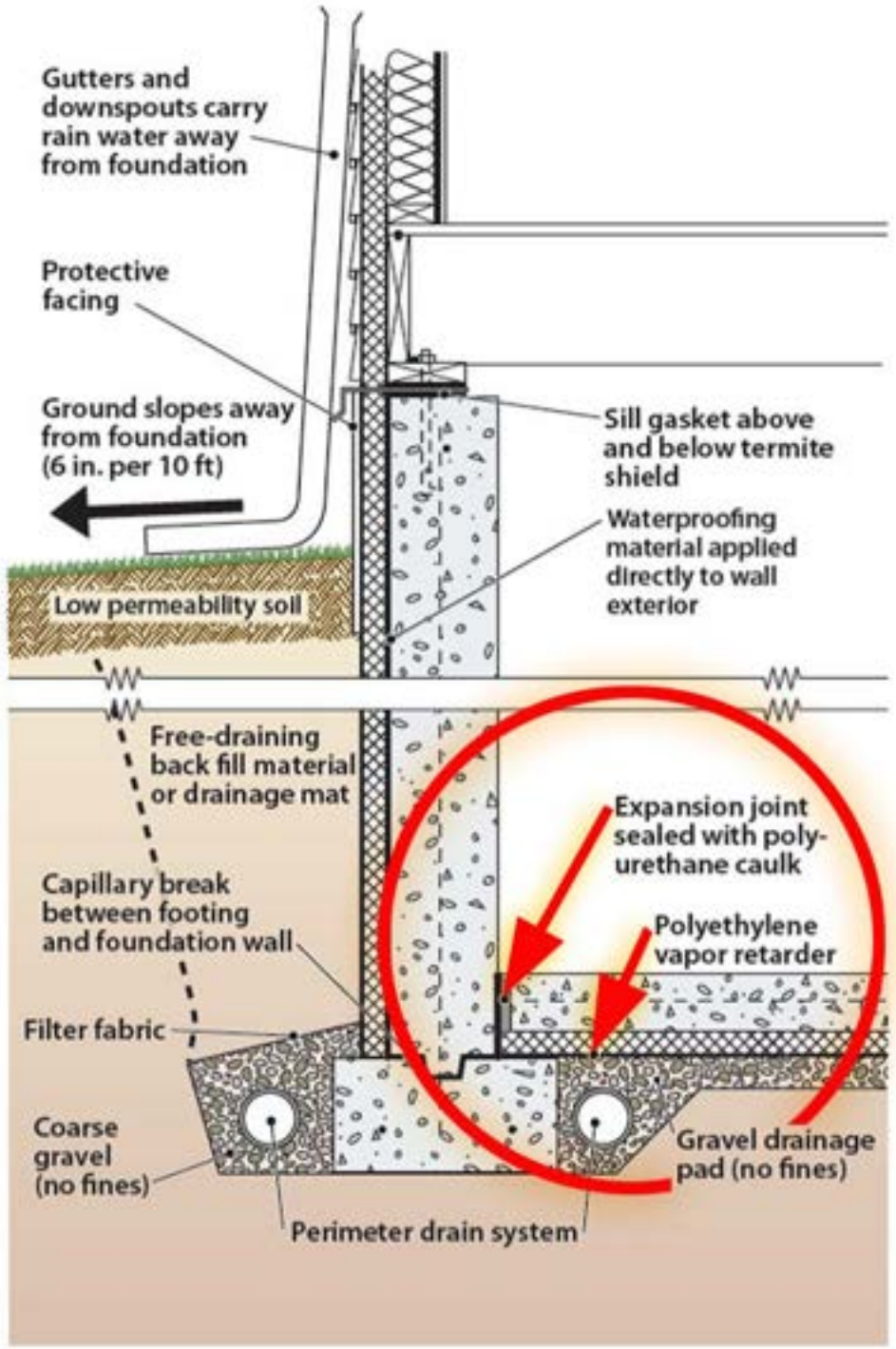
Mold and Moisture

- Moisture problems generally occur in bathrooms, kitchens, crawlspaces, and basements.
- Always treat the source or the problem first!
- Installing a bath fan or range hood can mitigate moisture problems – consider push button pre-set timer controls

Ameren MISSOURI

Mold and Moisture

Do not use a plastic moisture barrier in basement walls!



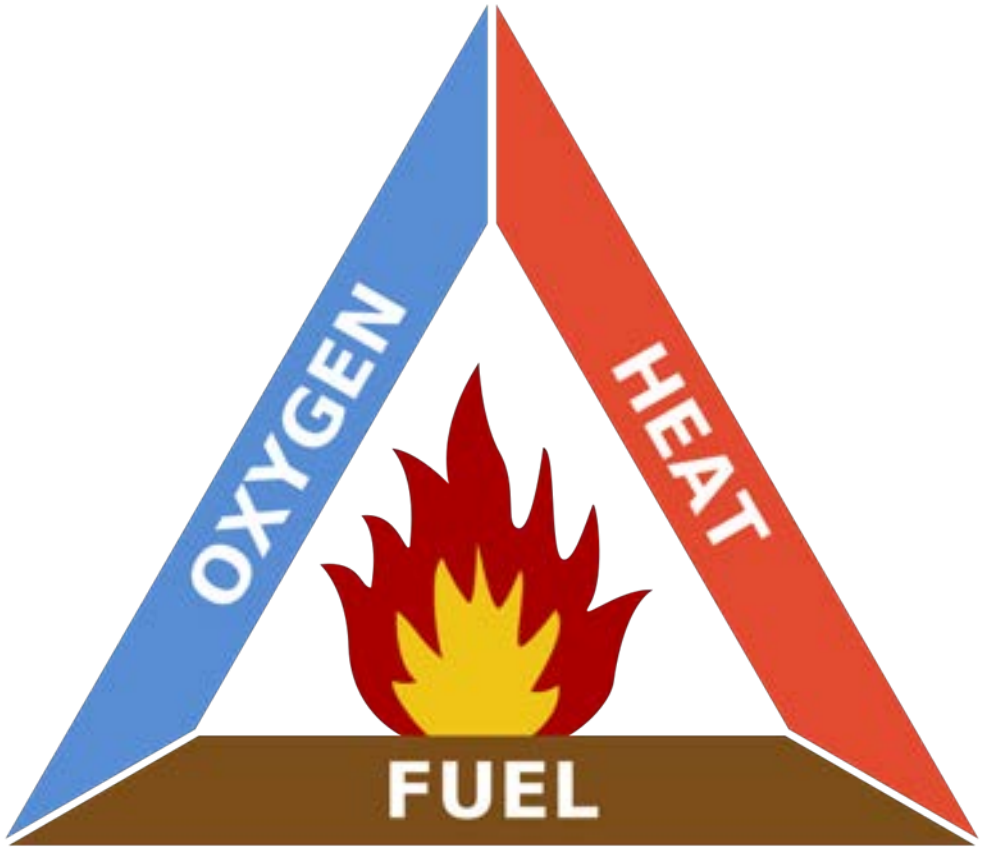
Mold and Moisture

- Some details might be harder (more expensive) to correct in existing homes
- Some techniques to consider:
  - Regrade the site to direct water away from home
  - Install footing or French drains
  - Use dimpled plastic moisture barrier on exterior surfaces of below grade walls
  - Utilize pervious surfaces to allow water to drain properly

Ameren MISSOURI

Combustion Safety

- Carbon Monoxide is a byproduct of incomplete combustion
- Improperly vented appliances and negative pressures in the home can magnify the problem
- Air sealing a house saves energy but means the oxygen available for appliances is reduced – Provide fresh air for the occupants and upgrade the appliances to have their own separate combustion air



Ameren MISSOURI

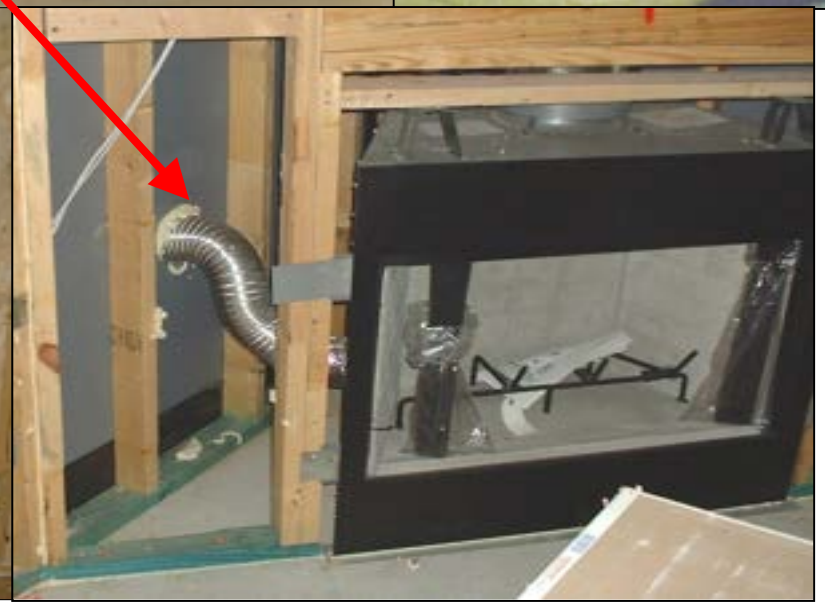
Combustion Safety

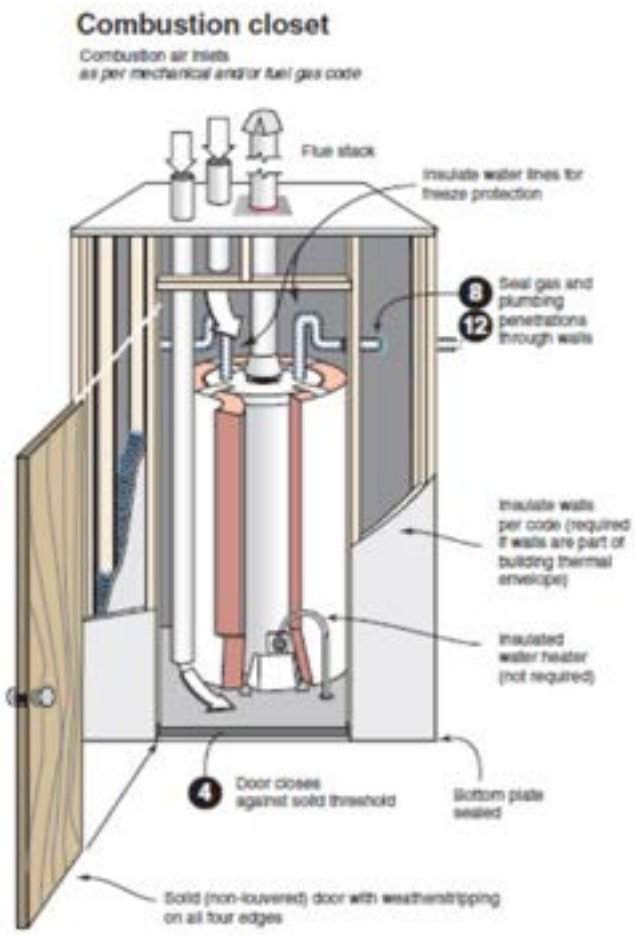
- **Proper air sealing with ventilation from a known source is key**
- **Making the house tighter without proper ventilation could:**
  1. Make existing problems worse
  2. Create new problems
- **These existing and new problems could be lethal**
  1. Carbon monoxide, Gas leaks, Back-drafting, Moisture (and mold)
- **Energy efficiency should not be a health hazard**

Ameren MISSOURI

Two Essentials for Safe Combustion

1. ***Separate*** *source / supply of* ***Oxygen***
2. ***Flue pipe*** *that exhausts combustion products to outside*





Ameren MISSOURI

Sealed Combustion Furnaces/Boilers

- Safer because combustion air comes from exterior (if vented properly)
- More efficient because a secondary heat exchanger extracts more heat before venting
- Produces condensation and must be drained

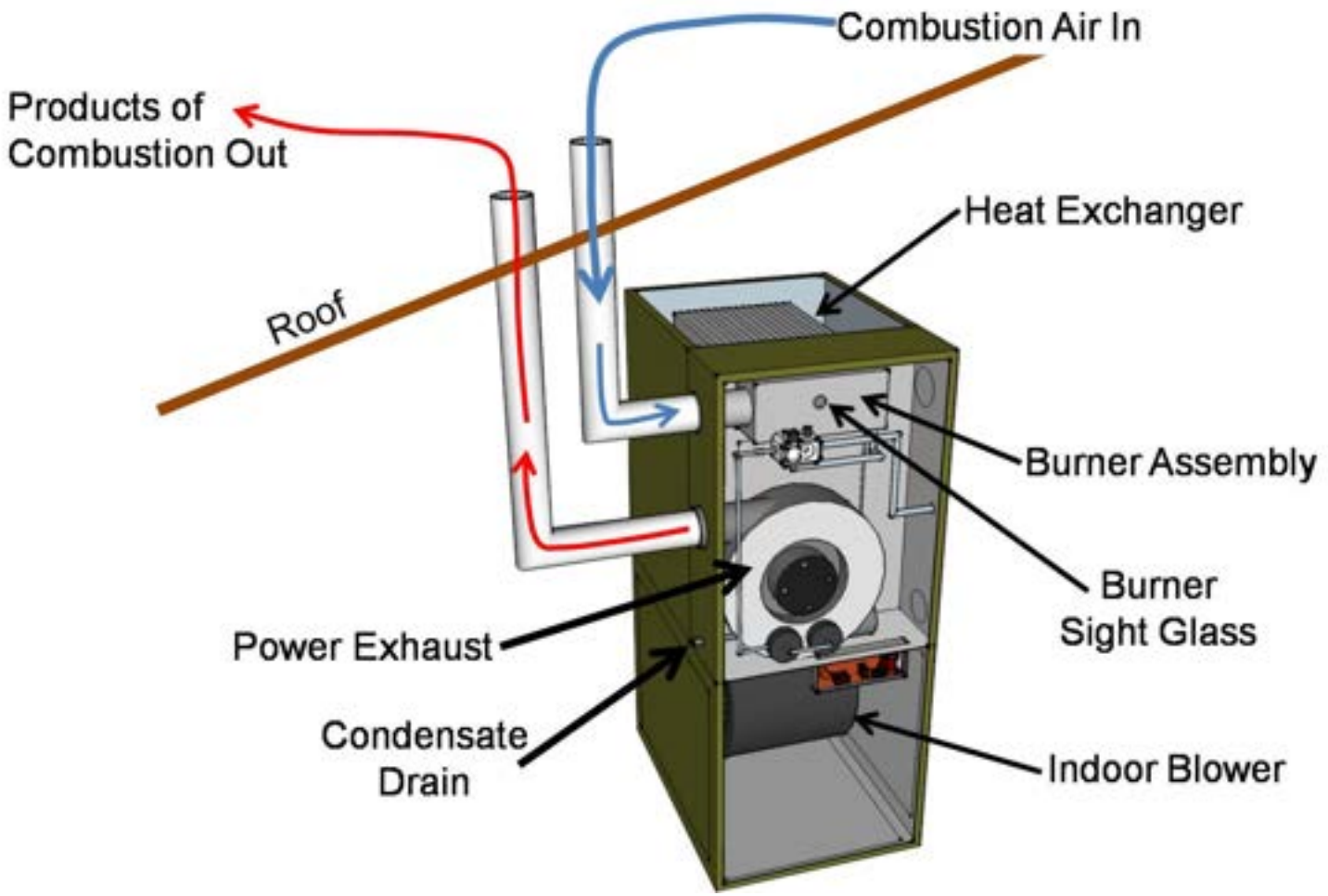
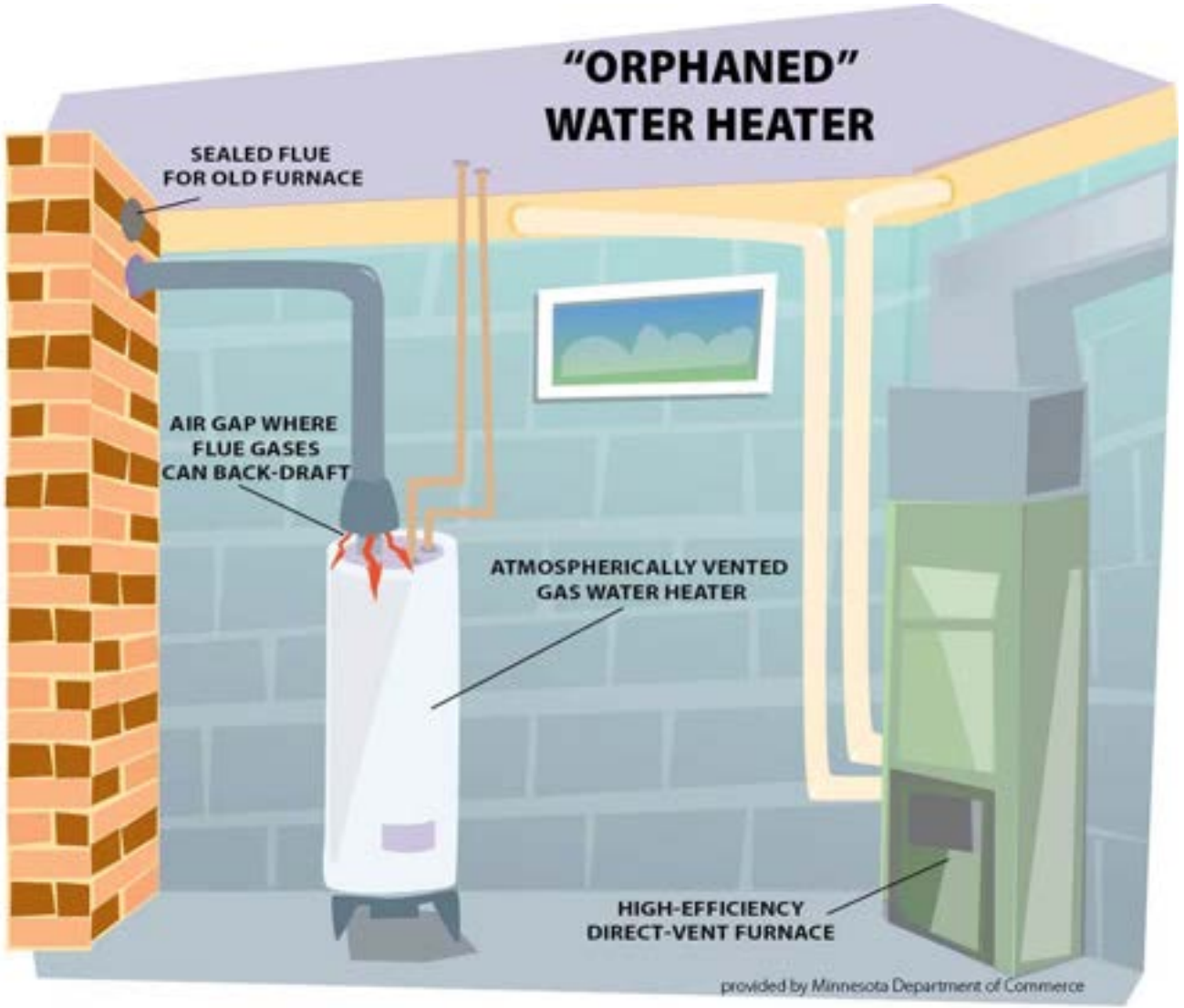


Diagram courtesy of Building America

Ameren MISSOURI



After upgrading to a high efficiency furnace, there may be insufficient "draft" in the chimney to properly exhaust the flue gasses from an atmospherically vented gas water heater. Under certain conditions this can lead to **dangerous levels** of carbon monoxide and other pollutants. Solutions include adding a power vent to the existing water heater or replacing with a new direct vent water heater.

