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WEATHERIZATION ENERGY AUDITOR SINGLE FAMILY

House as a System

By attending this session, participants will:

- Be exposed to basic weatherization technology.
- Become aware of the potential for interaction among building components and mechanical systems.
- Understand how air sealing a home can negatively affect indoor air quality.

Why Do we Weatherize?

- Save energy and money for the client.
- Improve indoor air quality.
- Promote building durability.
- Increase comfort.

Save Energy

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- Almost 40% of energy used in the US goes to power commercial and residential buildings.
- Half of that (20% US energy) is for space heating and cooling.
- Half of ***that*** (heating and cooling energy) is wasted.

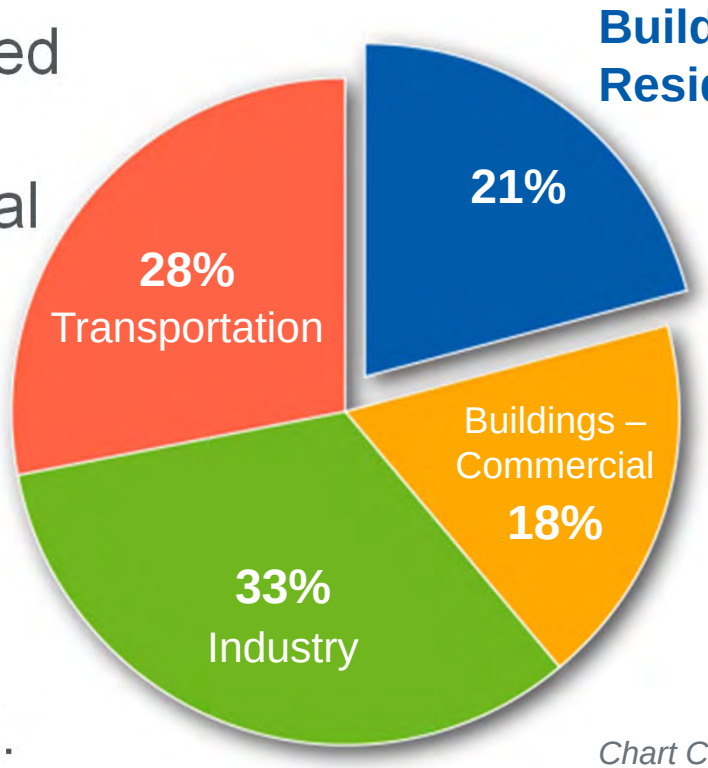
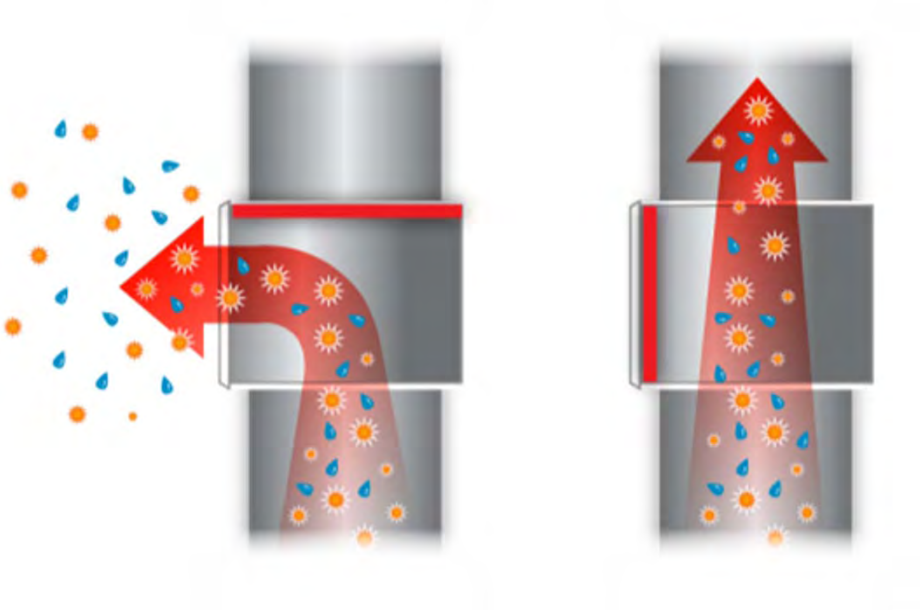


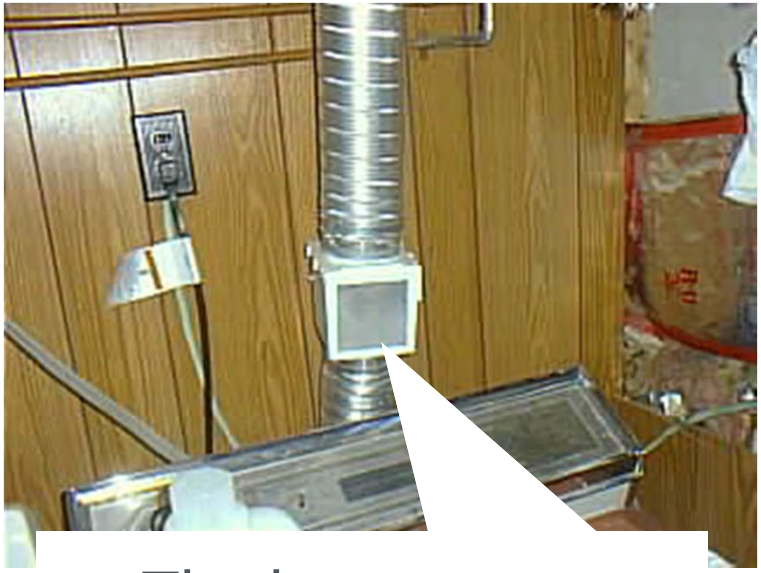
Chart Courtesy of 2008 Buildings Energy Data Book.