Photo courtesy of InterNACHI

Ameren MISSOURI

Direct Vent Water Heater

- For new construction & retrofit replacement of electric water heaters
- Requires no electric power
- Uses double wall vent pipe
- All air for combustion is taken from outside. No chimney to install
- Can be side vented

Ameren MISSOURI

Power Vented Water Heater

- Uses 3” PVC or CPVC or ABS vent piping
- Vents horizontally or vertically
- High efficiency- up to 11% more than a standard EF water heater
- Electronic ignition (eliminates pilot)
- Pressure switch reduces backdraft risk

Ameren MISSOURI

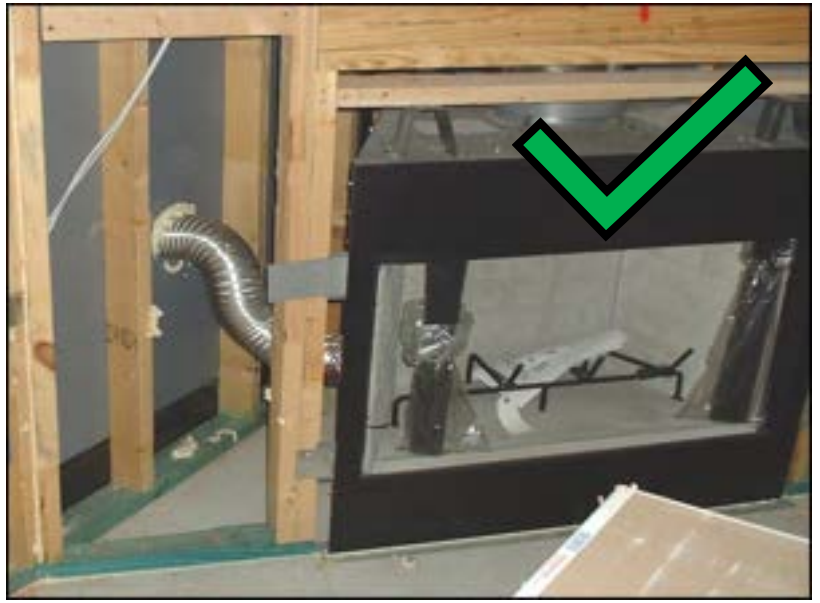
Tankless Water Heaters

- Only heats water when it is being used
- Eliminates standby energy losses associated with storage water heaters
- Can use multiple units in parallel for larger heating loads or in combination with traditional units
- Retrofits have “hidden cost” of running larger gas lines

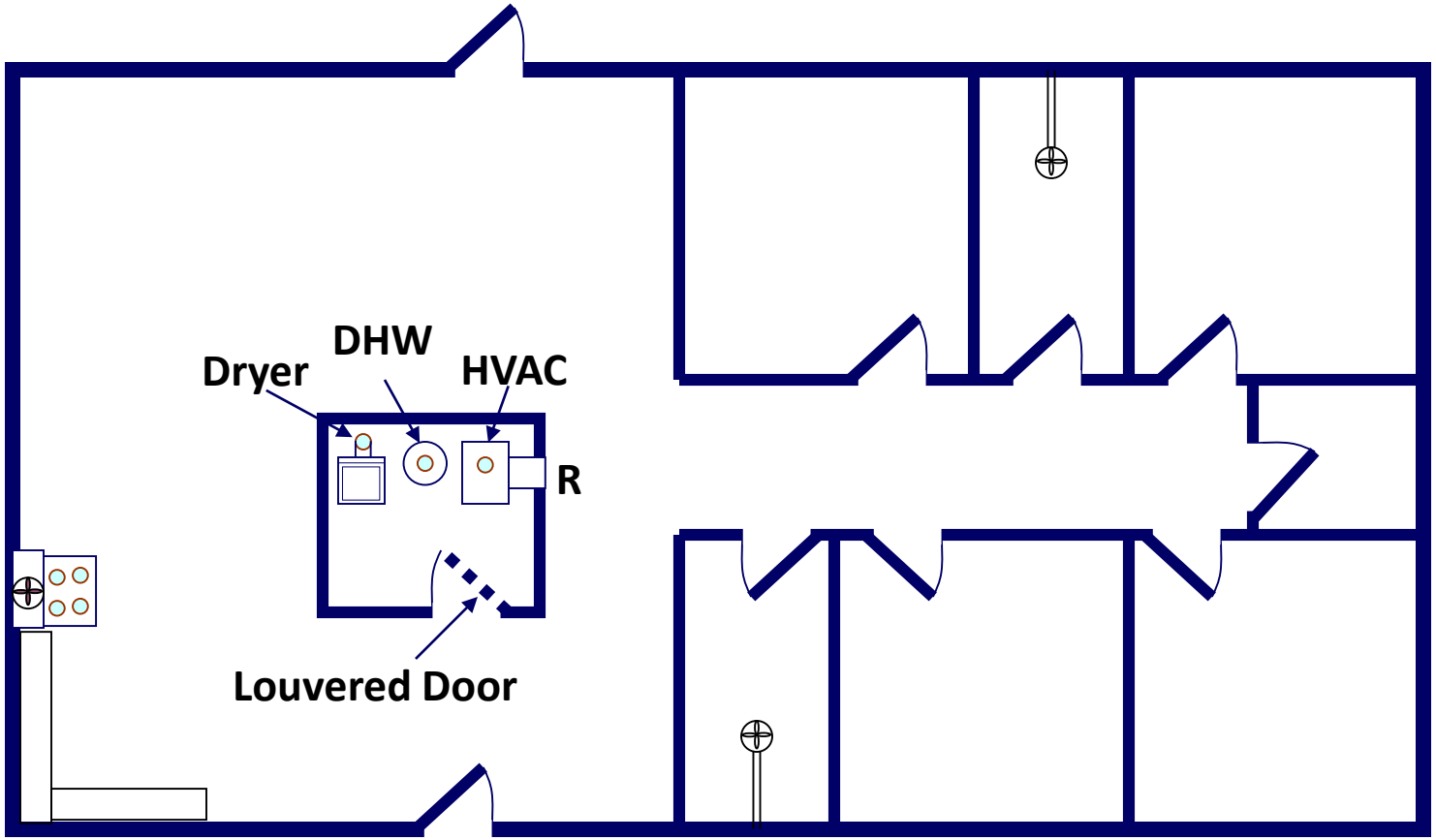
Ameren MISSOURI

Unvented Appliances

- *All* gas appliances can produce CO
- Fireplaces & other combustion equipment should be equipped with (a) flue pipe and (b) outside combustion air supply
- **Don’t use unvented gas appliances!**

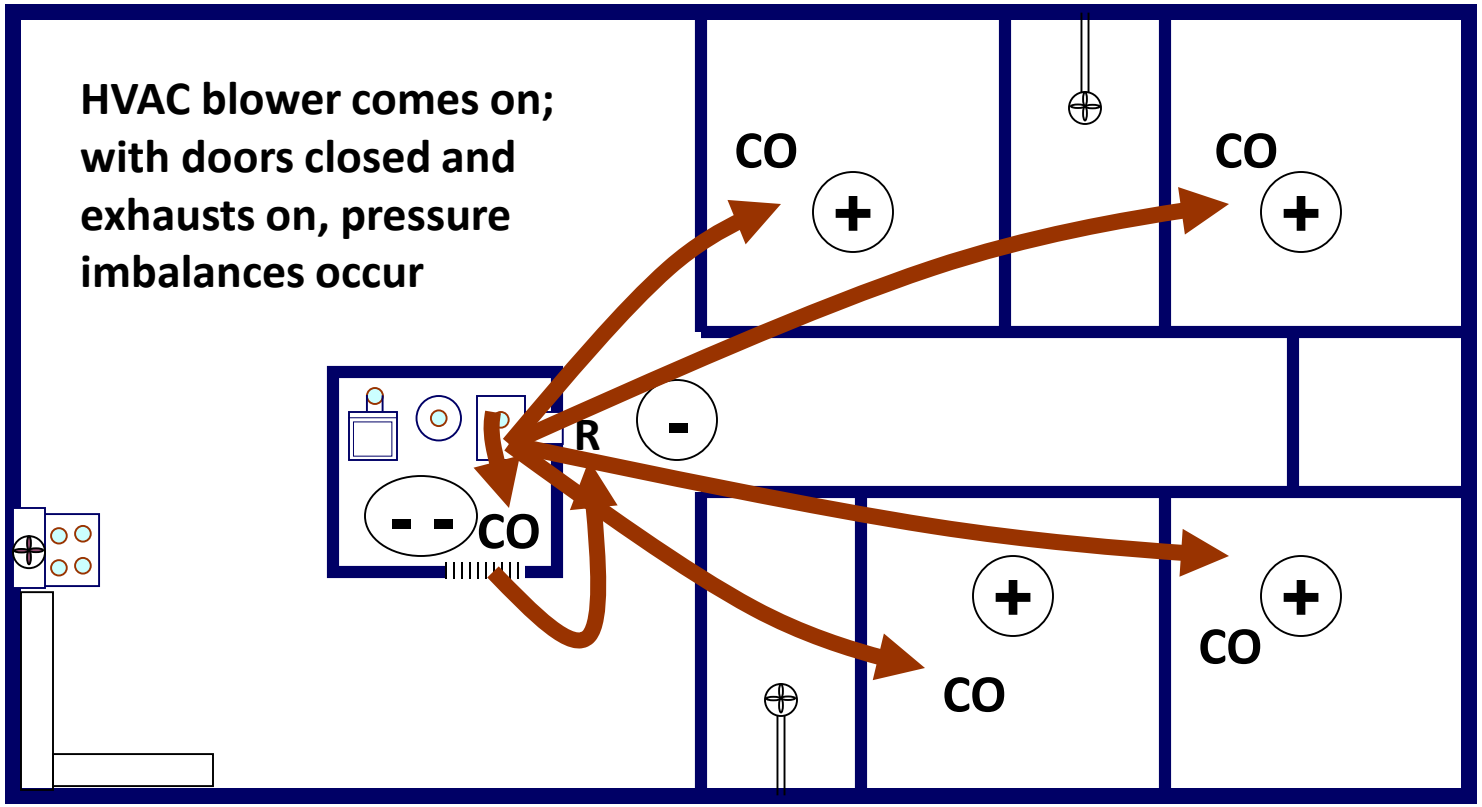


House as a System Problem



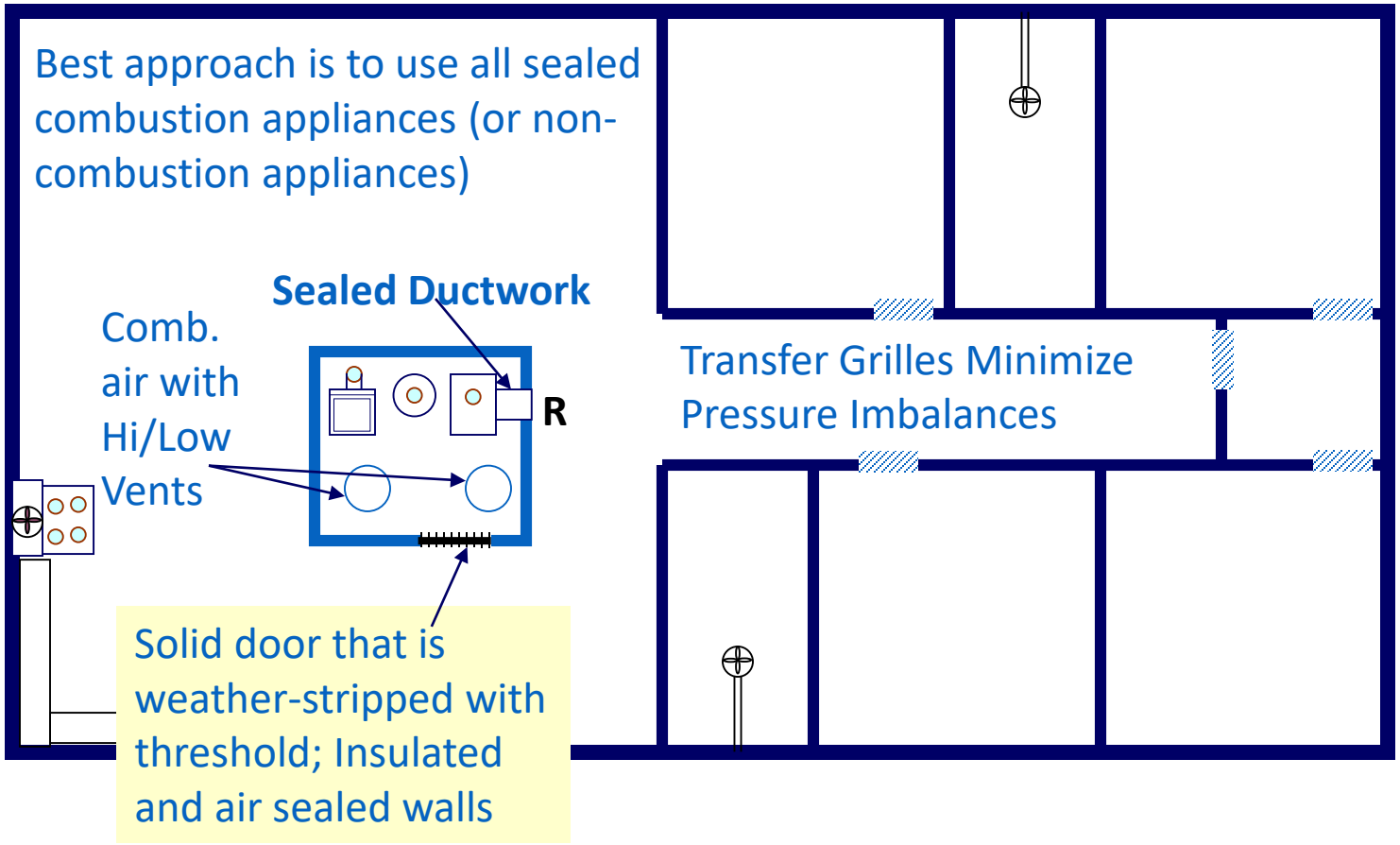
In this configuration, all equipment operated properly.

Negative Pressures



In this configuration, negative pressures caused backdrafting, which produced CO!

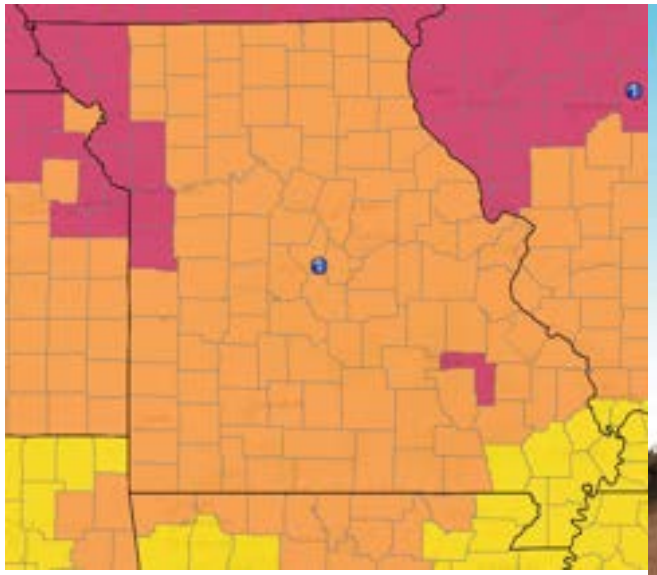
“House As A System” Approach



There are numerous ways to solve/prevent this problem!

Radon

- Radon is the second leading cause of lung cancer and the number one cause of lung cancer among non-smokers, according to EPA estimates
- Must test to know if radon is a problem and requires remediation
- Test after upgrades



Invisible killer: Spreading the word about radon cancer risk

FEATURE December 16, 2019 Georgia Health News 0

Ameren MISSOURI

Thermal Boundary

Improving Efficiency, Comfort, and Health in Existing Homes

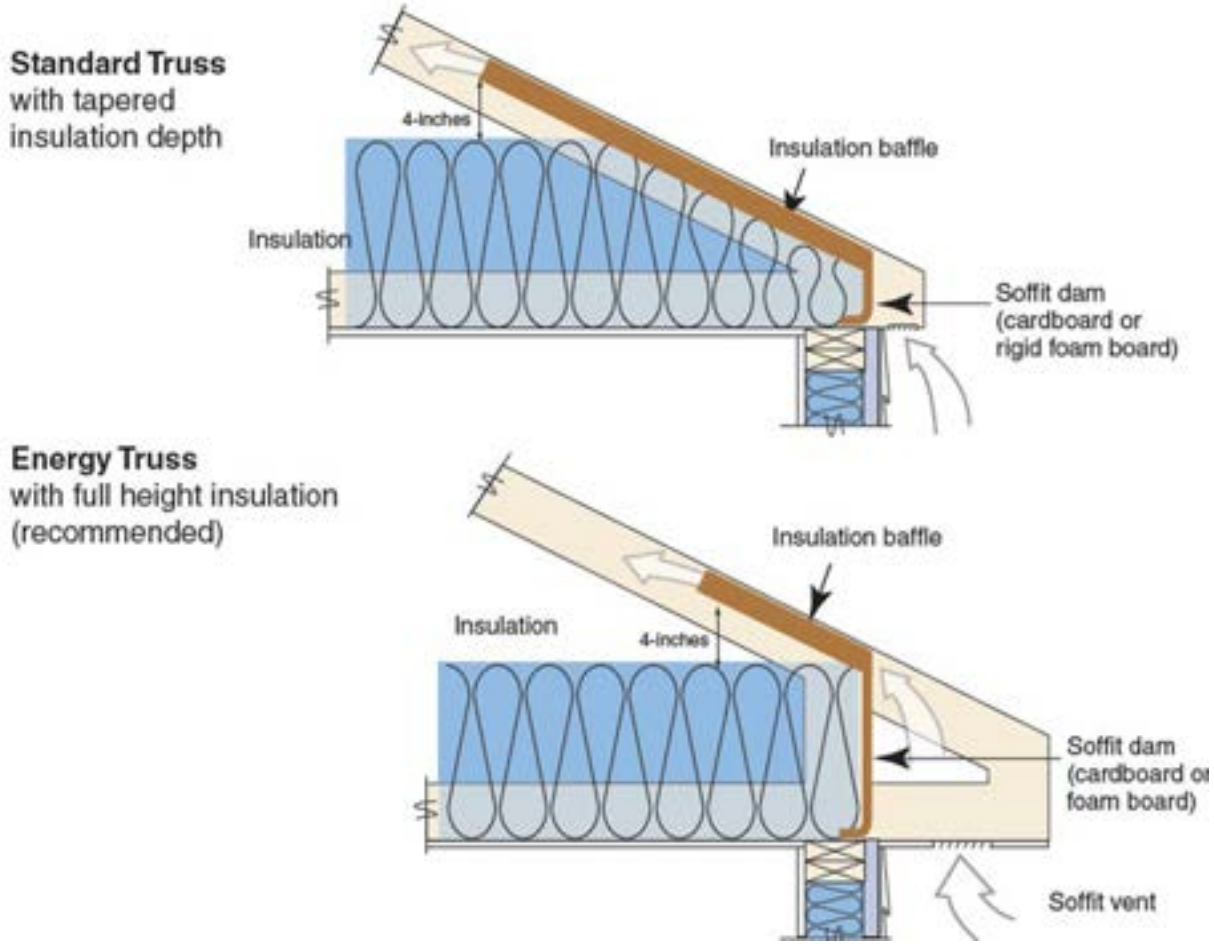
Ameren MISSOURI

402.2.1 – Ceilings with Attics

- R-49 is the prescriptive requirement in Zones 4 and 5
- Complete coverage of continuous R-38 (raised heel) is deemed to comply
- Rulers required every 300 sq.ft. for blown attic insulation
- First perform attic air sealing and prep, then add insulation
- Okay to install new insulation over existing (unless existing insulation is compromised)

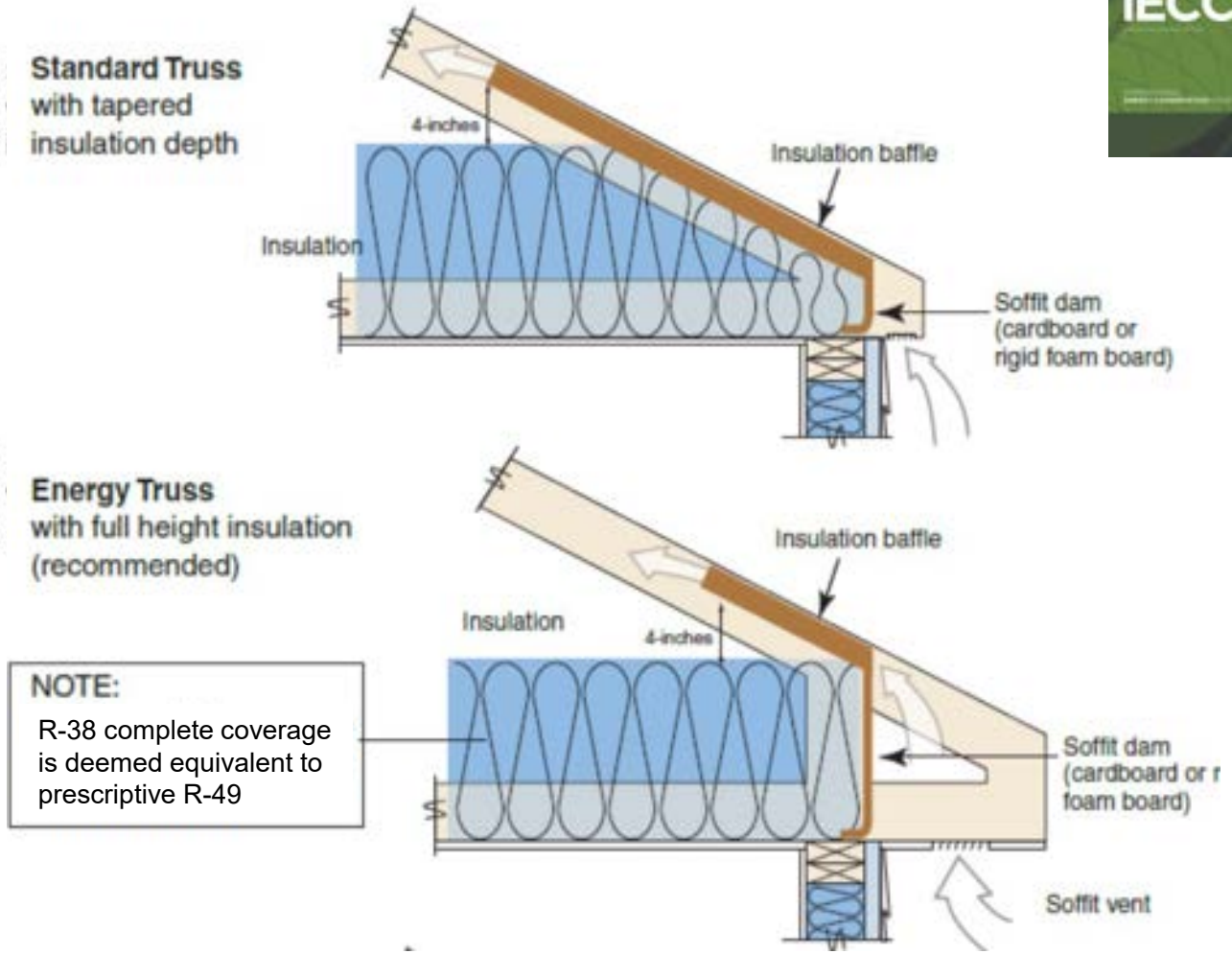
402.2.1 – Ceilings with Attics

- Insulation coverage needs to 100% of the ceiling area
- Best performance is full height, uncompressed R-49 insulation that **extends completely** over the wall top plate at the eaves (meets or exceeds code)



R402.2.1 Ceilings with Attic Spaces

R402.2.1 Ceilings with attic spaces. Where Section R402.1.2 requires R-38 insulation in the ceiling, installing R-30 over 100 percent of the ceiling area requiring insulation shall satisfy the requirement for R-38 wherever the full height of uncompressed R-30 insulation extends over the wall top plate at the eaves. Where Section R402.1.2 requires R-49 insulation in the ceiling, installing R-38 over 100 percent of the ceiling area requiring insulation shall satisfy the requirement for R-49 insulation wherever the full height of uncompressed R-38 insulation extends over the wall top plate at the eaves. This reduction shall not apply to the *U*-factor alternative approach in Section R402.1.4 and the Total UA alternative in Section R402.1.5.

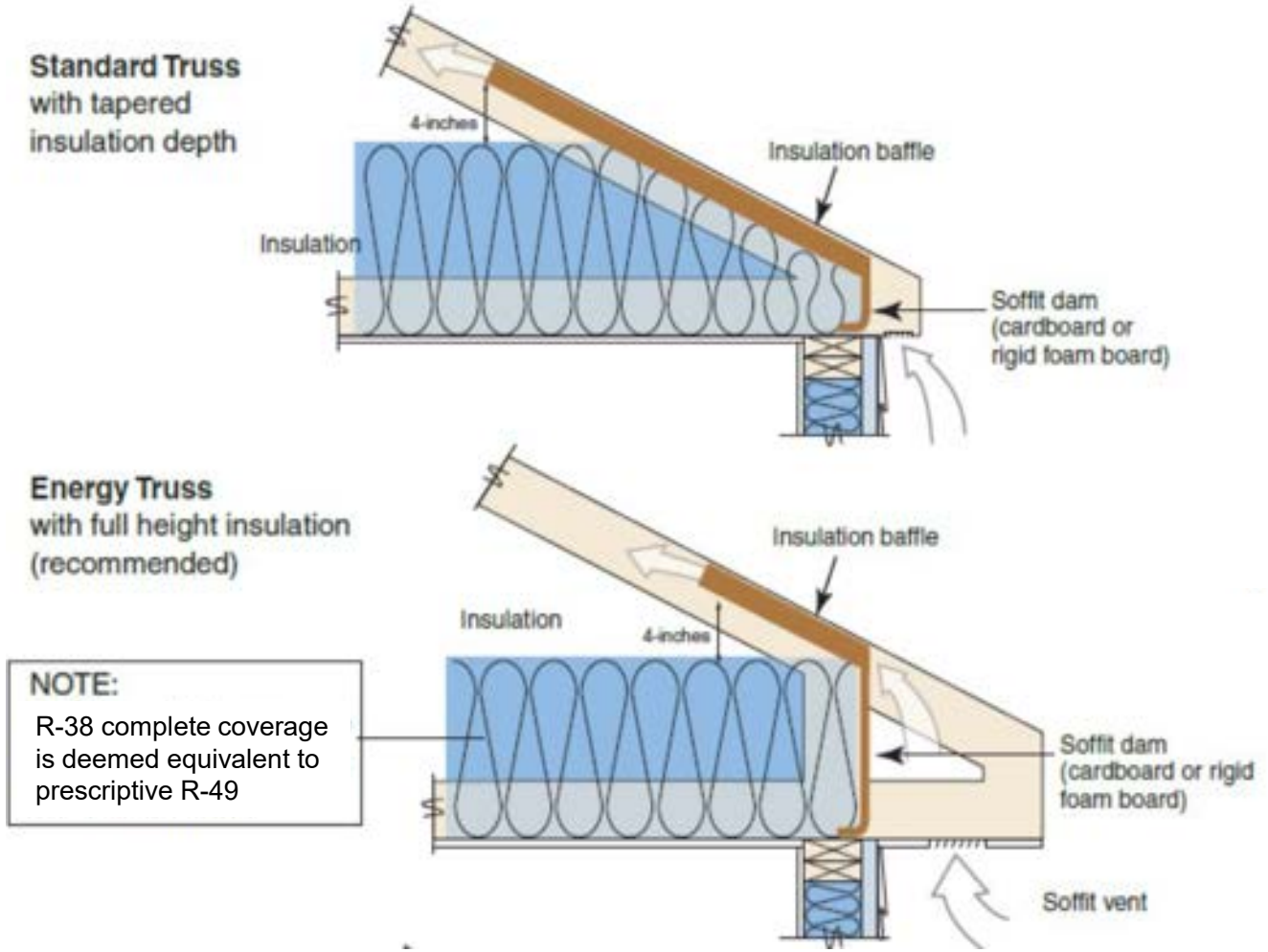


Eave Baffles

- For air-permeable insulation (fiberglass or cellulose insulation) in vented attics, baffles must be installed adjacent to soffit and eave vents
- At a minimum, 1 inch of space must be provided between the insulation and the roof sheathing and at the location of the vent
- The baffle must extend over the top of the insulation inward until it is ~4 inches vertically above the top of the insulation
- Any solid board material or thin insulating sheathing is permissible as the baffle /insulation dam

Ameren MISSOURI

R402.2.3 Eave Baffles



60

Ameren
MISSOURI

R402.2.2 Ceilings Without Attic Spaces

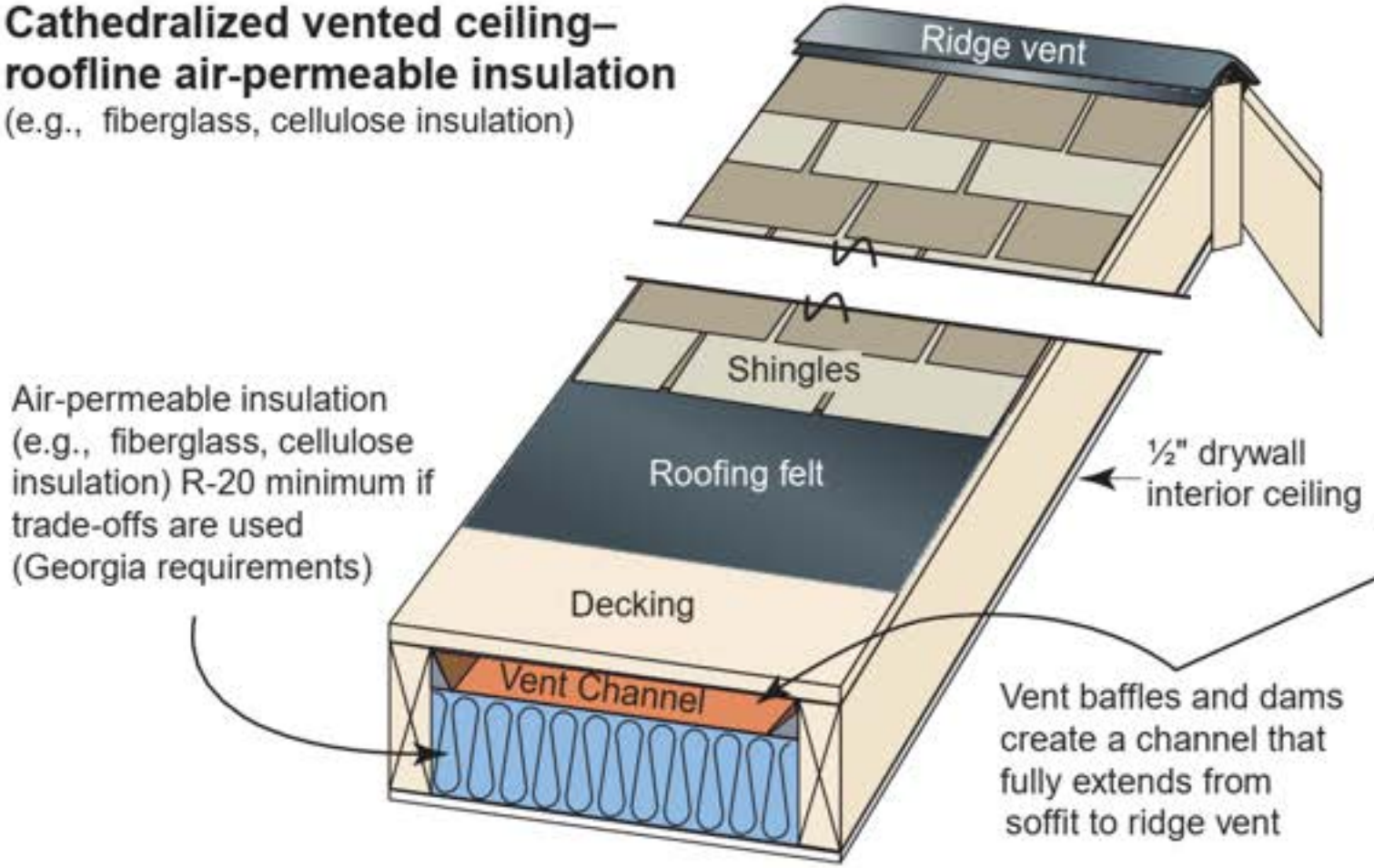
- If vaulted ceiling design does not allow sufficient space for required insulation, insulation can be reduced to R-30
- The area of the reduced insulation shall be limited to 20 percent of the insulated ceiling, (maximum 500 s.f.)
- For prescriptive path only

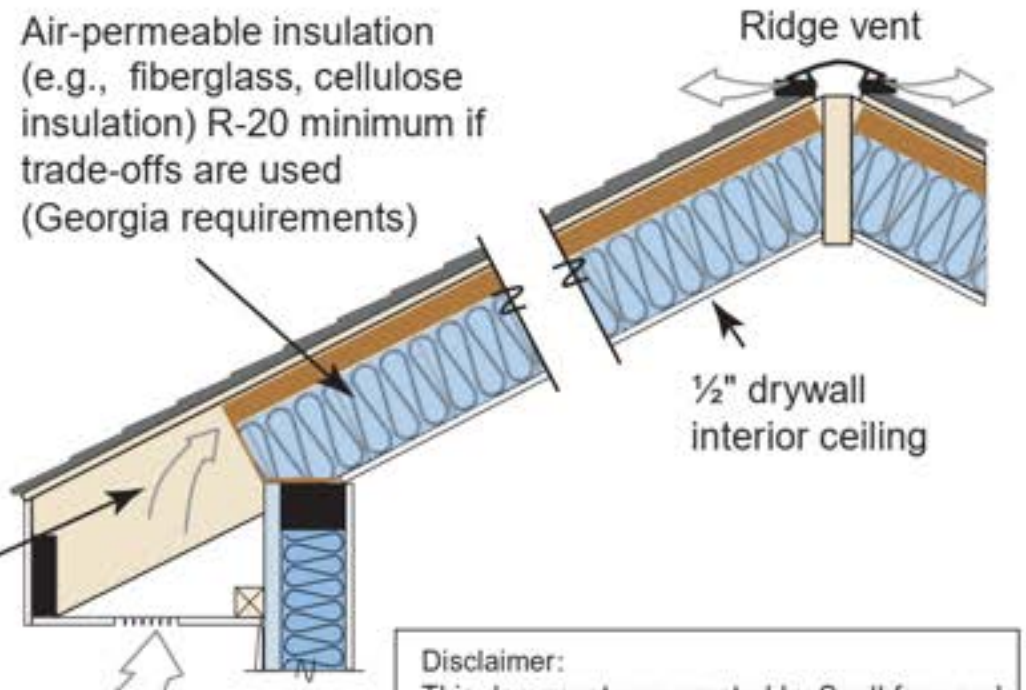
Ameren MISSOURI

62

Old School Vault with Vents

Cathedralized vented ceiling–roofline air-permeable insulation
(e.g., fiberglass, cellulose insulation)





Disclaimer:
This document was created by Southface and is intended solely to help graphically demonstrate the air leakage and insulation provisions of the 2015 IECC (2020 Georgia Energy Code). It does not cover all air sealing locations, materials or techniques. Other code provisions may be applicable as well.

Georgia International Energy Conservation Code Supplements and Amendments 2020

Ameren MISSOURI

63

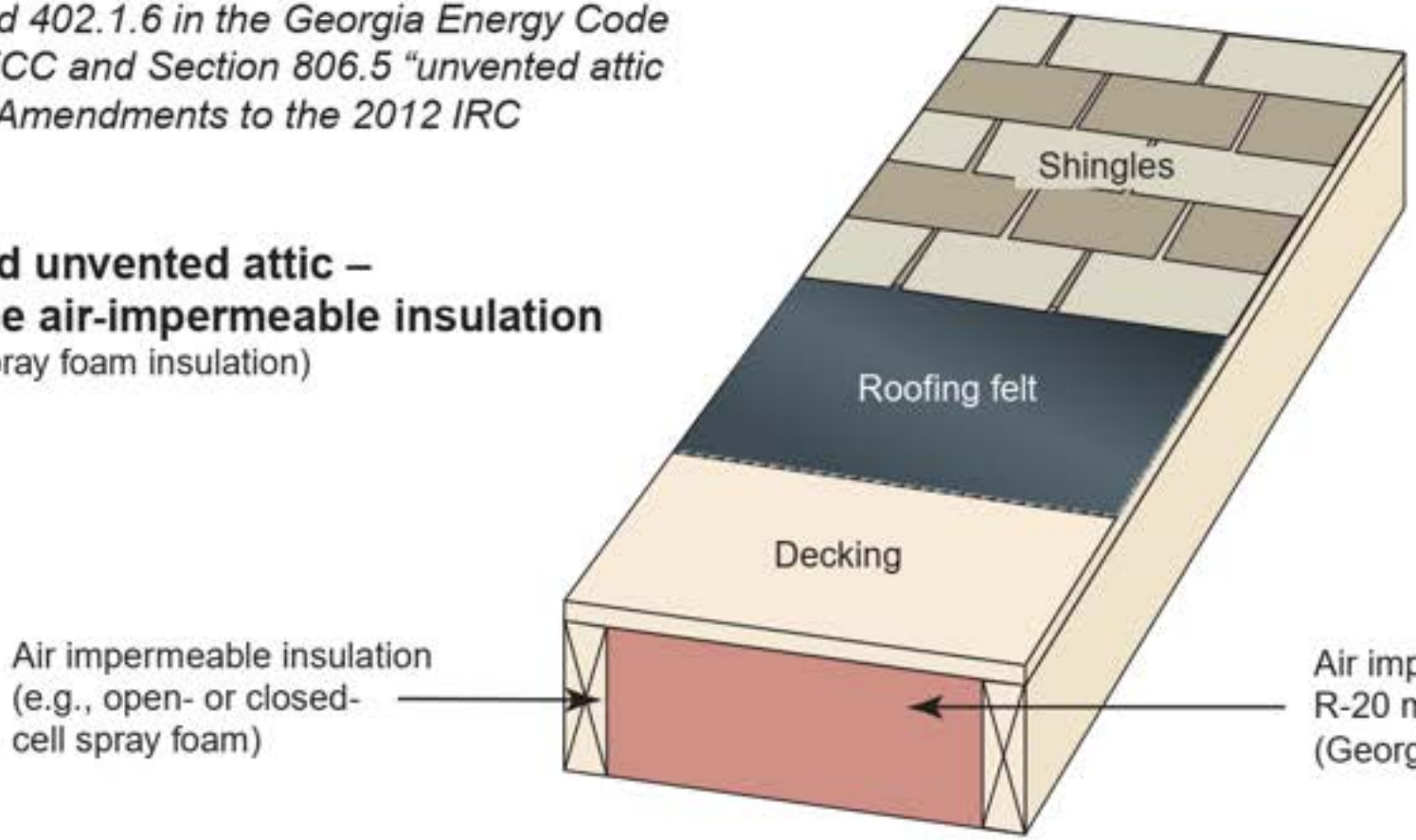
Unvented Vault with SPF

Appendix RA

Roofline Installed Insulation Options

Reference Table 402.1.1 and 402.1.6 in the Georgia Energy Code amendments to the 2015 IECC and Section 806.5 "unvented attic assemblies" in the Georgia Amendments to the 2012 IRC

Vaulted unvented attic – roofline air-impermeable insulation
(e.g., spray foam insulation)



Ameren MISSOURI

64

IRC 806.5 Unvented Roof Assemblies

- To reduce risk of condensation, install a certain amount of “air-impermeable” insulation before using an “air-permeable” product in an unvented roof assembly
- Provides Thermal break and also “Condensation break”

TABLE R806.5
INSULATION FOR CONDENSATION CONTROL

CLIMATE ZONE	MINIMUM RIGID BOARD ON AIR-IMPERMEABLE INSULATION *R*-VALUE[a, b]
2B and 3B tile roof only	0 (none required)
1, 2A, 2B, 3A, 3B, 3C	R-5
4C	R-10
4A, 4B	R-15
5	R-20
6	R-25
7	R-30
8	R-35

a. Contributes to but does not supersede the requirements in Section N1102.

b. Alternatively, sufficient continuous insulation shall be installed directly above the structural roof sheathing to maintain the monthly average temperature of the underside of the structural roof sheathing above 45°F (7°C). For calculation purposes, an interior air temperature of 68°F (20°C) is assumed and the exterior air temperature is assumed to be the monthly average outside air temperature of the three coldest months.

Ameren MISSOURI

65

Peachcrest Community Center – Roof Retrofit

66

Hybrid Insulation Approaches

Vaulted unvented attic – roofline air-permeable insulation
(e.g., fiberglass, cellulose insulation)

Option 1
Air impermeable insulation continuous above rafters (e.g. rigid foam board) combined with air-permeable insulation (e.g., fiberglass, cellulose insulation)

Air impermeable insulation (e.g. rigid foam board)

Shingles

Roofing felt

Decking

R-5 minimum in climate zones 2 & 3
R-15 minimum in climate zone 4

Air-permeable insulation (e.g.. fiberglass, cellulose insulation) R-20 minimum if trade-offs are used (Georgia requirements)

Option 2
Air impermeable insulation between rafters (e.g. rigid foam board or spray foam) combined with air-permeable insulation (e.g., fiberglass, cellulose insulation)

Shingles

Roofing felt

Decking

Air-permeable insulation (e.g., fiberglass, cellulose insulation) R-20 minimum if trade-offs are used (Georgia requirements)

Ameren MISSOURI

5.3. Where preformed insulation board is used as the air-impermeable insulation layer, it shall be sealed at the perimeter of each individual sheet interior surface to form a continuous layer.

67

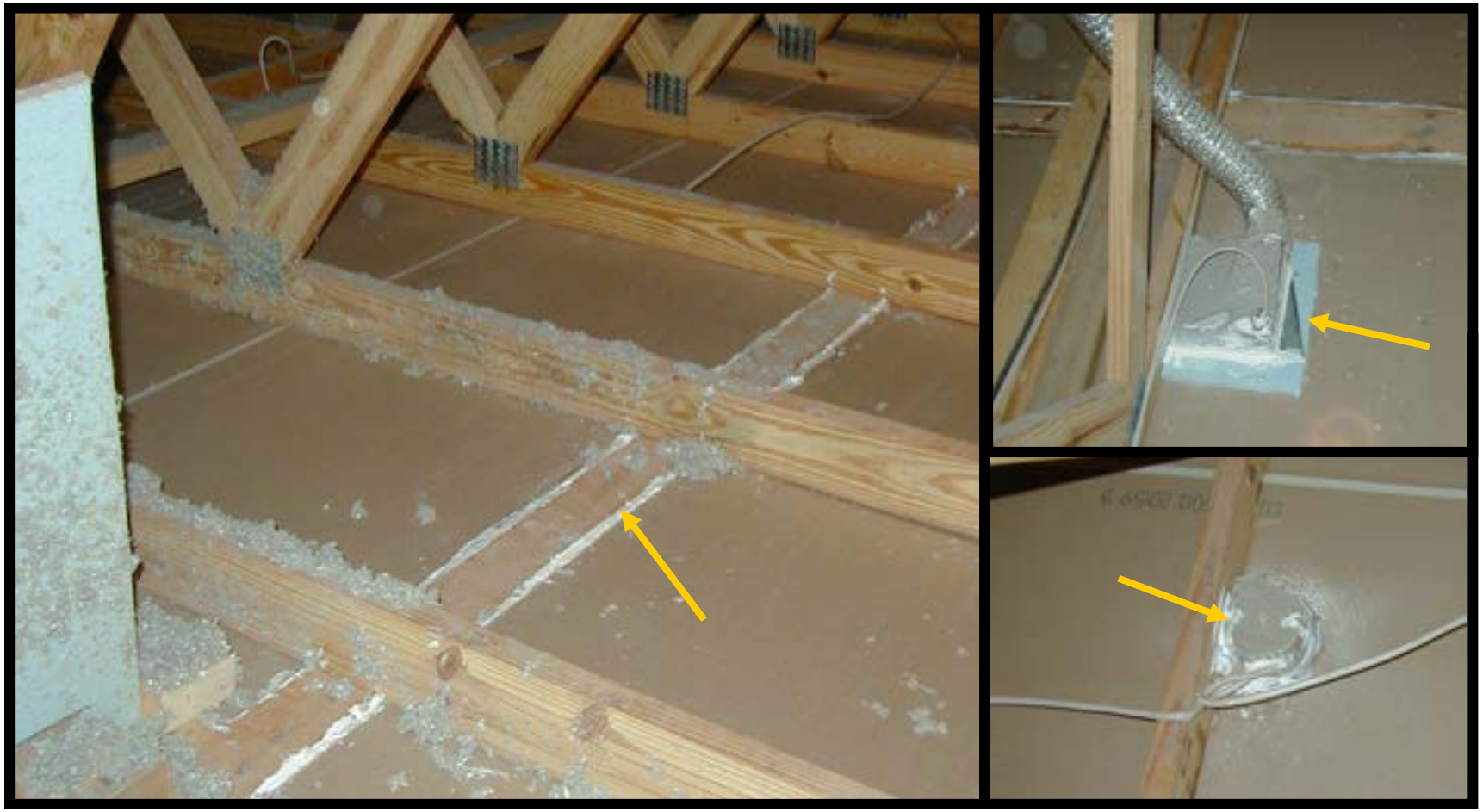
- Dams and baffles at eaves
- Electrical okay
- Air sealing performed
- Bath fans ducted to outdoors
- Decking/ catwalk elevated
- Rulers

- Dams and baffles at eaves
- Electrical okay
- Air sealing performed
- Bath fans ducted to outdoors
- Decking/ catwalk elevated
- Rulers

Ameren MISSOURI

Attic Air Sealing Before Insulation

- Top plate to drywall (interior wall cavities often connect to attic)
- Duct and electrical penetrations