A 5 Quad savings opportunity!

Improve Indoor Air Quality

- Prevent mold/mildew.
- Eliminate odors.
- Reduce respiratory ailments.





The homeowner installed this device to save energy.

Why is it a bad idea?

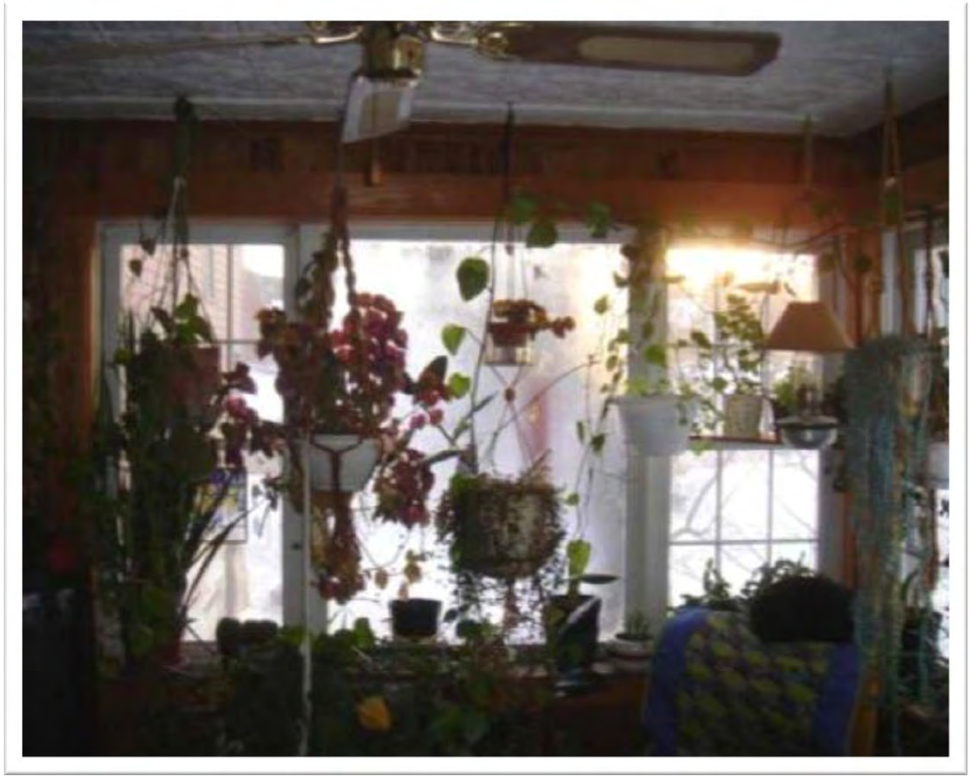
Extend Building Life

- The same conditions that lower IAQ can reduce building durability.
- What's bad for the home is usually bad for the occupants!

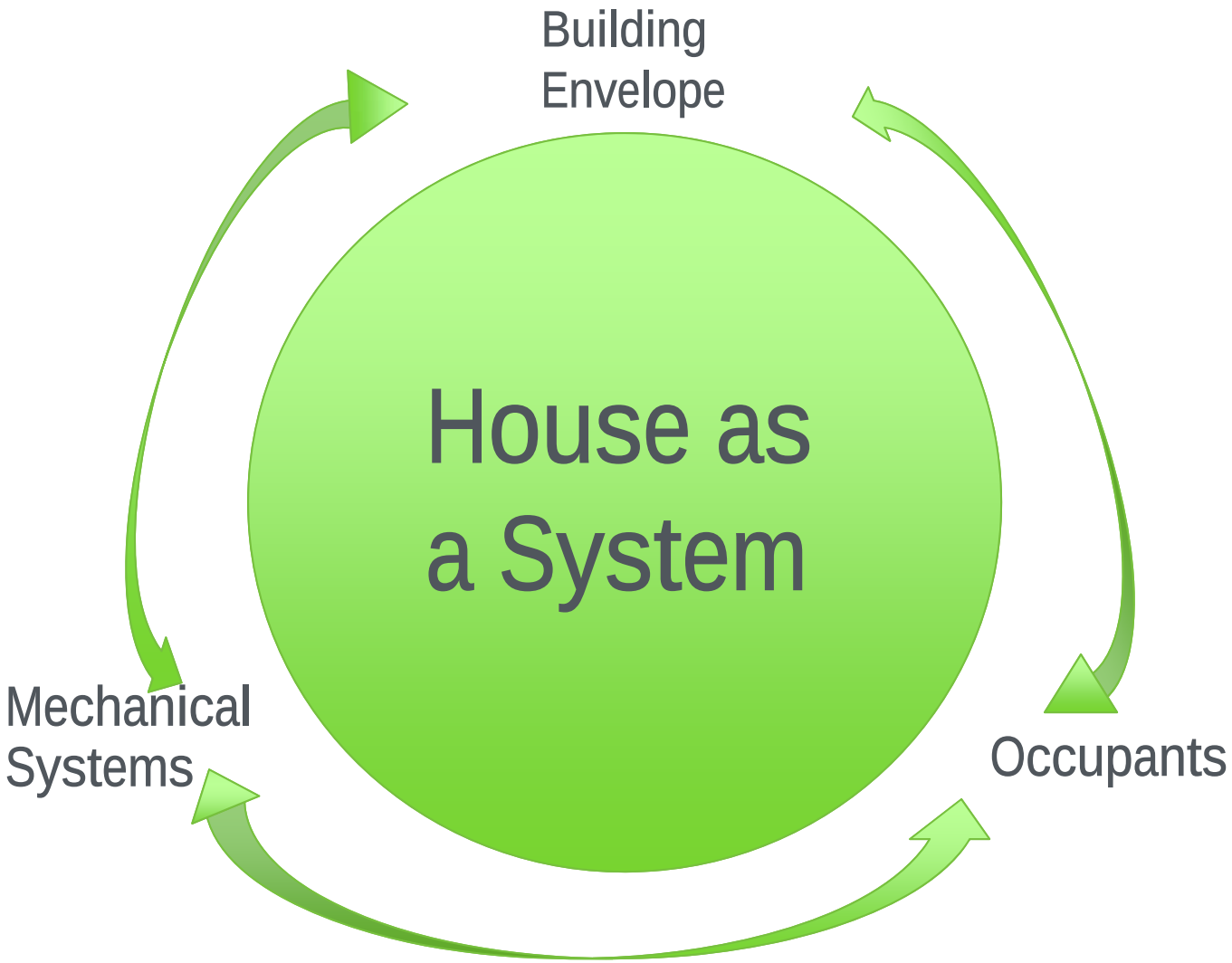
Mold growing on floor stringers over a dirt-floored crawl space.

Increase Comfort

- No drafts.
- No cold floors.
- No hot or cold rooms.
- No fogged windows.



Houses Are Systems!



A house is a system of interdependent parts.

- The operation of one part affects many others.
- When they all work together, the house is comfortable, safe, efficient, and durable.

A house will experience problems when its house parts don't work together properly.

- Some obvious, some invisible.
- Some now, some years down the road.

HOUSE As a SYSTEM

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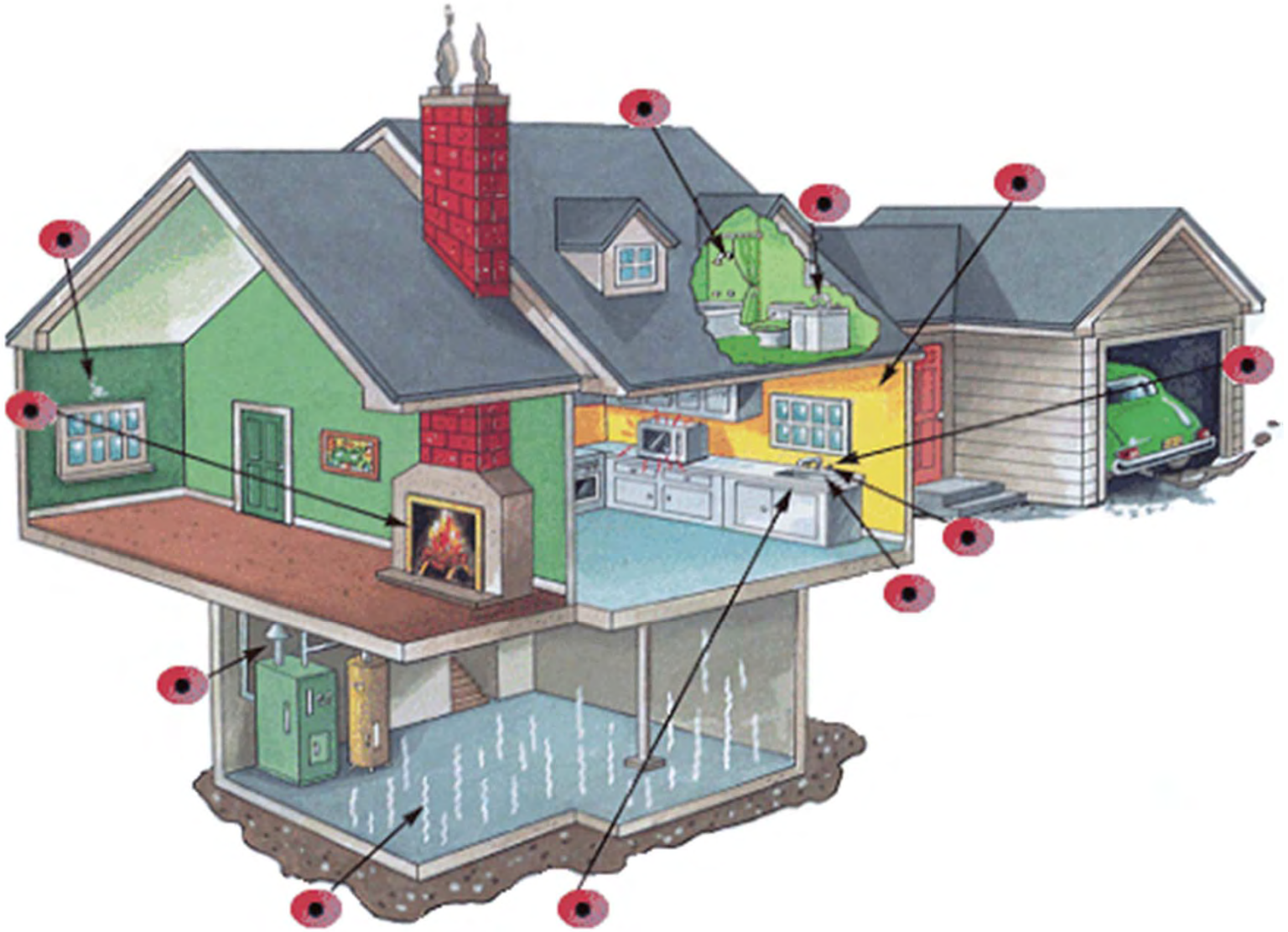
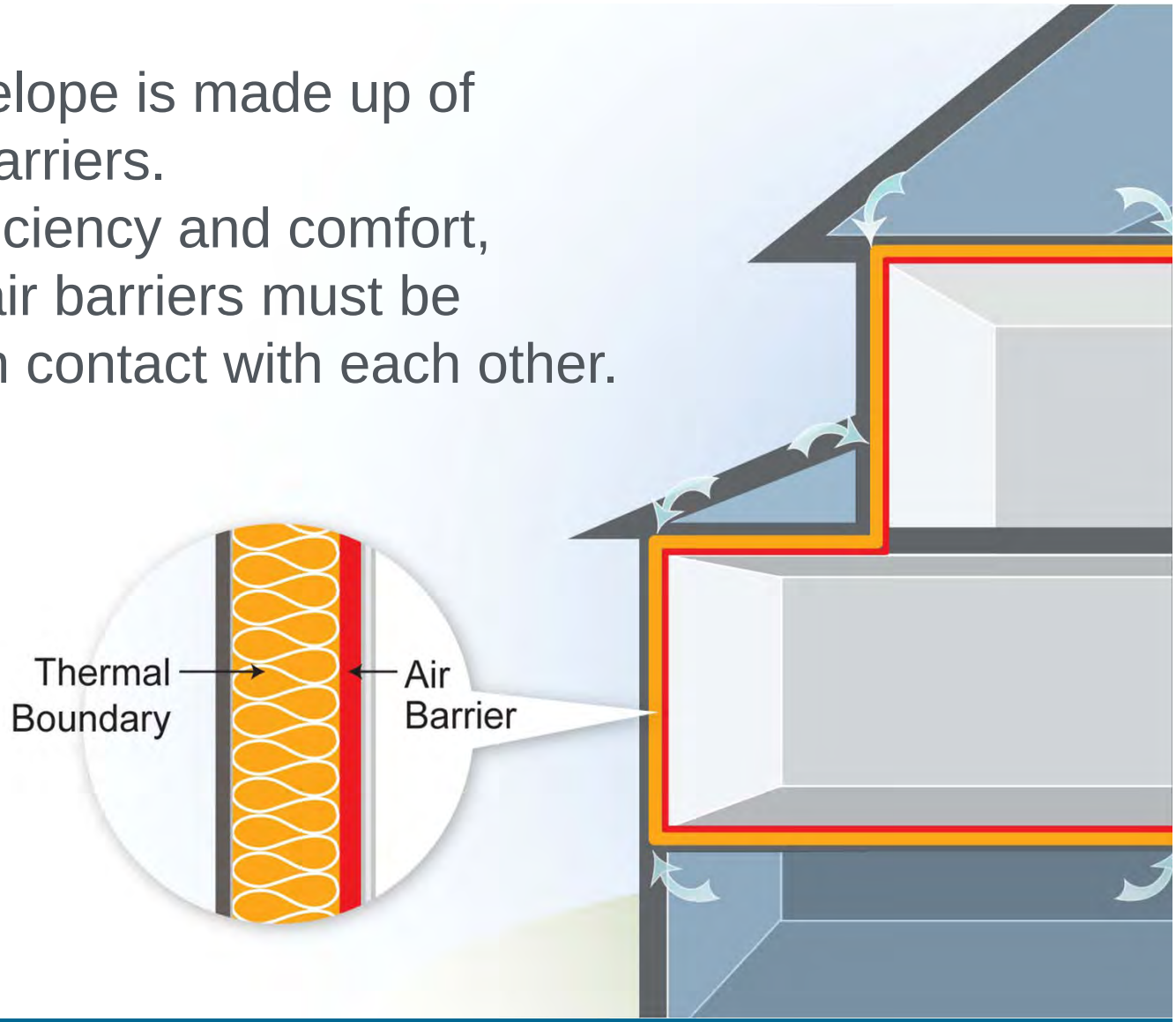