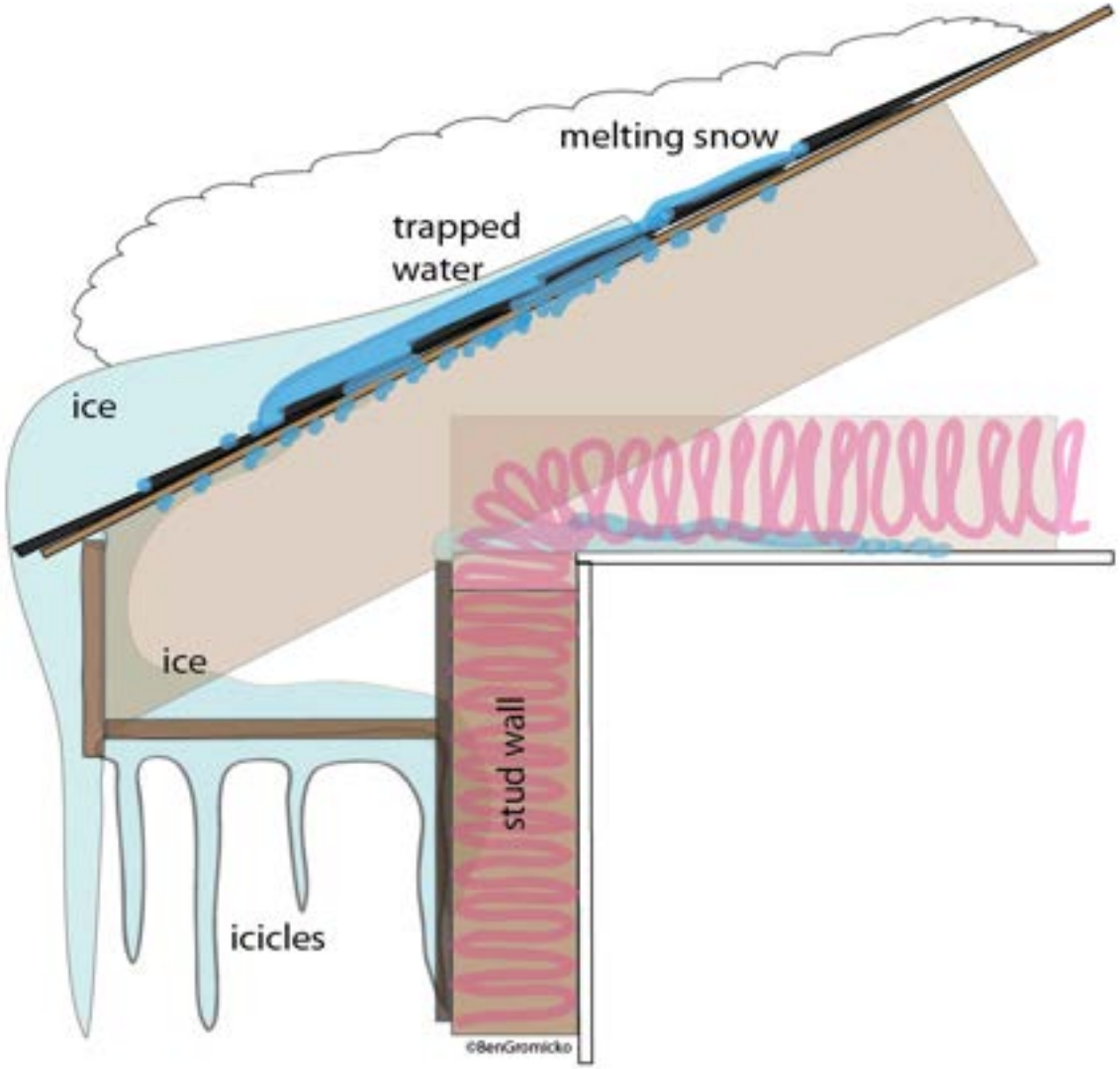
Attic Air Sealing Before Insulation

- Seal plumbing, HVAC, and electrical penetrations

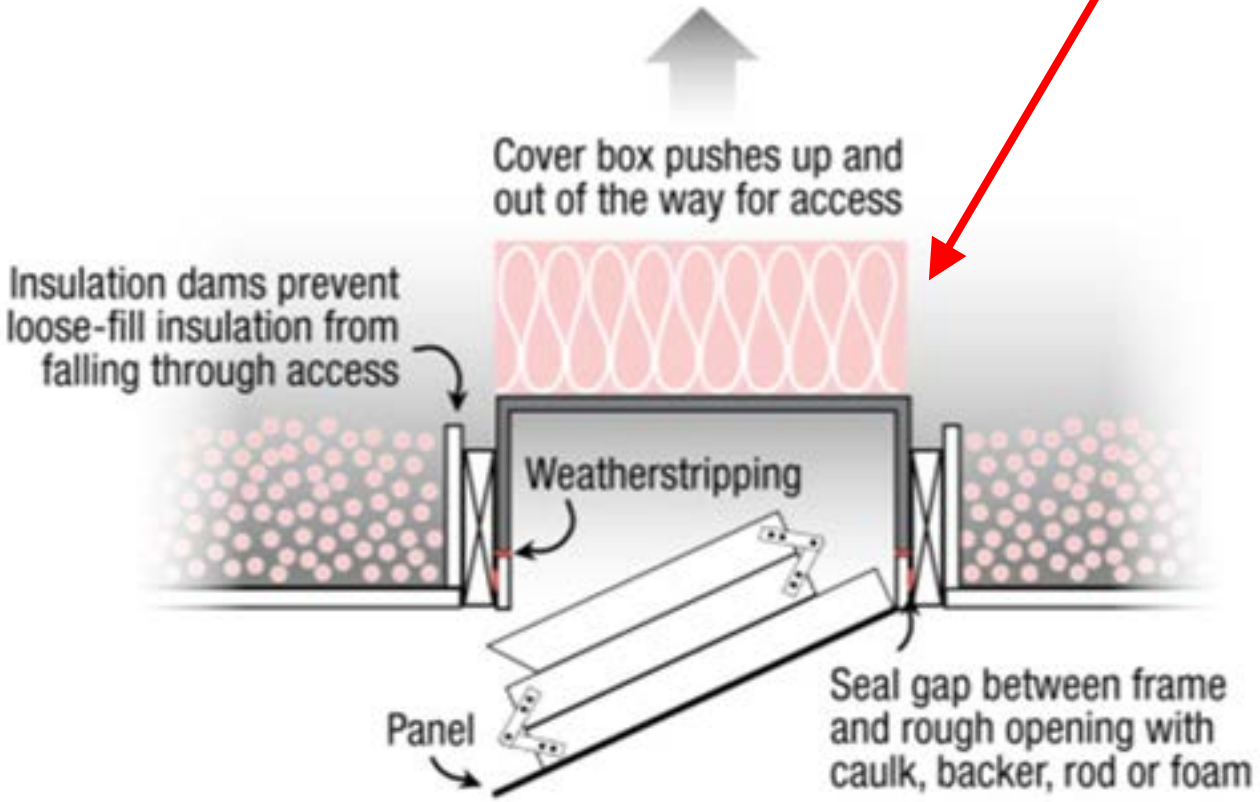
- Dams and baffles at eaves
- Electrical okay
- Air sealing performed
- Bath fans ducted to outdoors
- Decking/ catwalk elevated
- Rulers

Ice Damming

- If there are air leaks or the insulation is not continuous (e.g., does not cover the top plate), heat from the interior will transfer through the compromised insulation to the roof, causing snow to melt on the roof and cause ice damming



Attic Stairs



Graphic courtesy of http://www.energysavers.gov

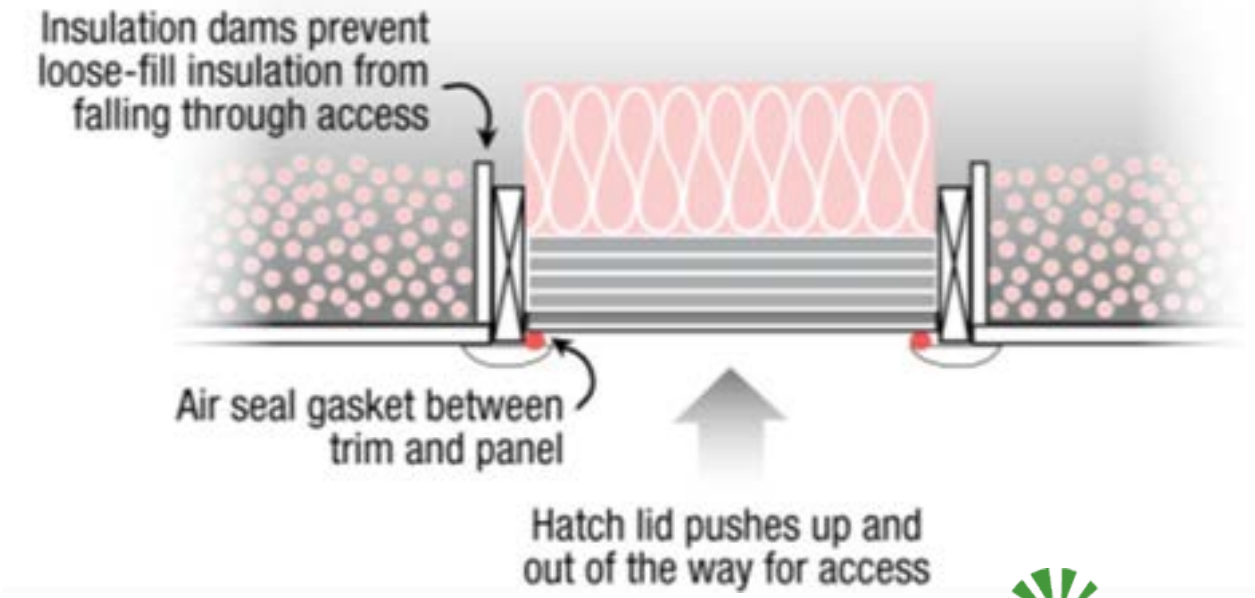
Foam board stairs cover (assembled with mastic and nails, batt glued to top)

Insulation in stairs door

Ameren MISSOURI

Attic Access Options

Attic Hatches



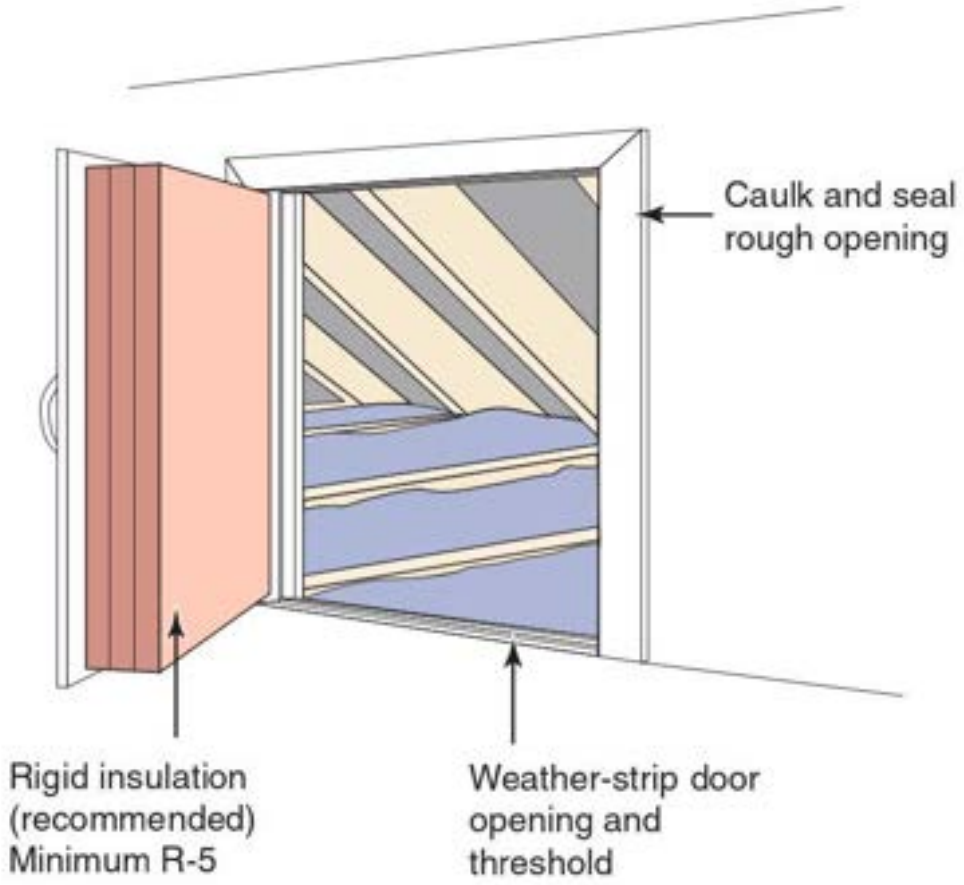
Graphic courtesy of http://www.energysavers.gov

Ameren MISSOURI

Attic Doors

Vertical doors should have a minimum of R-5 and must be weather-stripped for air sealing.

Ideally, should have same R-value as knee wall.

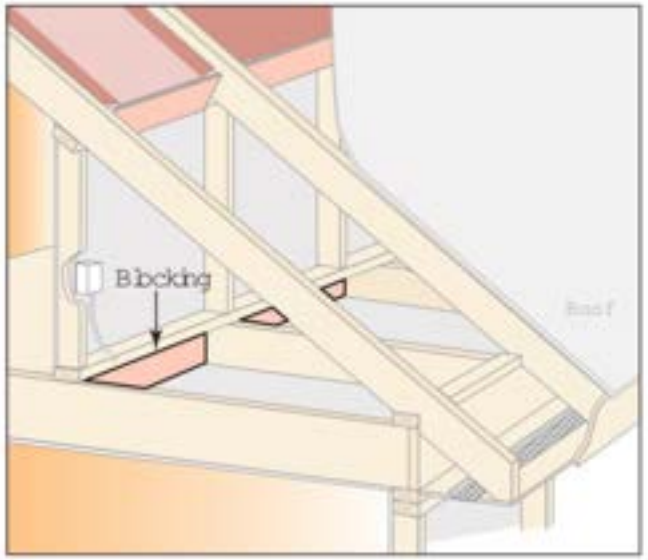


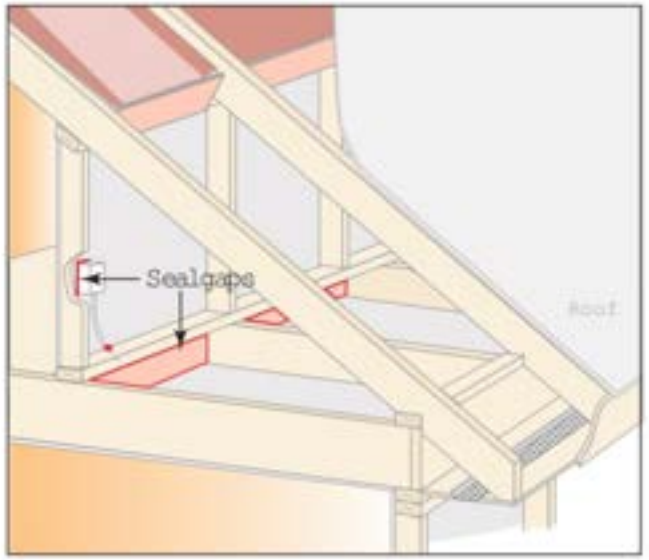
Knee Walls

No blocking under knee walls

Air permeable knee wall insulation needs to be encapsulated on **all** sides

Knee Walls





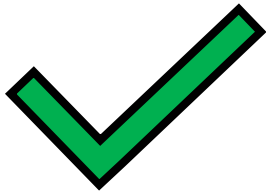
Ameren MISSOURI

R402.2.8 Floors

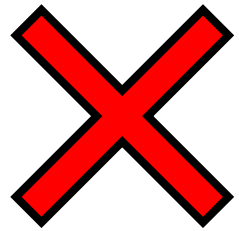
- Floor insulation must maintain **permanent** contact with the subfloor.

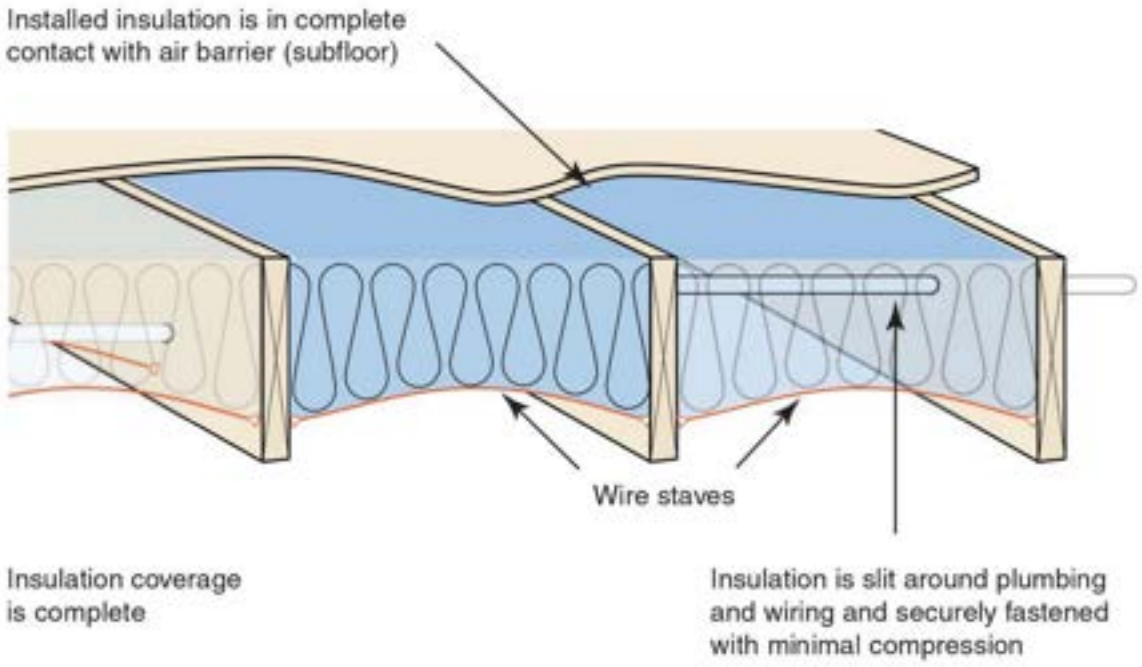
Floor Insulation

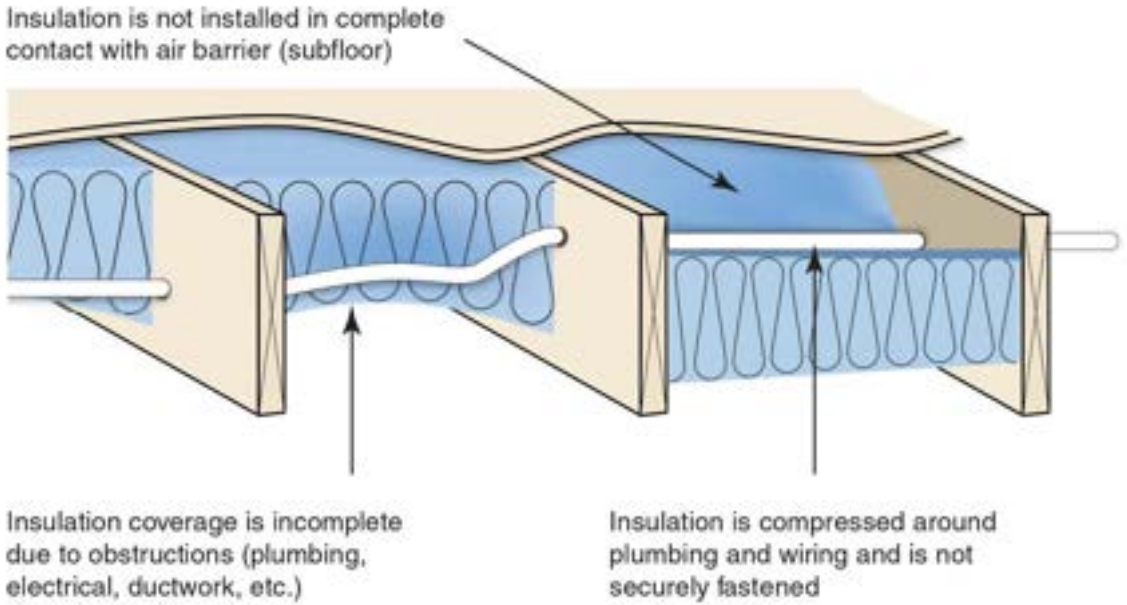
GOOD!



BAD!