The Building Envelope

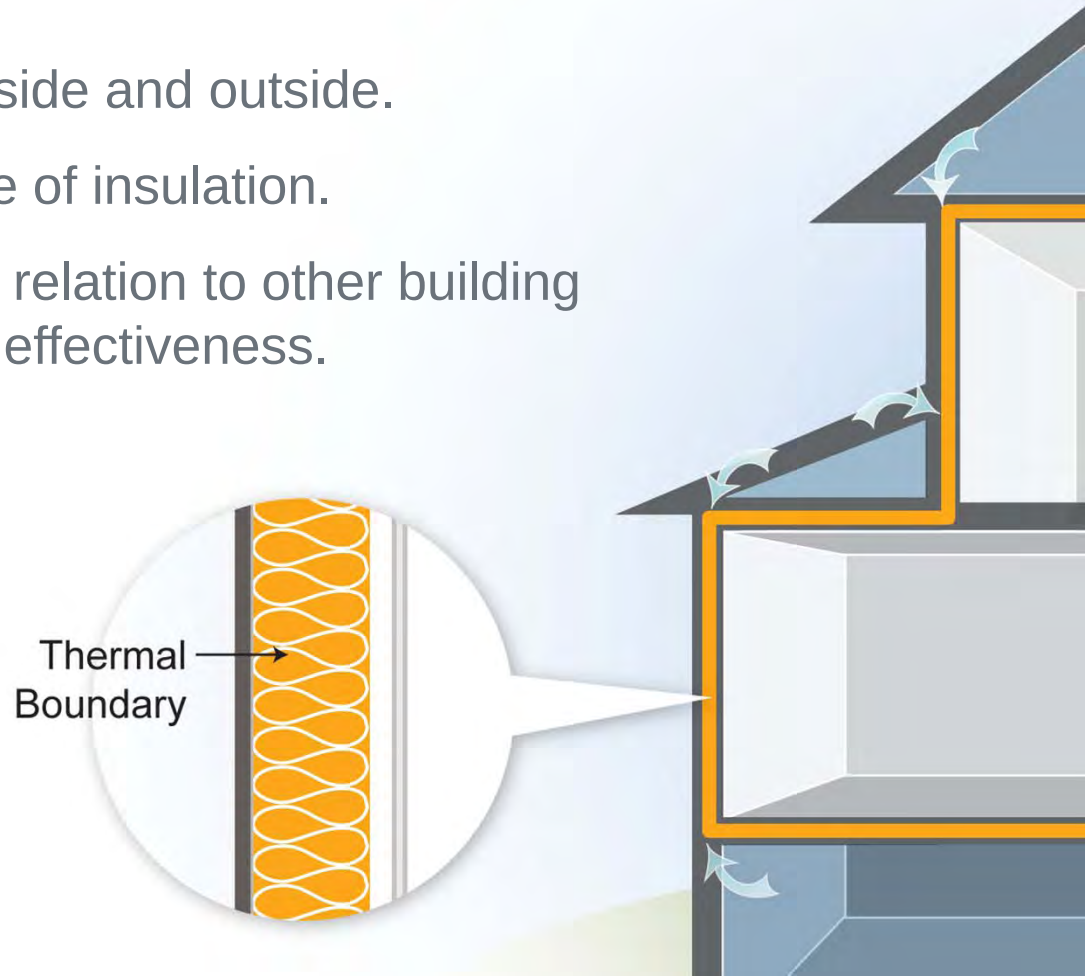
PRESSURE & THERMAL BOUNDARIES

The building envelope is made up of thermal and air barriers.
For maximum efficiency and comfort, the thermal and air barriers must be continuous and in contact with each other.



The Thermal Boundary:

- 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 very important.
- Voids of 7% can reduce effective R-value by almost 50%.



Thermal Boundary is Obvious

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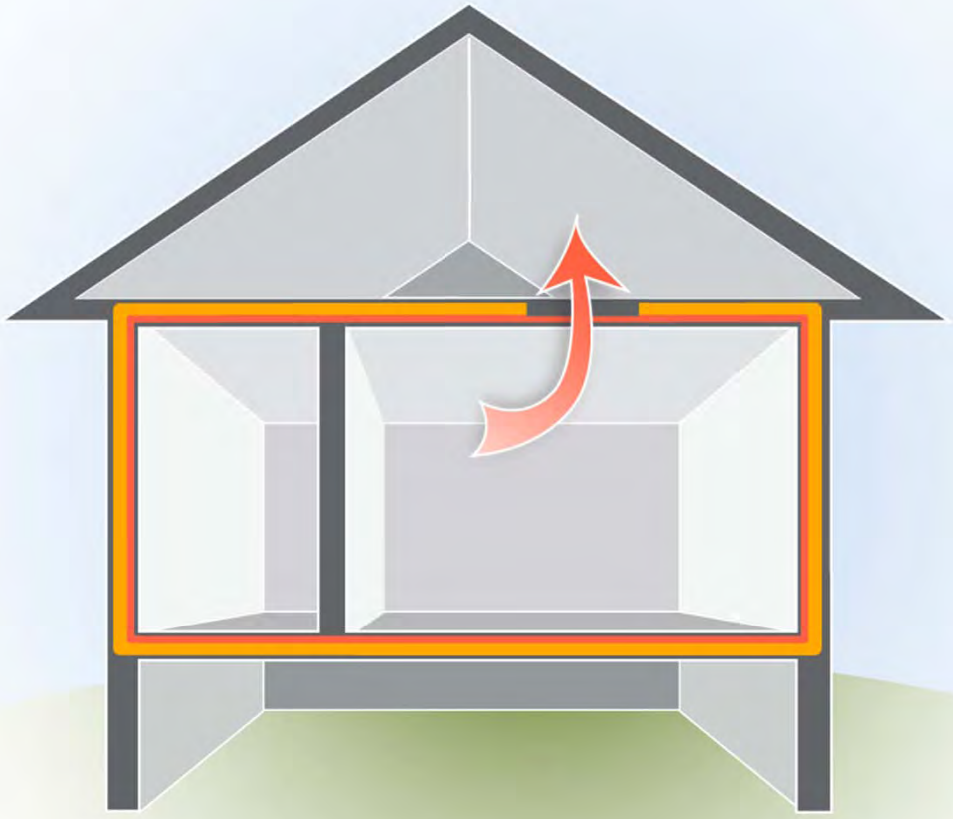
ALIGNING PRESSURE & THERMAL BOUNDARIES

Photo courtesy of the US Department of Energy

Gap in Thermal Barrier



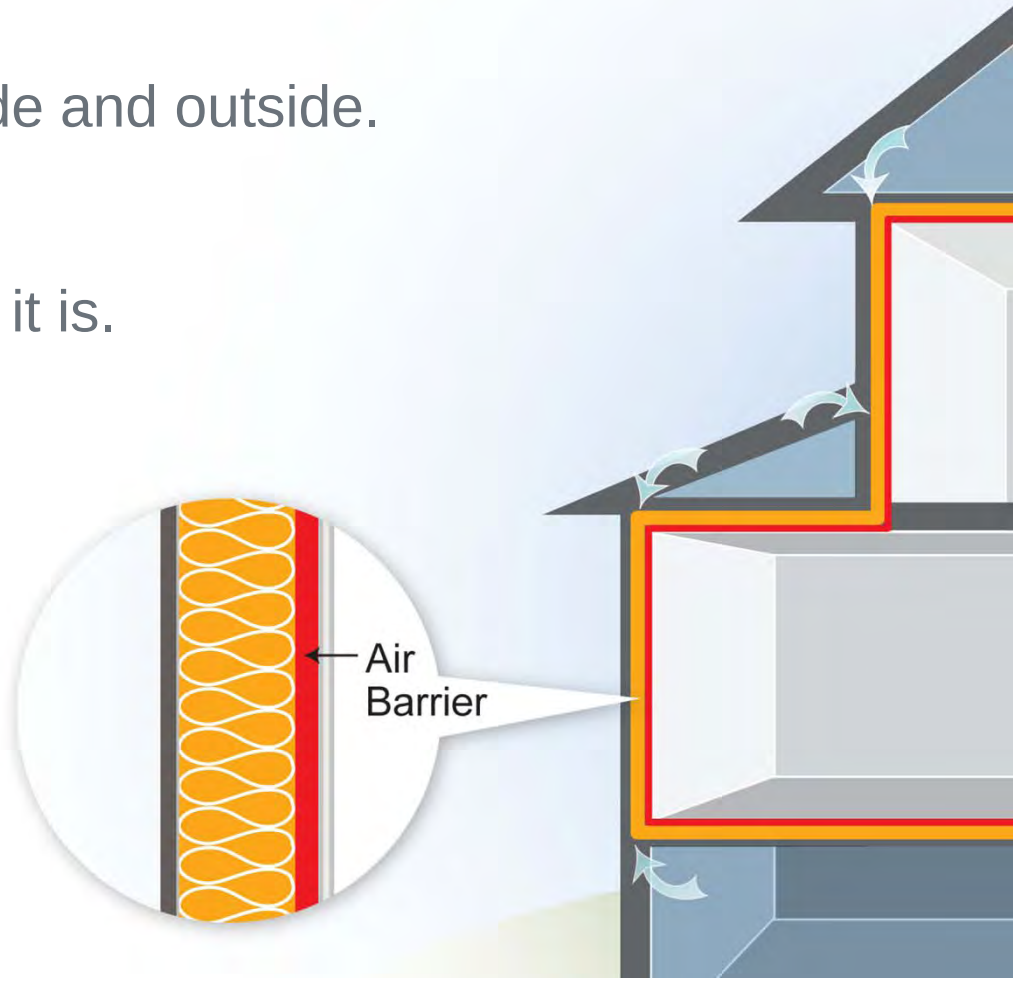
An uninsulated attic hatch is a gap in the attic's thermal barrier.

Air Barrier

Thermal Barrier

The Air Barrier:

- Limits air flow between inside and outside.
- More difficult to identify.
- Not always where you think it is.
- Blower door is used to locate air barrier.



Air Barrier Where?