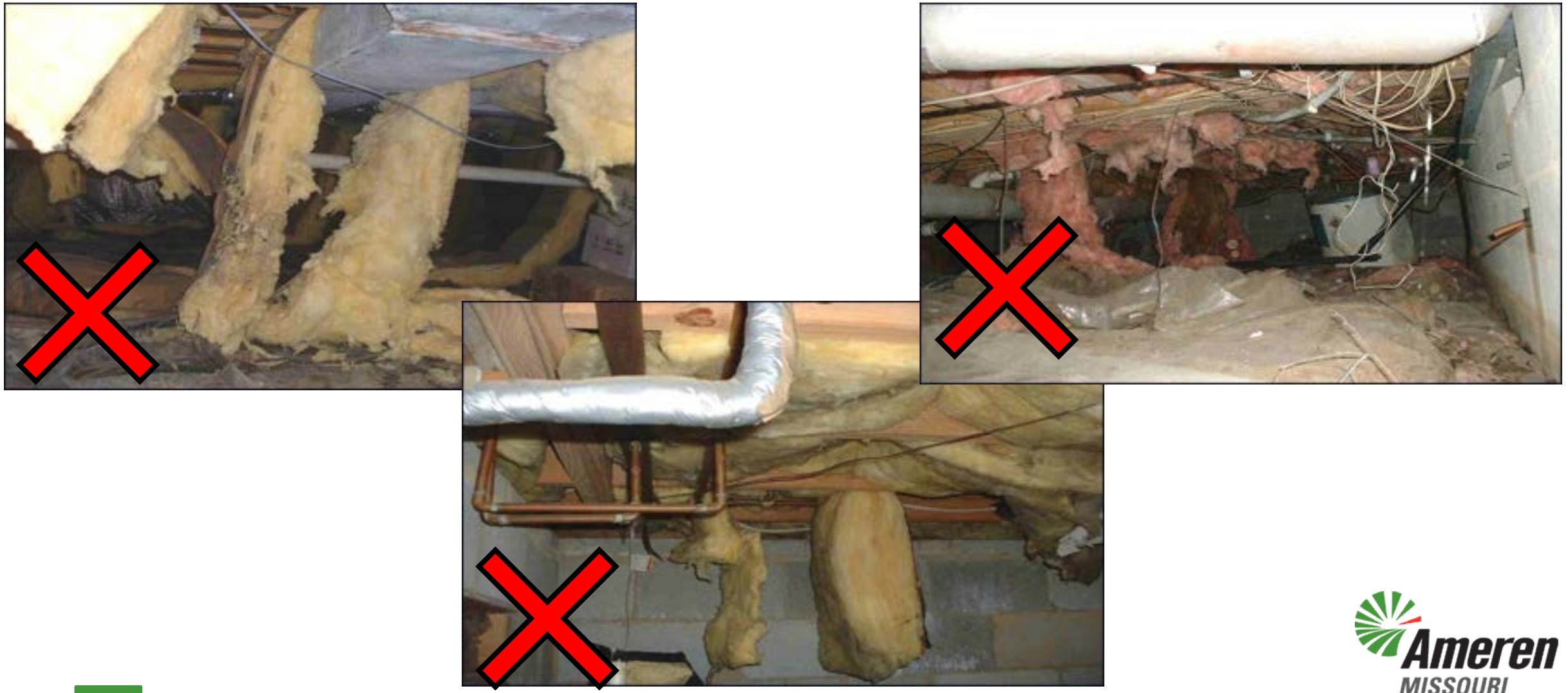




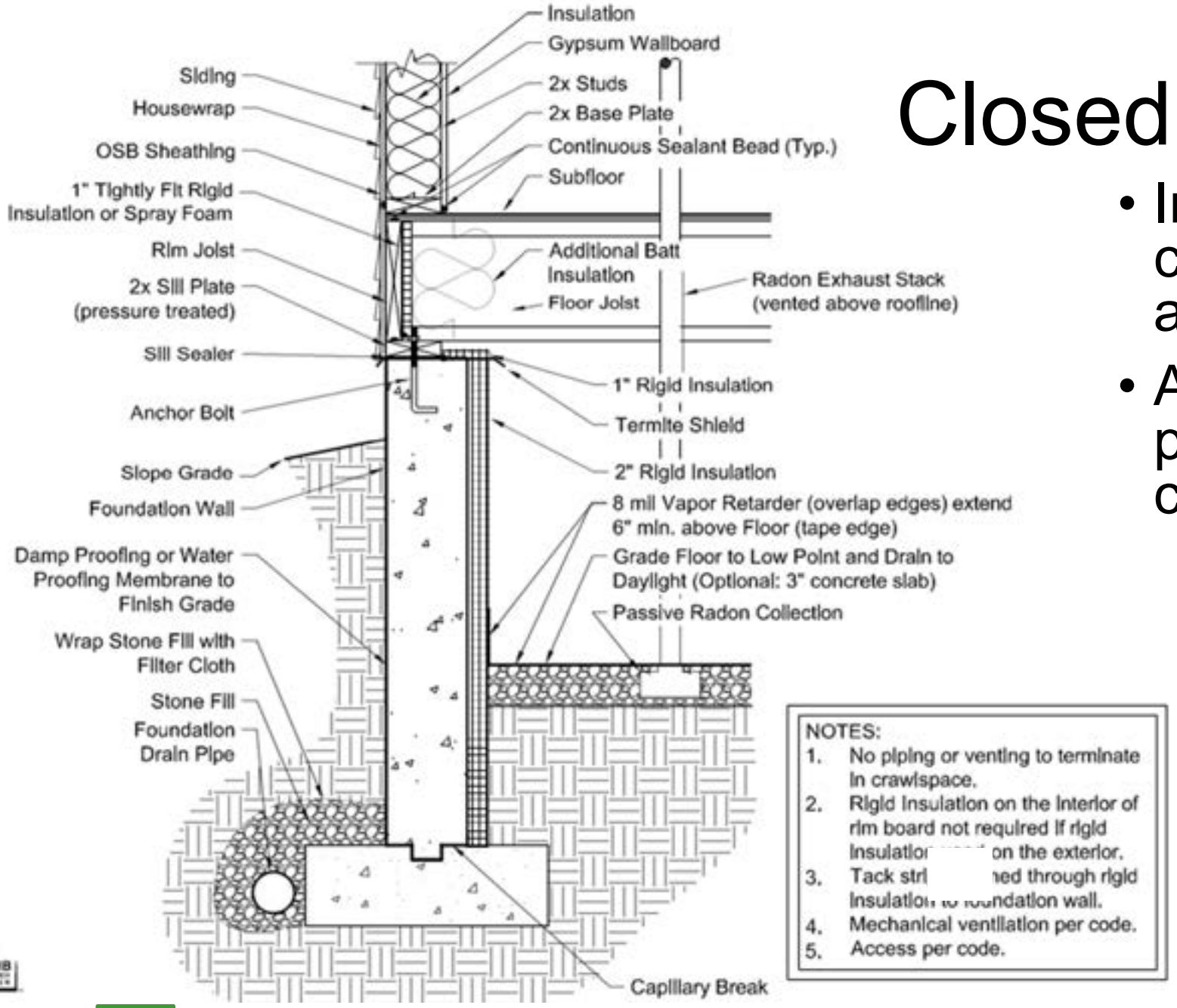


Ameren MISSOURI

Problems with Floor Insulation



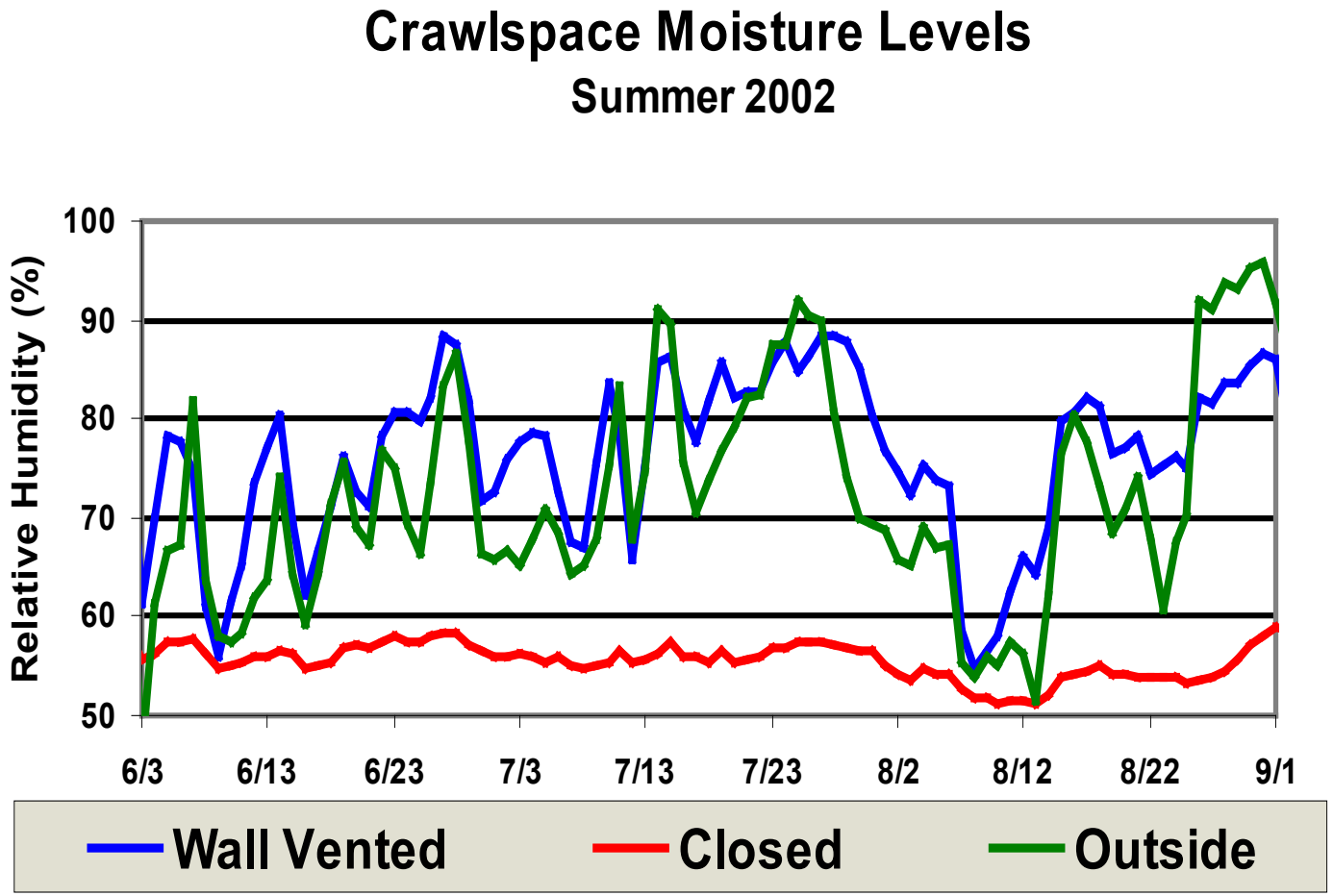
Closed Crawlspaces



- In mixed-humid climates, crawlspace encapsulation is an excellent option
- A properly sealed, moisture-protected, and insulated crawlspace will:
  - increase comfort,
  - save on energy costs
  - improve the durability homes
  - reduce moisture intrusion
  - reduce pest entry

Ameren MISSOURI

Closed Crawlspace Case Study



- If crawlspace is vented, the humidity levels will often be at least as high as the ambient air

www.crawlspaces.org

Ameren MISSOURI

R402.2.11 Crawlspace Walls

- Air seal & insulate band area
- Insulation must be permanently fastened and extend at least to the finished interior grade
- Pest control inspection strips required in some areas
- Complete plastic sealed to walls at least 6 inches up the stem wall
- Overlap seams by 6 inches

Ameren MISSOURI

Insulation techniques – Crawl Walls

Ameren MISSOURI

86

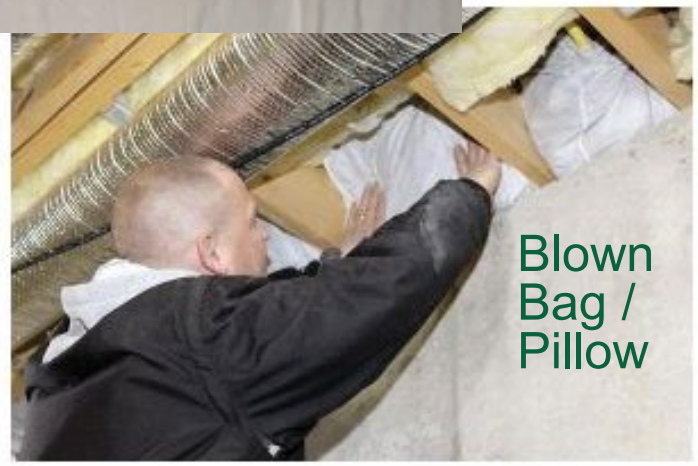
Insulation techniques – Band area

Open/ Closed Cell Foam

Caulk and Fiberglass Batt

- Pest Control industry struggles with band area fully filled with SPF
- SPF that fills band blocks inspection for pest control
- Air seal and then insulate with movable insulation product (batts, pillows, rigid board, etc.)

- Must air seal and insulate rim/band area in basements & crawlspaces



Blown Bag / Pillow

The band joist area can be a challenge to insulate correctly. For installers working with blown fiberglass or cellulose, a fire-rated bag can be filled with blown insulation on site, then friction fit between joists.

Ameren MISSOURI

87

Crawlspace Walls

- Seal ground with minimum 6 mil plastic (6” up walls, 6” overlaps)
- Eliminate all vents and leaks (access doors sealed and insulated)
- Insulate all walls to R-10 continuous
- Use a sealed combustion/direct vent furnace or install a heat pump
- Condition crawlspace
  - Supply air
  - Dedicated dehumidifier (Best!)
- Install moisture sensor and alarm

Ameren MISSOURI

Atmospherically Vented Appliances

- Do **not** use atmospherically vented appliances in closed crawlspaces or attics

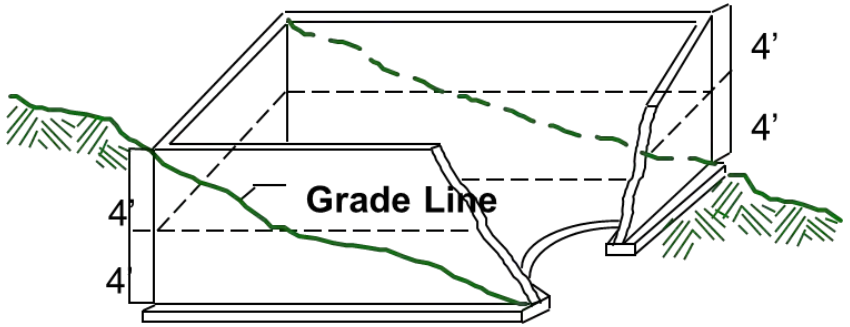
Systems Approach to Basements

Advantages to insulating *all* basement walls:

- Wall insulation lasts longer and stays in place better (R-10 wall in CZ4 vs. R-19 floor)
- Ducts and AHU are brought inside thermal envelope
- Main floor level is more comfortable
- Basement may be finished or unfinished

Ameren MISSOURI

Basement Walls



- Basement Wall – Average gross wall must be > 50% below grade and enclosed conditioned space

- CZ4: R-10 continuous or R-13 cavity

- CZ5: R-15 continuous or R-19 cavity

Try to avoid cavity insulation; continuous insulation performs better

Ameren MISSOURI

Basement Insulation Strategies

Cellulose batt

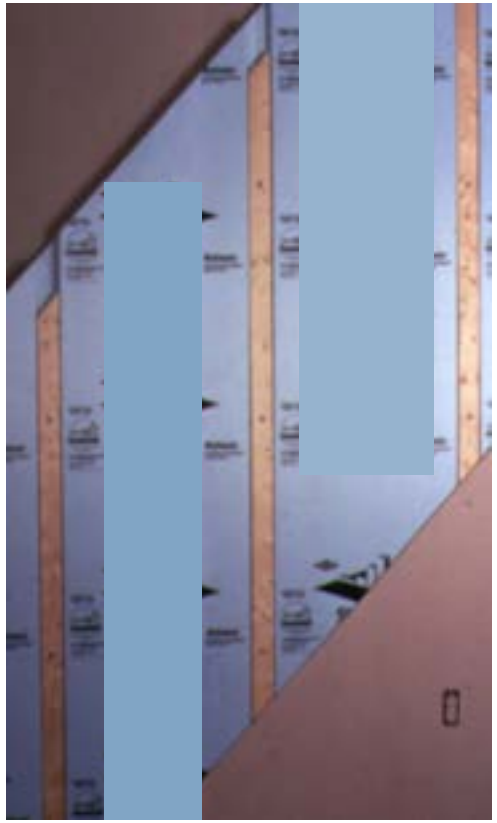
https://www.youtube.com/watch?v=la0ihgfqRDw

Fiberglass batts with vinyl backing

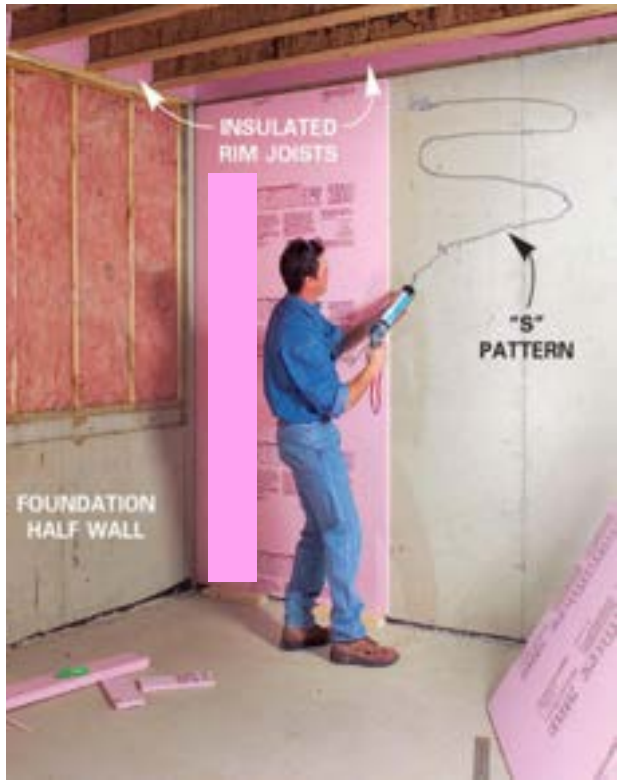
Foil-faced rigid foam board

Basement Insulation Strategies

Rigid foam board



Foam board on concrete



Spray Polyurethane foam

Ameren MISSOURI

Interior Insulation Strategies

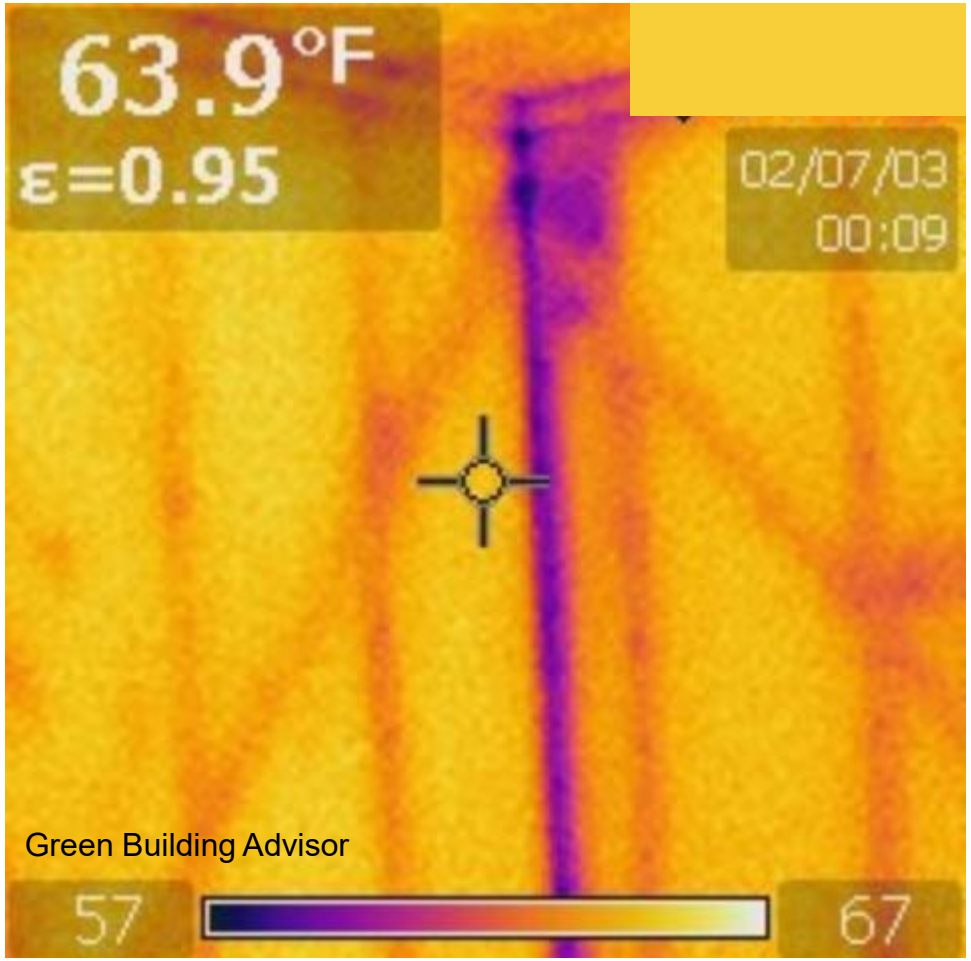
Blanket Basement Insulation Options

Exterior Wall Insulation

- Insulation must be applied to wood-frame, steel-frame, and mass walls that are above grade and associated with the building thermal envelope
- R20 or R13+5 c.i. is current IECC
- Continuous insulation is desirable because it prevents thermal bridging and is more effective overall

Thermal Bridging

- Studs conduct heat better than insulation, so each stud acts as a thermal bridge
- Continuous insulation creates a thermal break, which slows down conduction considerably
- Consider continuous insulation when renovating exterior walls. It can be installed on the interior or exterior (preferred) depending on the scope of the remodel



Ameren MISSOURI

Insulating Exterior Walls

Insulating Exterior Walls

Insulating Exterior Walls

Insulating Exterior Walls: from inside – drill holes and patch

Siding Remains: Drainage Plane Retrofit – Interior Stripped to Studs

- Install vertical spacer strips (sill gasket or foam strips) into sides of cavity
- Install ½" foam board piece (~14.25" width) against strips
- Seal edges with caulk or foam
- Slightly compress batt into cavity against foam board

Siding Remains: Drainage Plane Retrofit – Interior Stripped to Studs

Wall and Ceiling Vapor Retarders

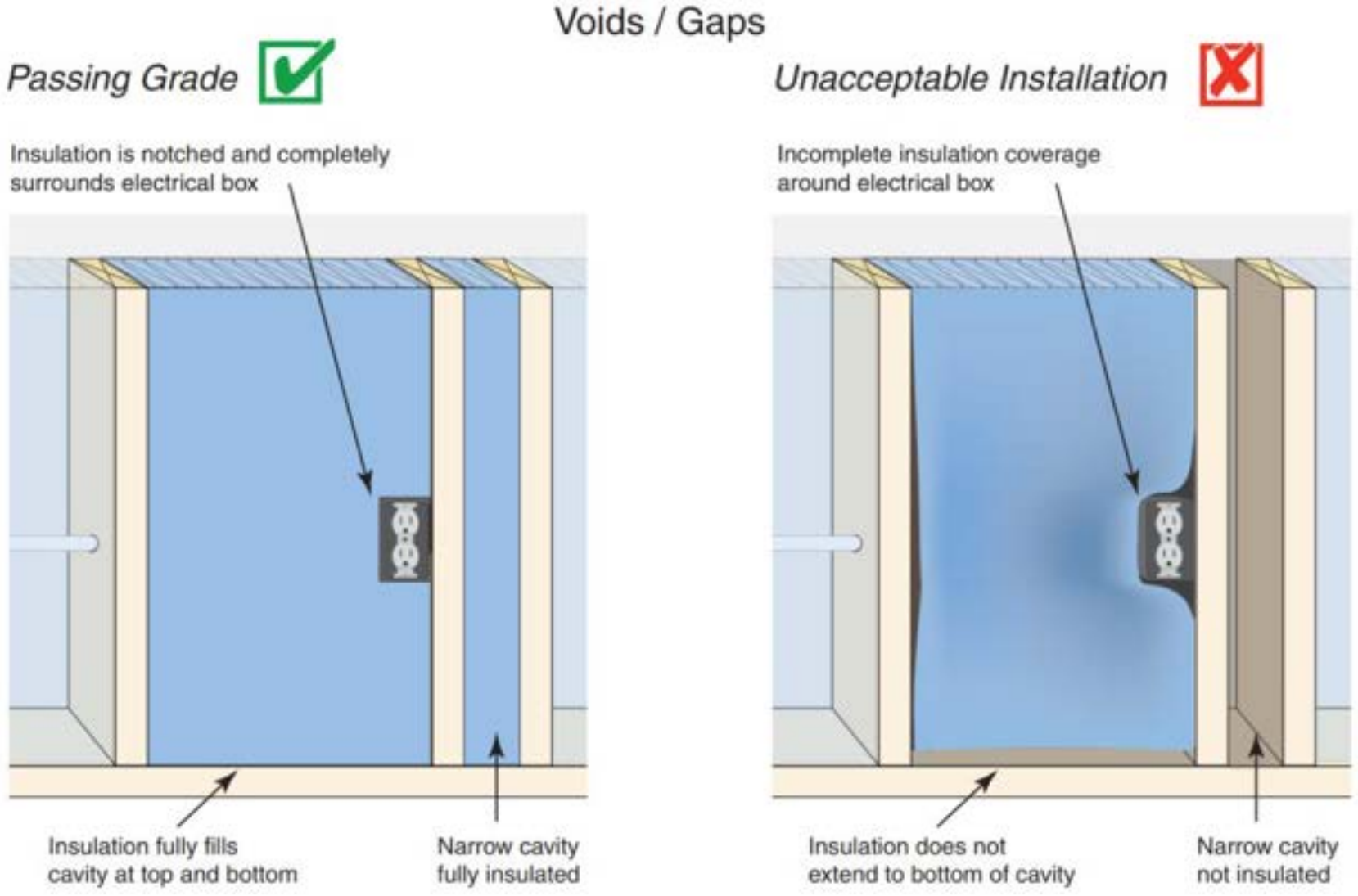
Not required in CZ 1-4

Class 1 or 2 vapor retarder is required on the interior side of frame walls per IRC in zone 5. Except for:

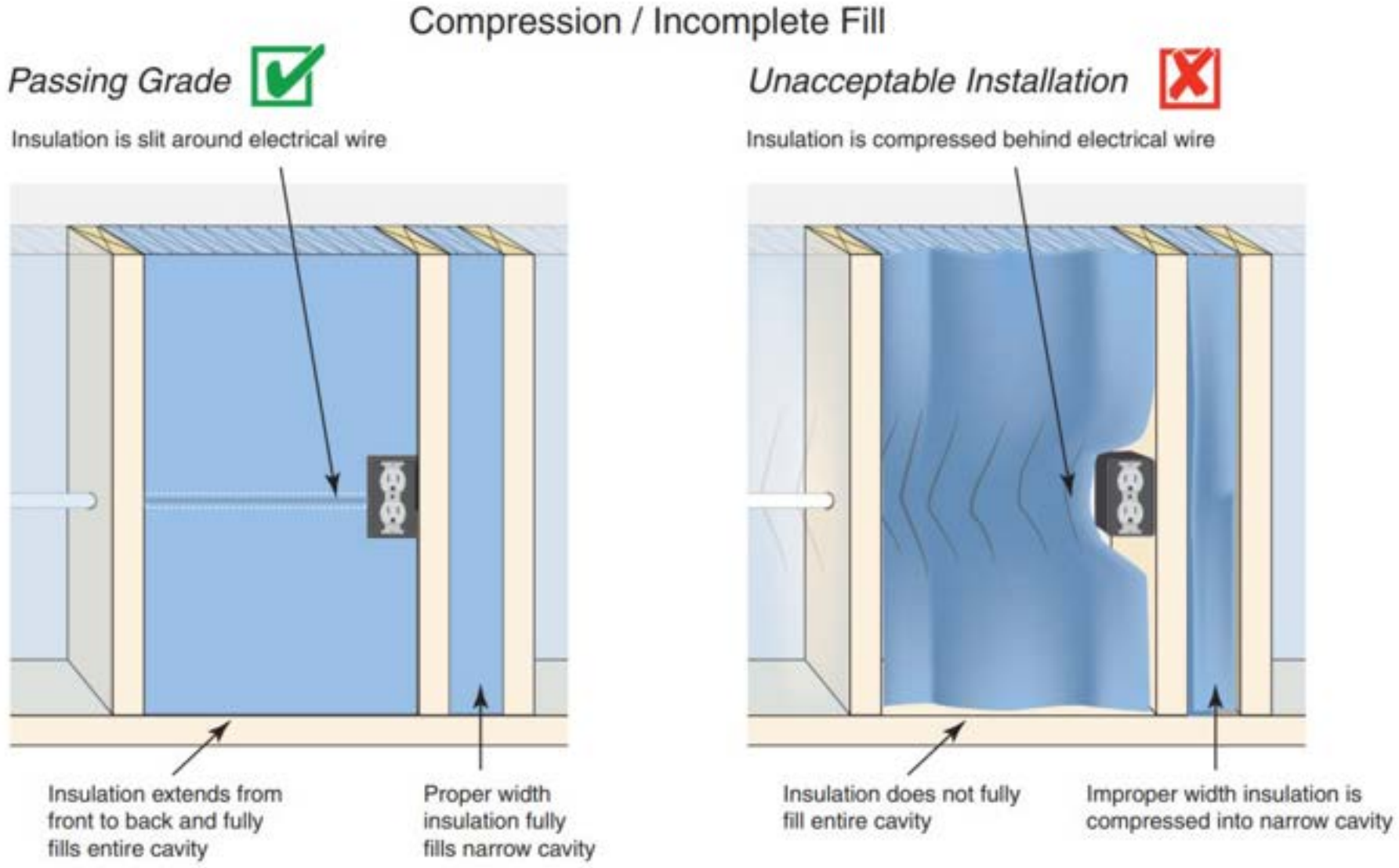
1. Basement walls.
2. Below-grade portion of any wall.
3. Construction where moisture or its freezing will not damage the materials

Ameren MISSOURI

Wall Insulation Details



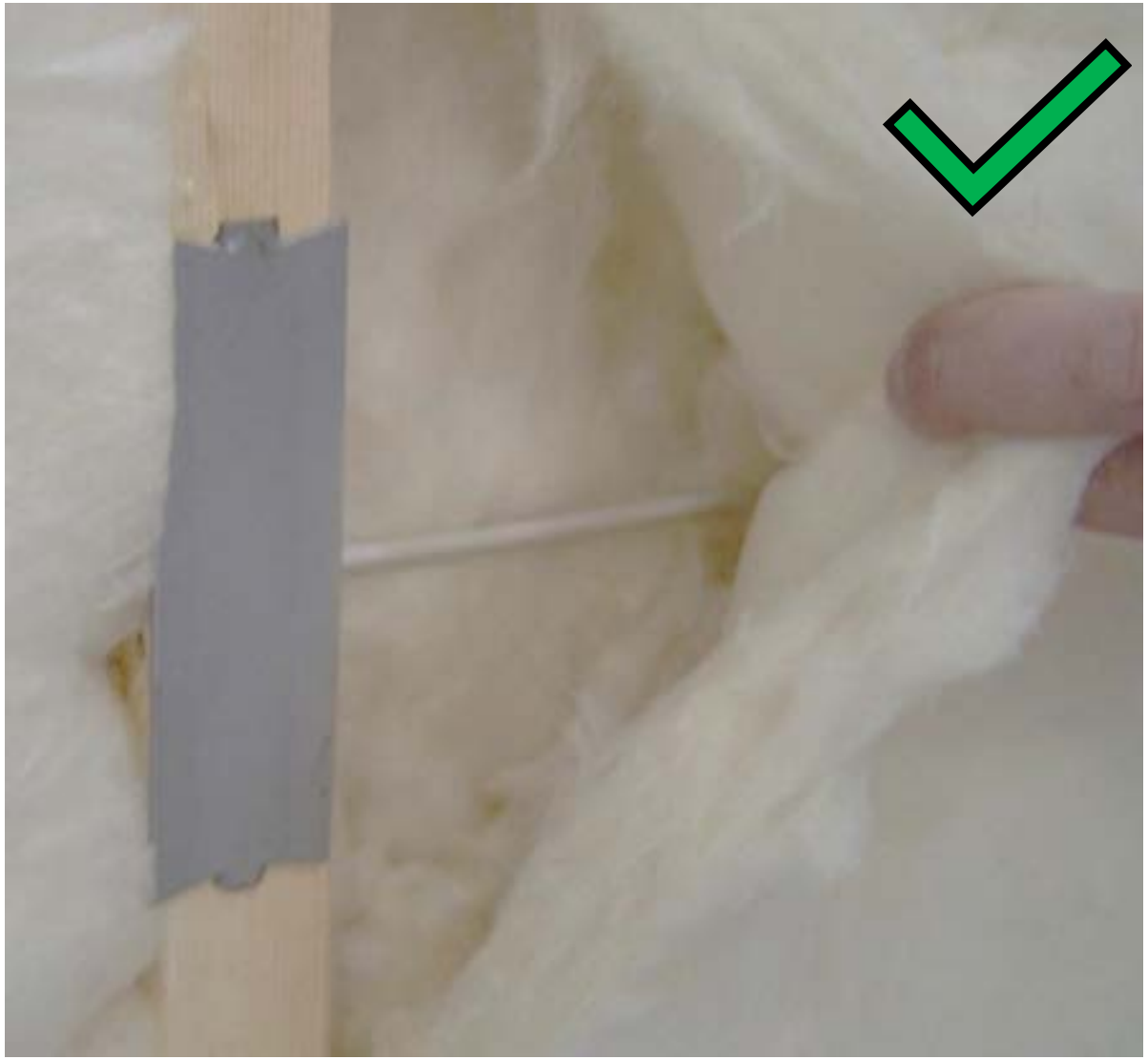
Wall Insulation Details



Ameren MISSOURI

Wall Insulation Details

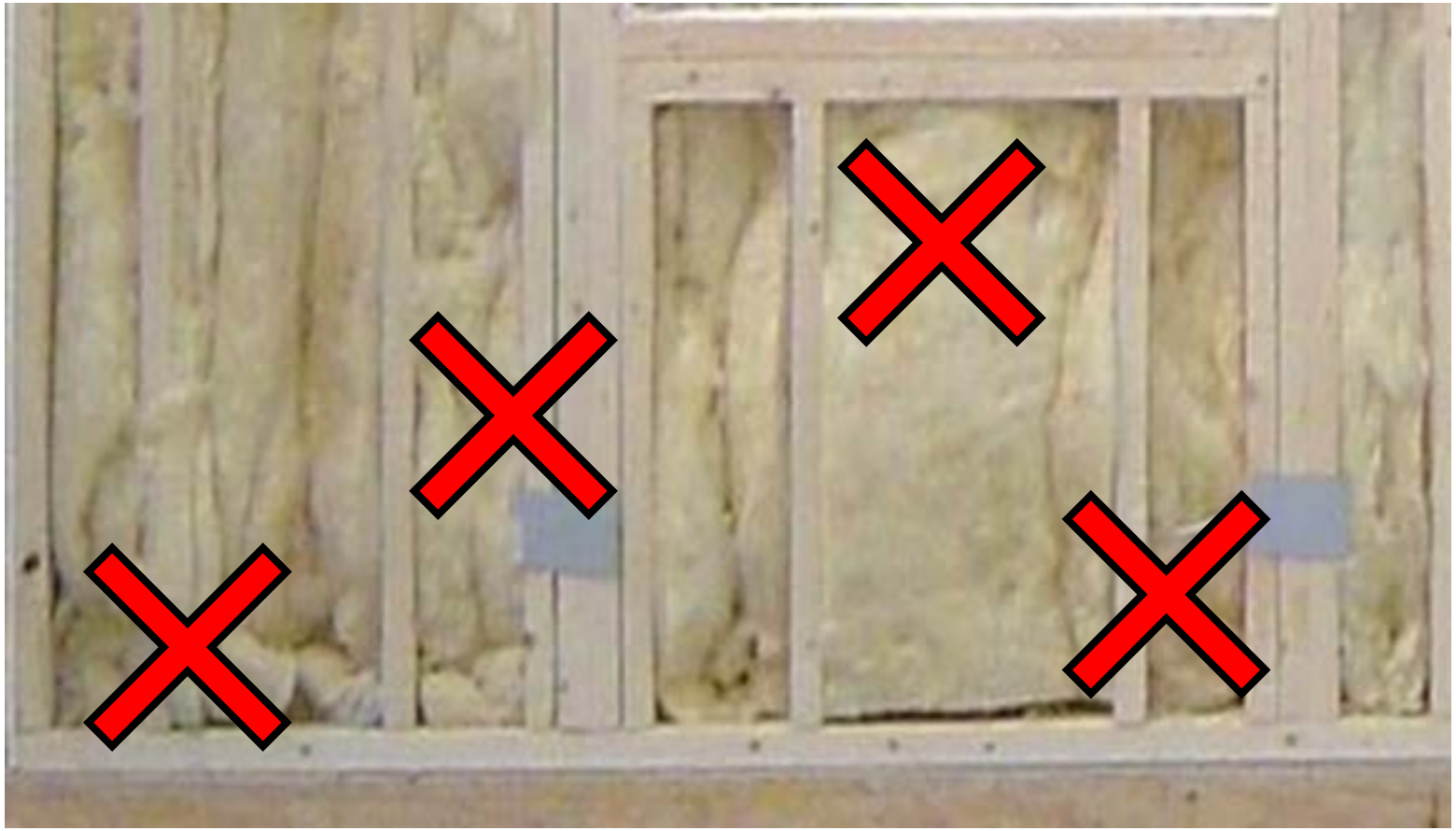
- Batt is split to allow the wire to bisect the cavity

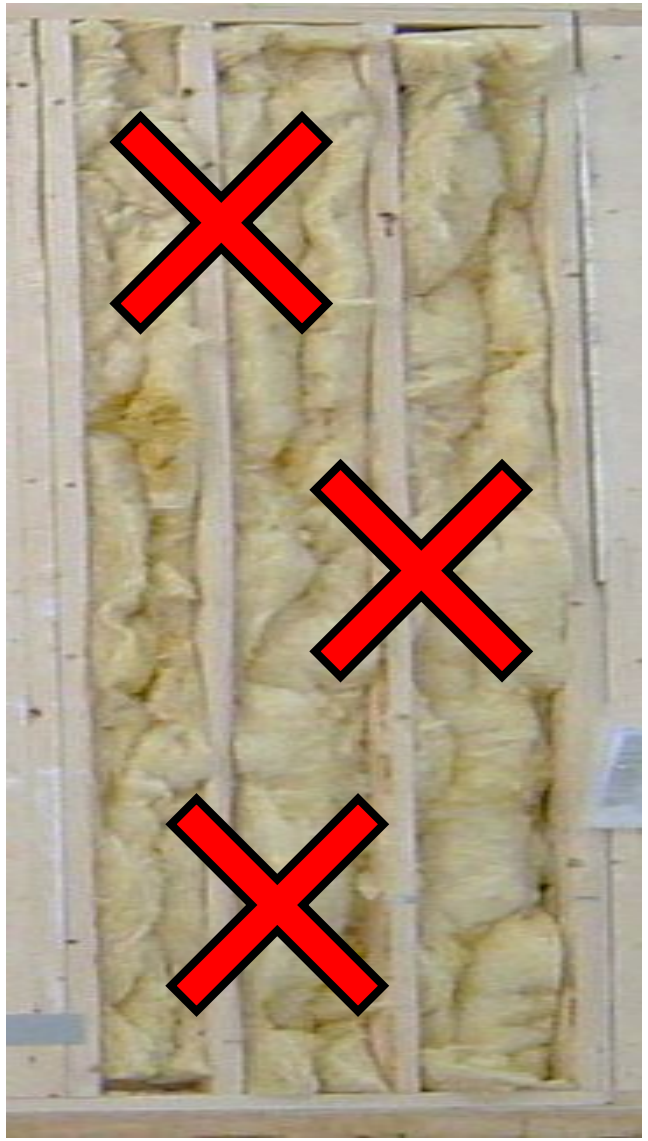


Wall Insulation Details

- Wire is compressing the insulation
- Voids around electrical outlet
- Missed a whole cavity

Wall Insulation Details





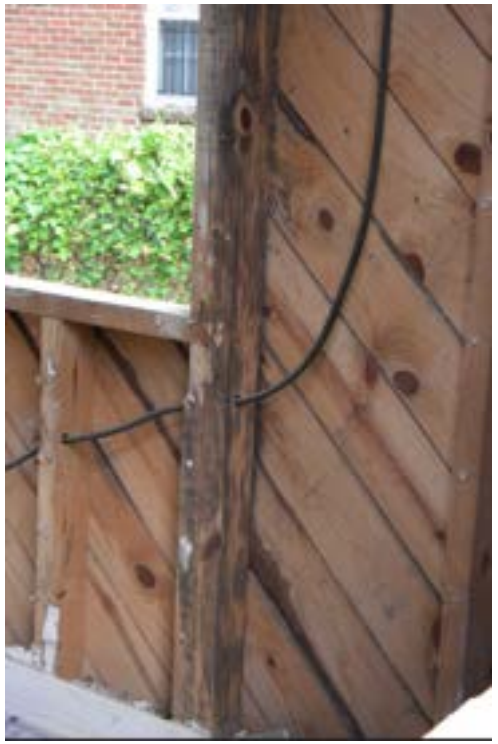
Wall Insulation Details

- Complete fill
- Goes behind tub
- Plumbing penetrations are neat

Wall Insulation Details

- Spray Polyurethane Foam is great for retrofits, if installed properly

Siding Drainage Plane Retrofit – Interior Wall Stripped to Studs



- Install vertical spacer strips into sides of cavity
- Install ½” foam board piece (~14.25” width) against strips
- Seal edges with caulk or foam
- Slightly compress batt into cavity against foam board