Cellulose insulation

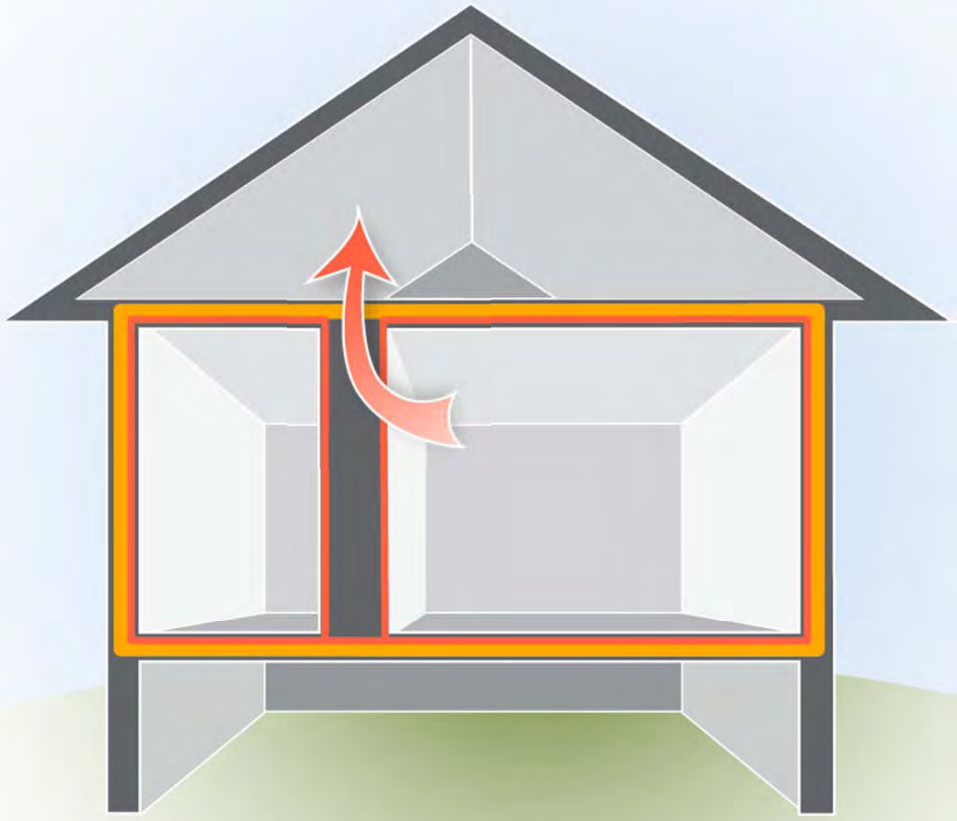
Original plaster ceiling

Exterior walls - bare

Dropped ceiling- bare

Walls below ceiling filled with cellulose

Gap in Air Barrier



A mechanical chase containing ducts can break the attic's air barrier.

Air Barrier

Thermal Barrier

Examples - House as a System

An uninsulated attic ...

Makes the heating and cooling system work harder than necessary.

Examples – House as a System

Leaky recessed lighting fixtures...

Increases heat loss/gain, and can cause ice dams.

Examples – House as a System

This bathroom exhaust fan does not exhaust to outdoors – just to the soffit.

Photos courtesy of The US Department of Energy

The moisture condenses on the roof deck and trusses causing damage.

Why seal the leaks at all?

In the Attic…

- 2” x 6” rafters with plywood decking.
- White “dots” are frost on nail points.