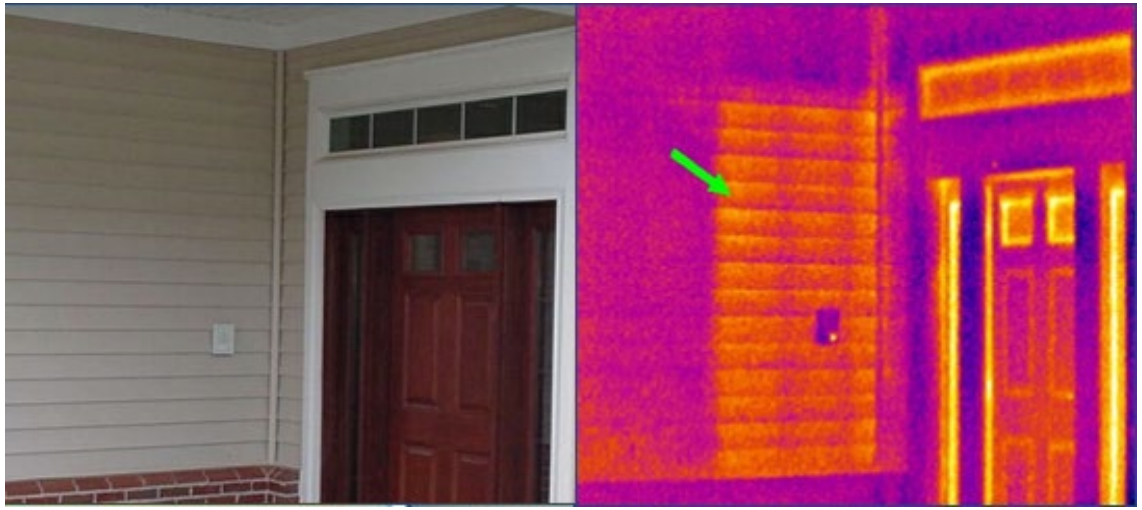
Ameren MISSOURI

Air Barrier Installation

Improving Efficiency, Comfort, and Health in Existing Homes

Ameren MISSOURI

Shower/Tub on Exterior Wall

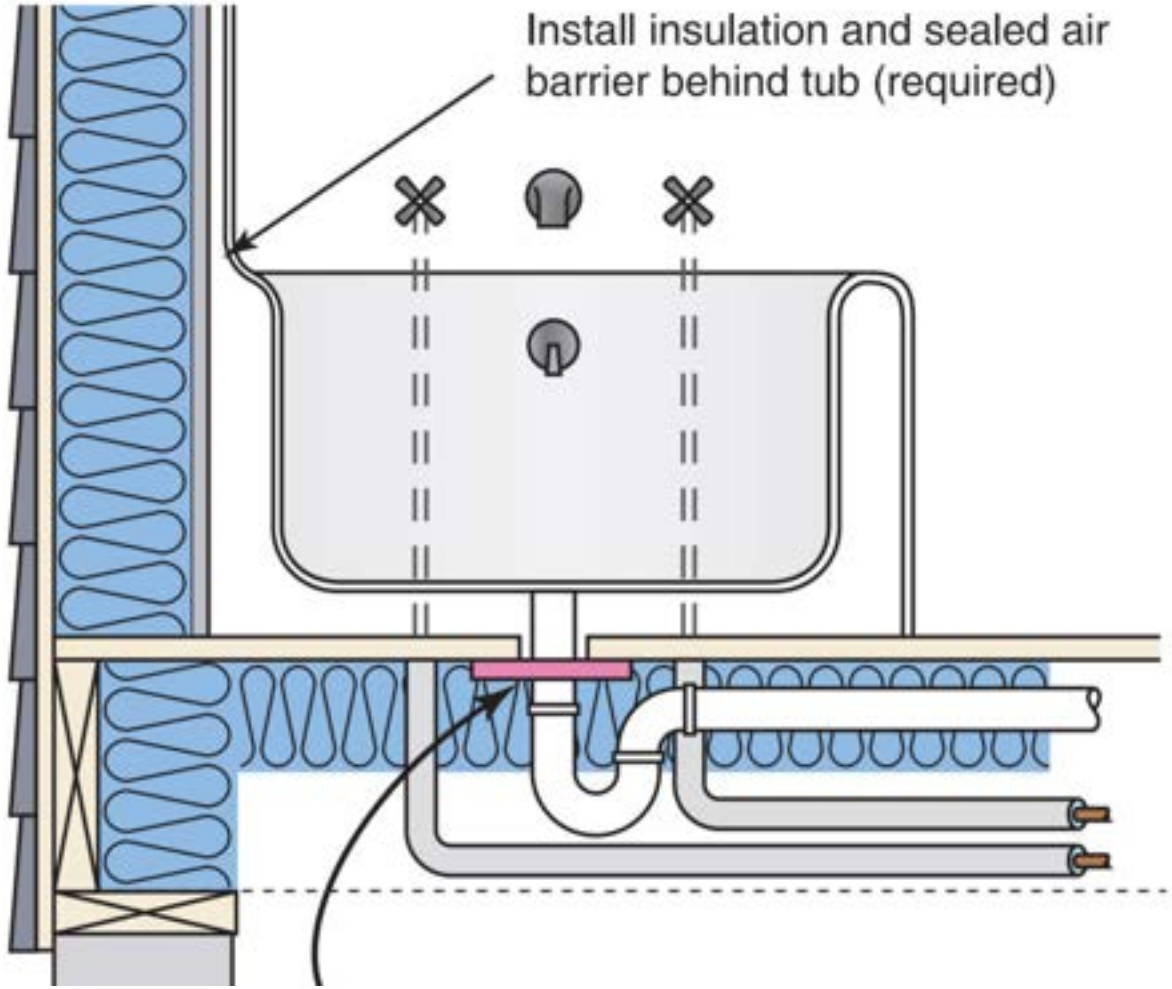


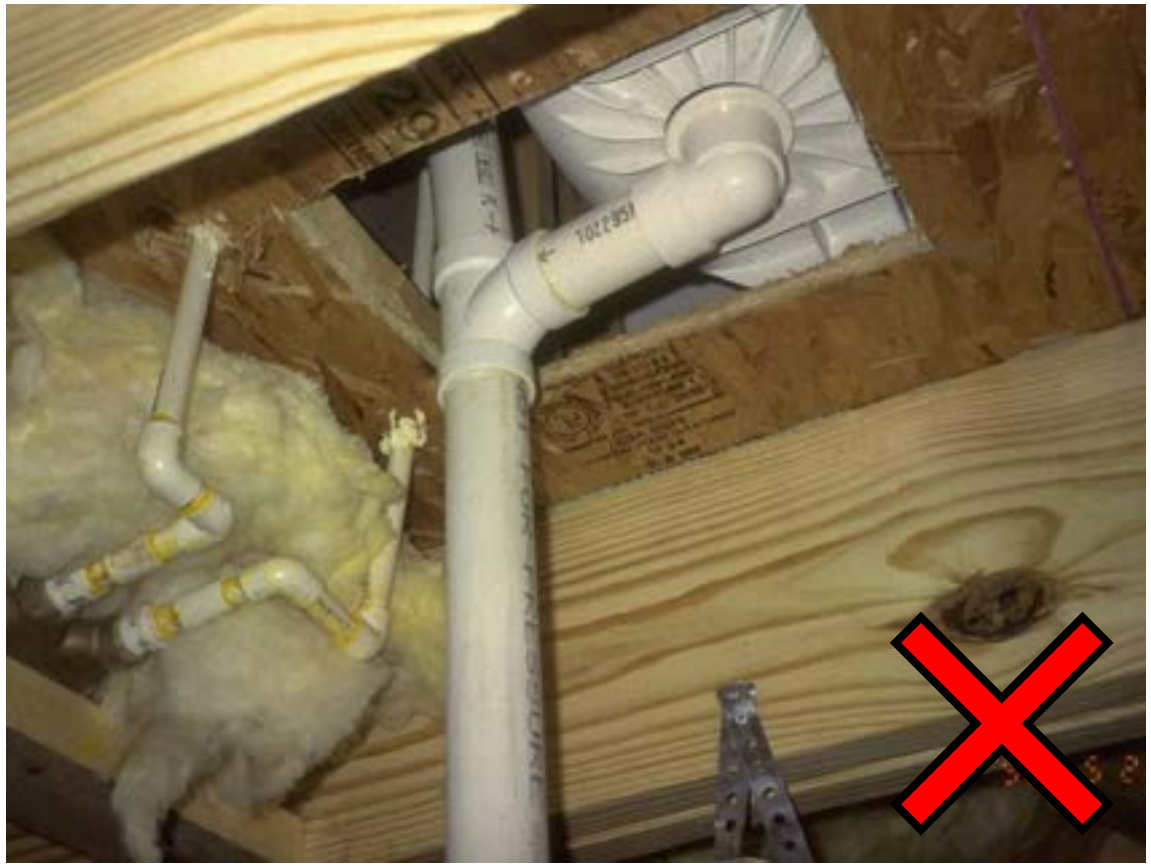
Shower/Tub on Exterior Wall

- Coordinate with your subcontractors so that insulation and air sealing details are not missed before it is too late!

Ameren MISSOURI

Plumbing and wiring

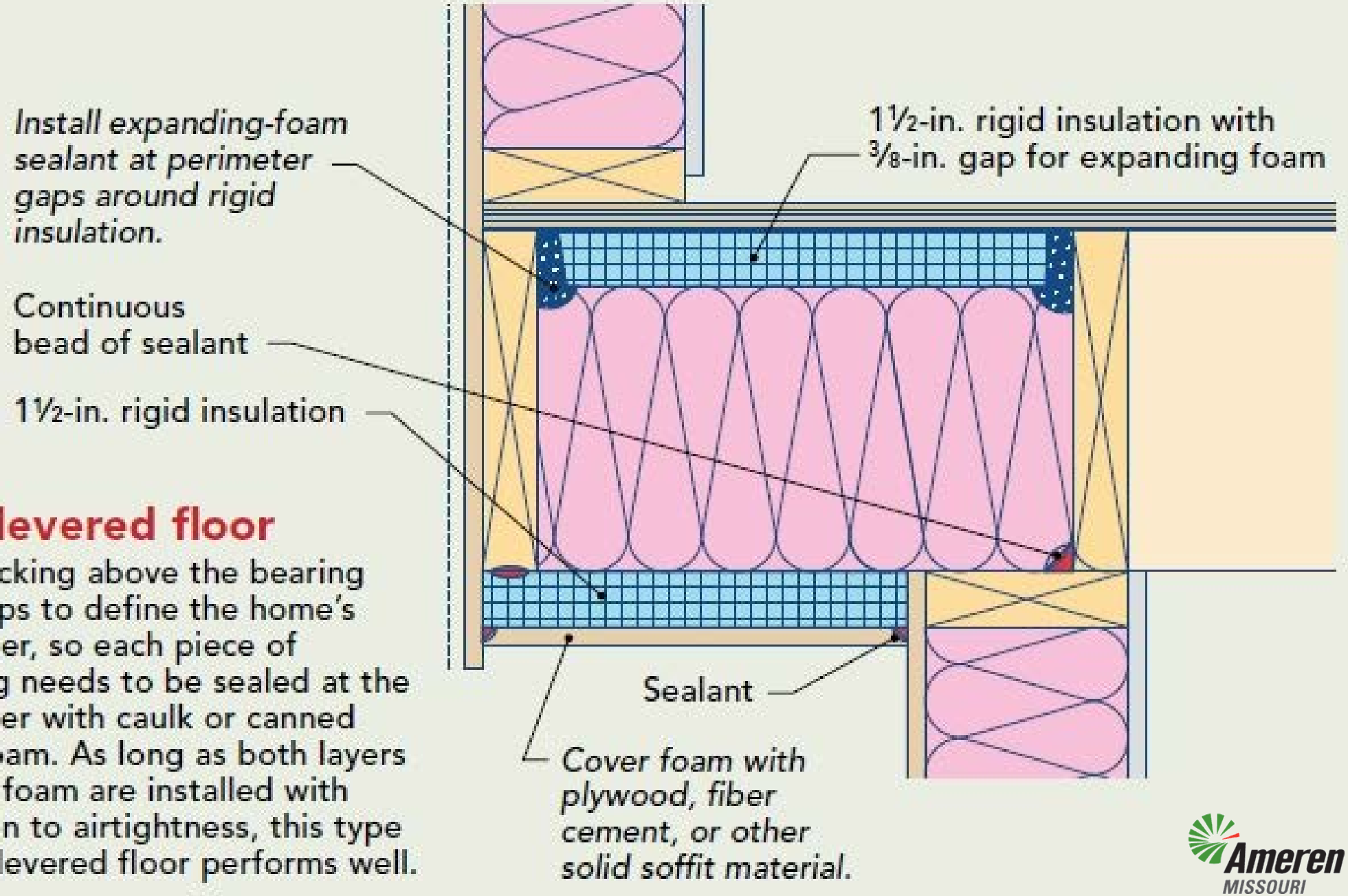




Air Sealing
Tub Drains

Cantilevered floor

Diagram courtesy of Green Building Advisor



Cantilevered floor

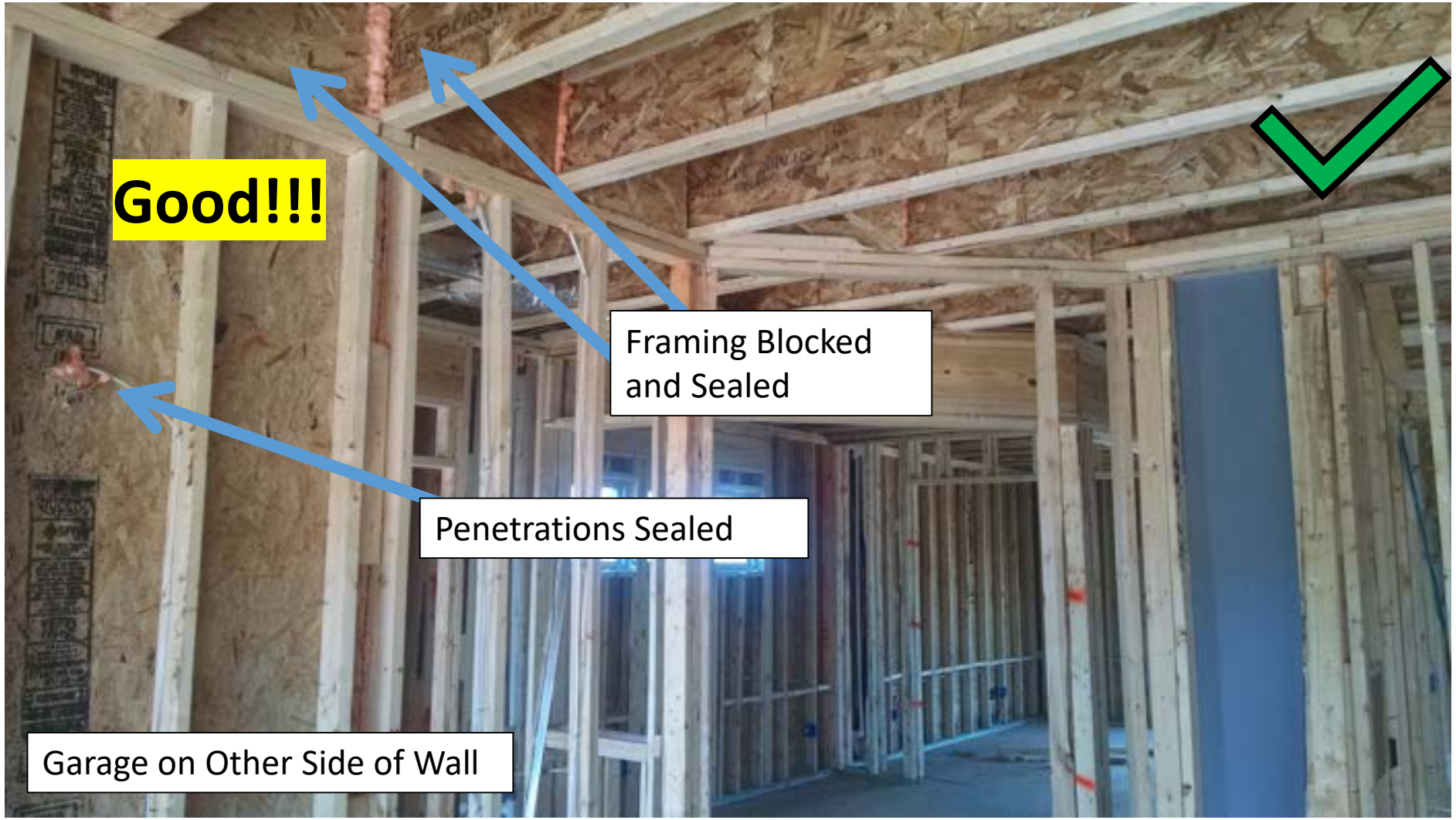
The blocking above the bearing wall helps to define the home's air barrier, so each piece of blocking needs to be sealed at the perimeter with caulk or canned spray foam. As long as both layers of rigid foam are installed with attention to airtightness, this type of cantilevered floor performs well.

Ameren MISSOURI


MONARCH
MADE IN USA

Garage Separation

Garage Separation



Ameren MISSOURI

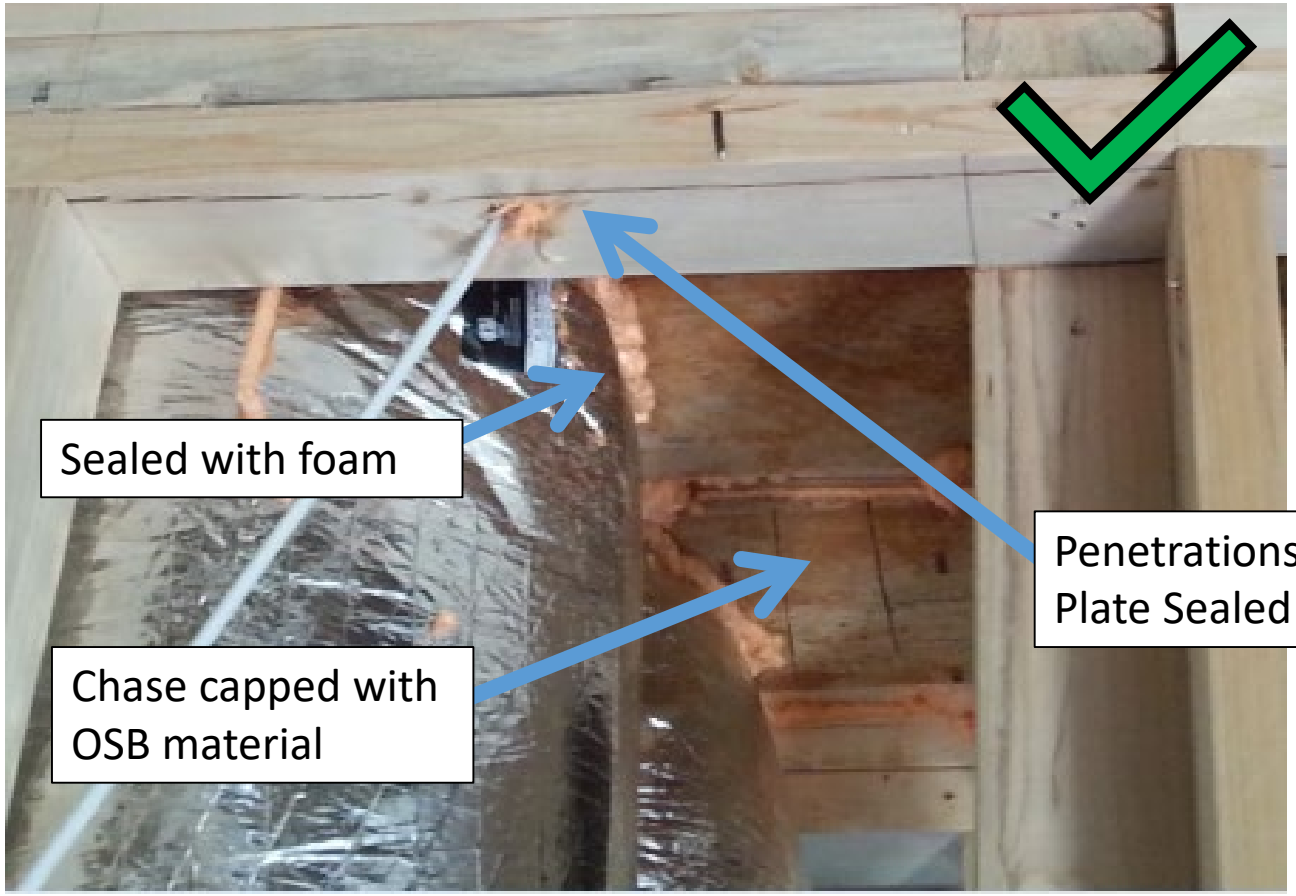
Chases are BIG Holes in the Envelope!

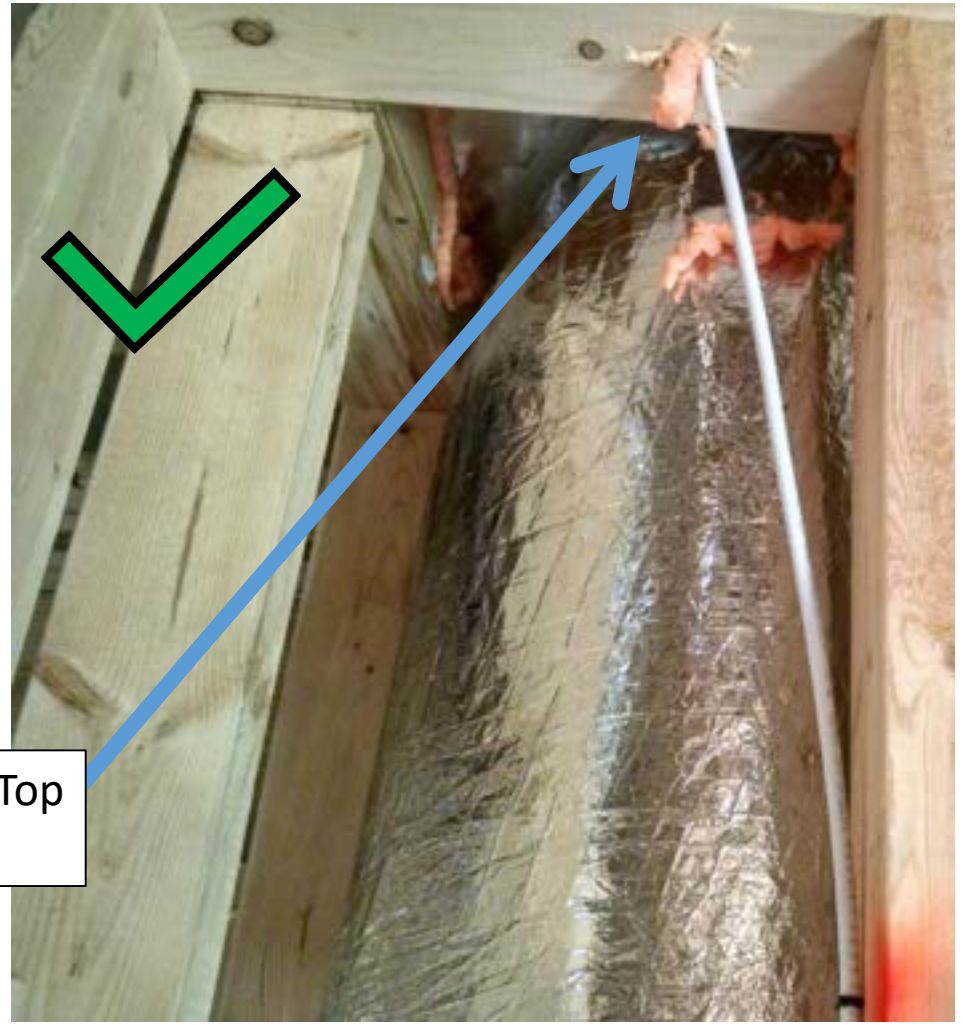
- First, cover with sheet material and seal
- Then insulate

Duct Shafts

Cap chases with rigid material and seal tight around ducts or flue pipes

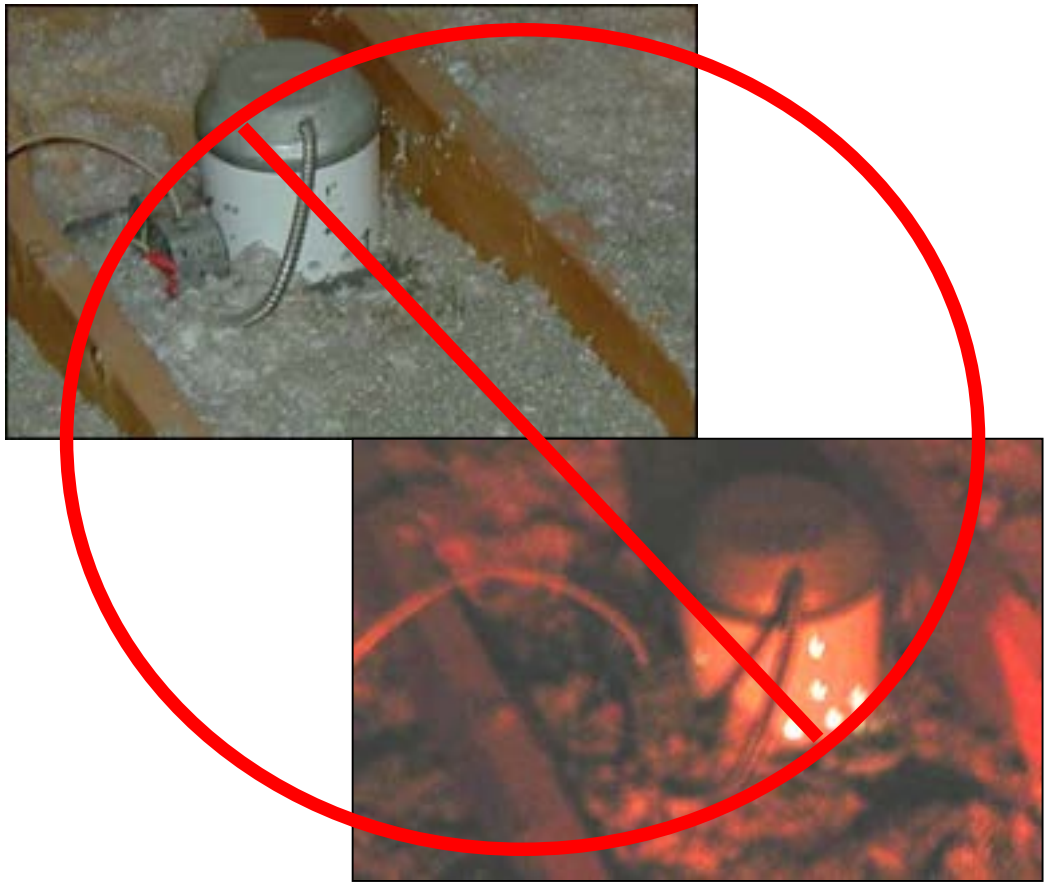
Duct Shafts


Sealed with foam
Chase capped with OSB material


Penetrations in Top Plate Sealed

402.4.5 Recessed Lights

- **Standard Can Light**

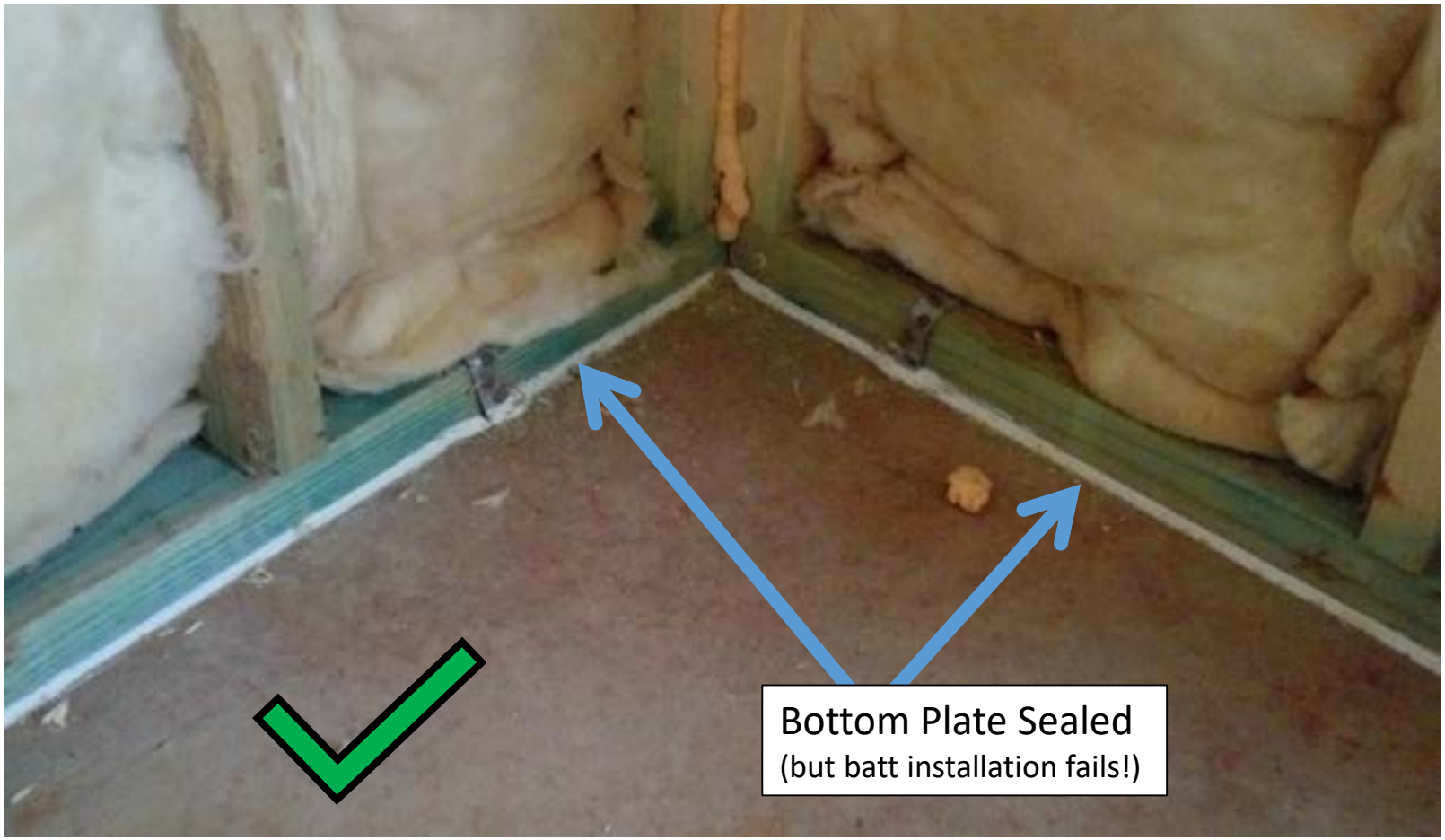


Airtight and IC Rated

- All recessed luminaires shall be labeled as having an air leakage rate not more than 2.0 cfm tested at 75 pa
- All recessed luminaires shall be sealed with a gasket or caulk between the housing and the interior wall or ceiling covering

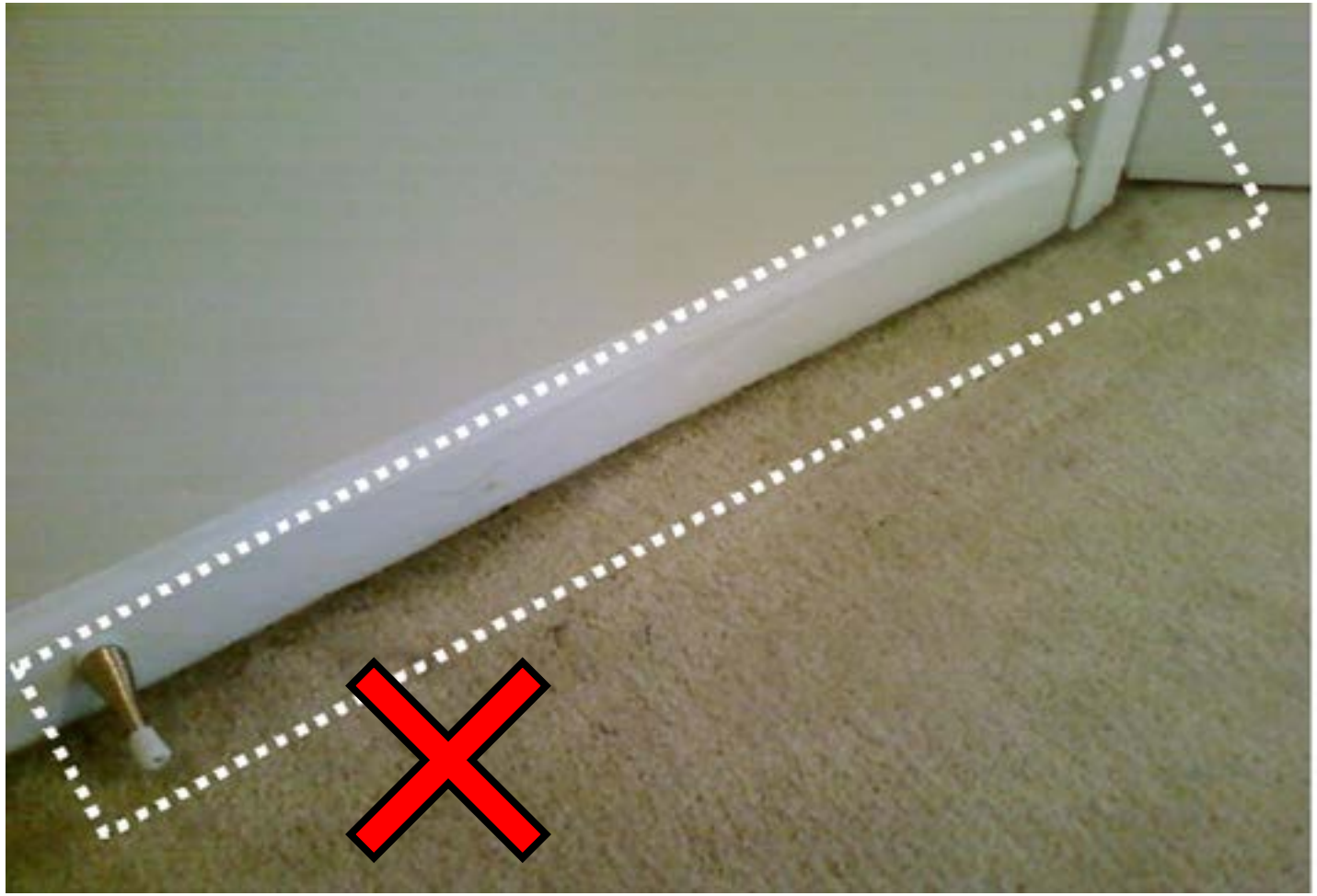
Ameren MISSOURI

Sill (bottom) plate



Dirty Carpet?!

- Dirty carpet on **exterior** wall indicates leak at wall sill plate
- On **interior** wall indicates wall leaking to and from attic



Whole House Fan

Whole House Fans

Ameren MISSOURI

Unused Fireplace

- First, close flue damper
- Then use mastic and foam board to glue a ledger
- When dry, seal foam board to ledger with mastic & fasteners

Ameren MISSOURI

Ducts

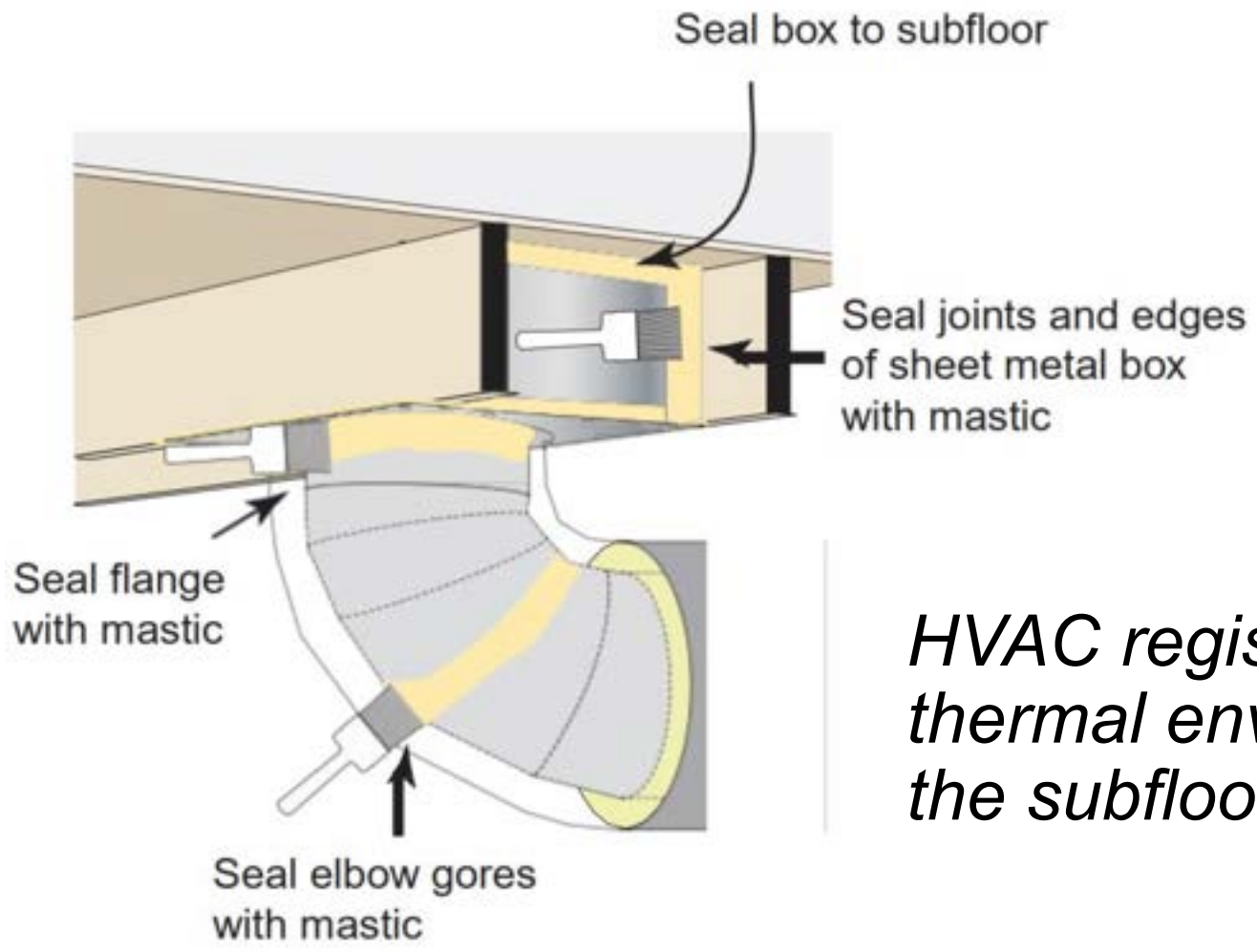
Improving Efficiency, Comfort, and Health in Existing Homes

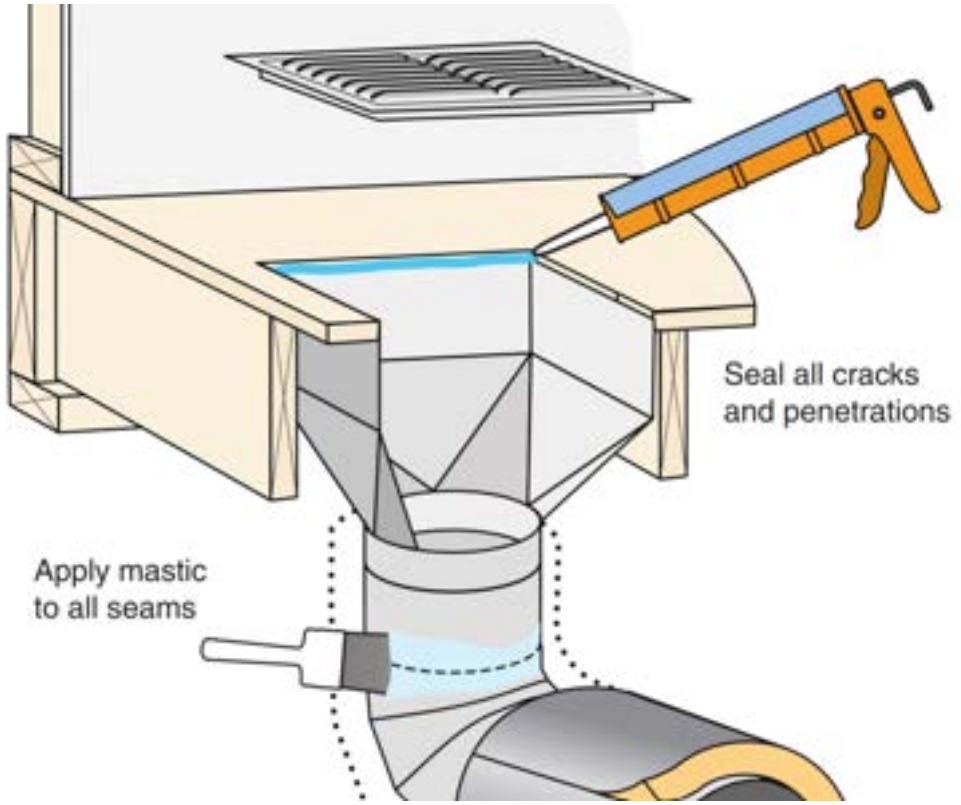
Duct Sealing

- All duct connections must be mechanically fastened
- **Regardless of duct location**, the joints and seams of all ducts, air handlers, and filter boxes should be sealed with mastic or mastic tape that is at least 2 mm in thickness (0.08 inch), approximately the thickness of a nickel
- Mastic shall be installed at the inner liner of rigid metal and flexible duct (not the outer insulation jacket).

Ameren MISSOURI

HVAC Register Boots





HVAC register boots that penetrate the thermal envelope must be sealed to the subfloor or drywall.

Ameren MISSOURI

Ameren MISSOURI

- Remove registers
- Vacuum duct
- Seal with mastic – start as far in as you can reach and work your way out
- Finish by sealing boot to floor/ceiling

Ameren MISSOURI

- Remove registers
- Vacuum duct
- Seal with mastic – start as far in as you can reach and work your way out
- Finish by sealing boot to floor/ceiling

Ameren MISSOURI

Ameren MISSOURI

Pan Returns

- Unlined building cavities should not be used as ducts, returns, or plenums!

Lighting

Improving Efficiency, Comfort, and Health in Existing Homes

R503.1.4 Lighting

New lighting systems that are part of the alteration shall comply with Section R404.1

Exception: Alterations that replace less than 50 percent of the luminaires in a space, provided that such alterations do not increase the installed interior lighting power.

R404.1 Lighting Equipment

- This requirement is **mandatory**
- Not less than 90 percent of the permanently installed lighting fixtures shall contain only high-efficacy lamps
- High efficacy lamps include
  - Compact fluorescents
  - T8 or T5 fluorescent bulb
  - **LEDs**
- Exception – low voltage lighting

Benefits of LED Lighting

- LEDs boast a 25,000-hour average life, which means less maintenance for your clients
- LEDs use 6 times less energy than comparable incandescent bulbs
- Ideally, upgrade all bulbs to LED
- Look for the ENERGY STAR® label

Ameren MISSOURI

Economics of Incandescent Lighting

9 bulbs x 60 watts each = 540 w

540 w x 4 hours a day = 2160 wh

2160 wh x 365 days = 788,400 wh a year

788,400 / 1000 = 788.4 kWh

788.4 kWh x $.127 = **$100.13** per year

Economics of LED Lighting

9 bulbs x **9 watts** each = 81 w

81 w x 4 hours a day = 324 wh

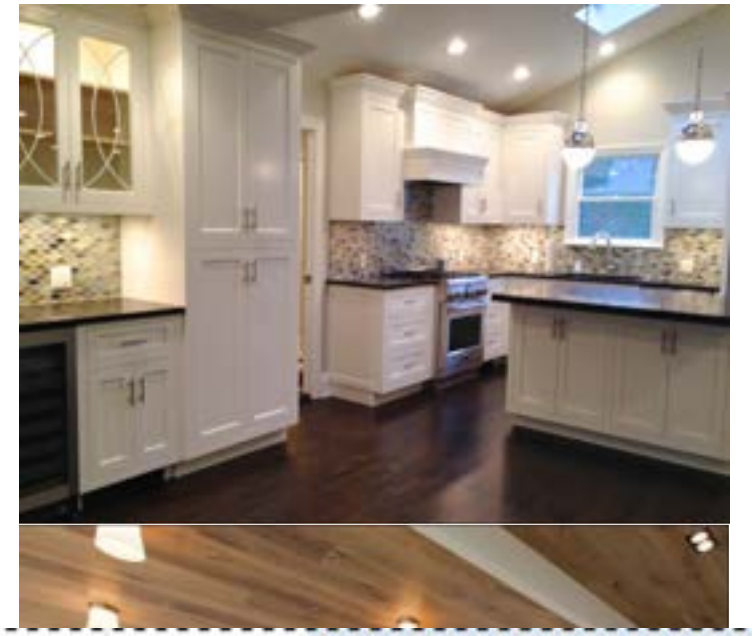
324 wh x 365 days = 118,260 wh a year

118,260 / 1000 = 118.3 kWh

118.3 kWh x $.127 = **$15.02 per year**

Ameren MISSOURI

The Economics of Lighting for Builders



- It would take ~3 weeks to payback LEDs if half the lights are left on during construction
- Just ~10 days if all lights are left on!

	$ Cost for 1 month - ON half the time			Simple Payback		
	Incand	LED	Total	$ Savings	(months)	(days)
100% Incand House	$ 158.11	$ -	$ 158.11	0		
50% Incand / 50% LED	$ 79.06	$ 13.18	$ 92.23	$ 65.88	0.80	24.3
100% LED House	$ -	$ 26.35	$ 26.35	$ 131.76	0.80	24.3

Bulb Cost Assumption: Electricity Rate: 0.12 $/kwh

Incandescent = $0.25

				Premium	Bulb Wattage	
					Incand	LED
50% LED House	30	30	$ 52.50	-	60	10
100% LED House	0	60	$ 105.00		60	10

Ameren MISSOURI

Color Temperature

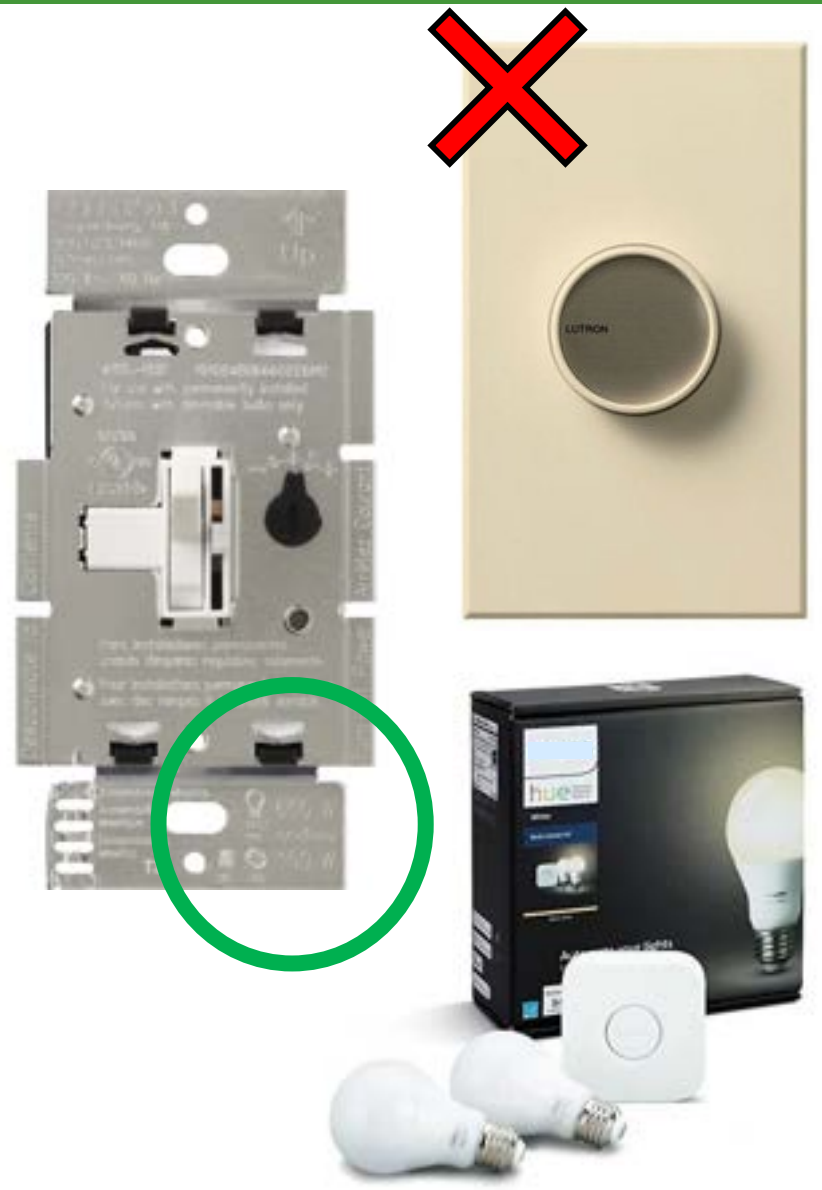
- LEDs are available in a wide range of color temperatures
- Some smart bulbs have color temperature ranges from 2000K-6500K + 16 million colors

westinghouselighting.com

Ameren MISSOURI

LED Retrofit Issues

- “Dimmable” LEDs might not be compatible with all existing dimmer switches
  - LED bulbs may flicker, blink, hum or buzz
  - Problems are more prevalent in track lighting fixtures or other fixtures with multiple bulbs
- Recommendation – Replace dimmers with standard switches or LED compatible dimmers
- Smart bulbs offer dimming capability



Ameren MISSOURI

Questions / Thoughts?

- When does code apply to additions and alterations (the short answer: **pretty much always**…the question is, how can you do it cost effectively)
- Historic preservation
- Mass wall improvements?

Ameren MISSOURI

Ameren
MISSOURI

FOCUSED ENERGY. For life.