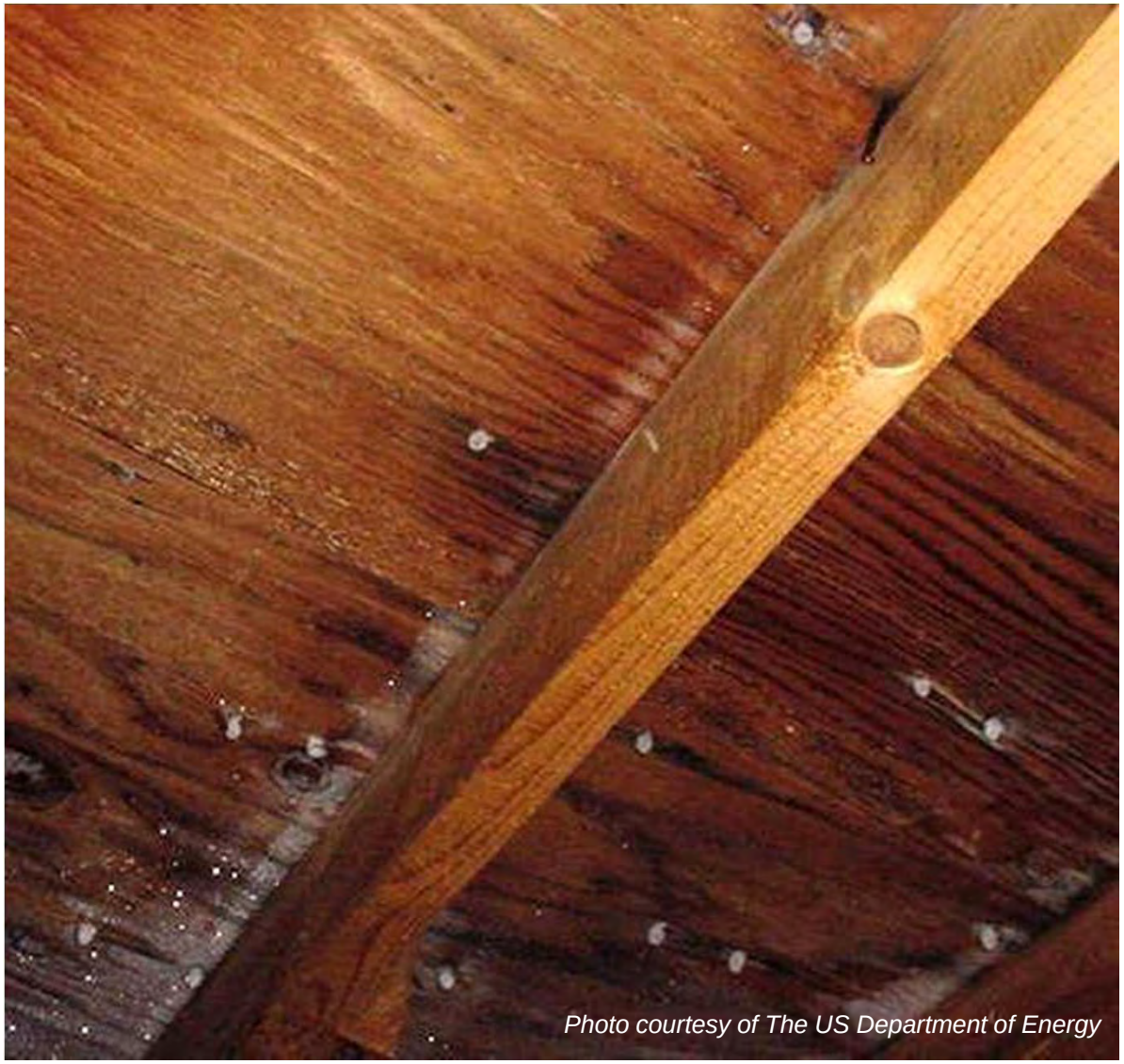


Photo courtesy of The US Department of Energy


Plumbing pipe and dirty insulation are clues . . .
. . . that an attic bypass is allowing air flow through the insulation.
Photos courtesy of The US Department of Energy

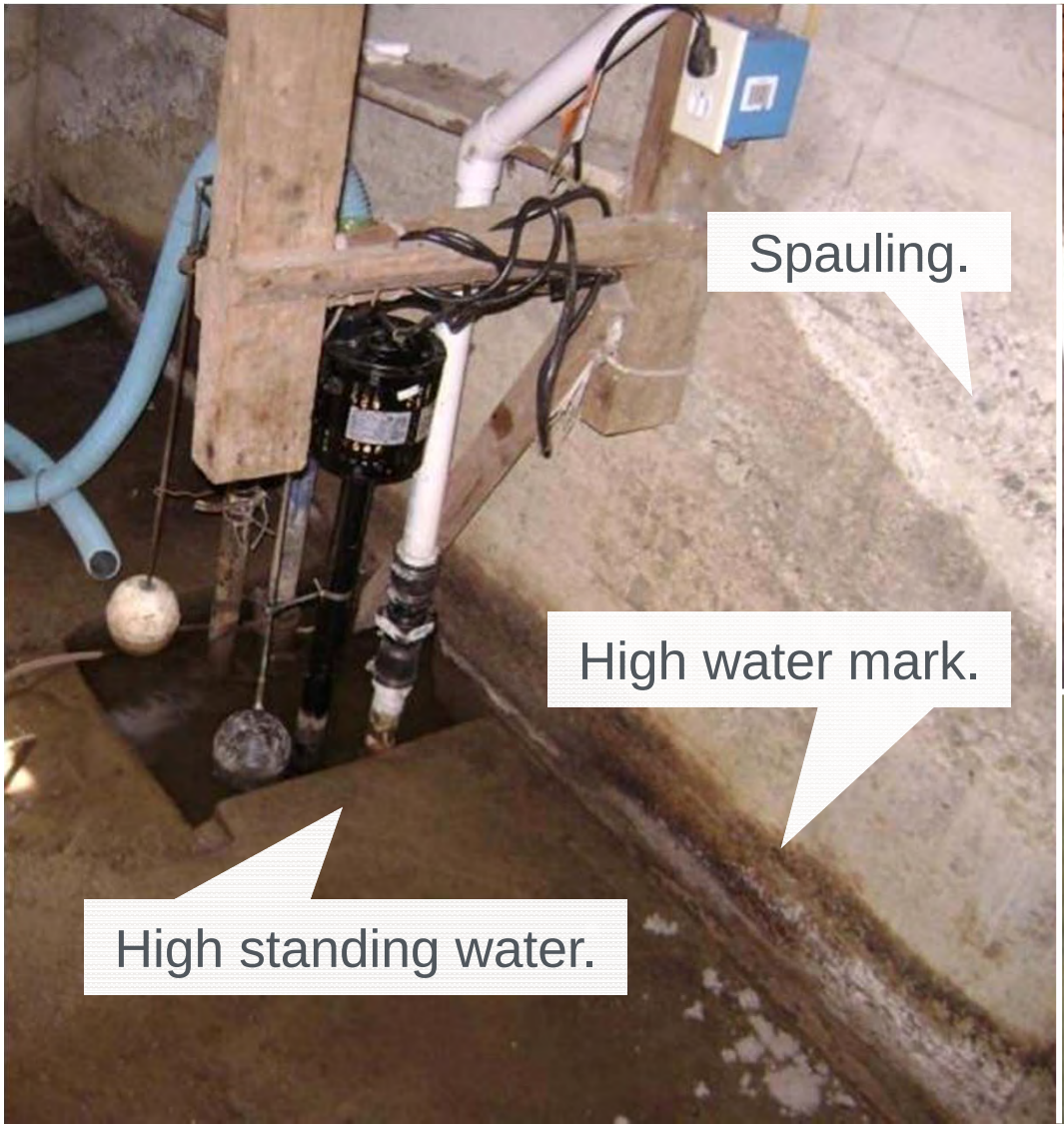
Chimney Chases

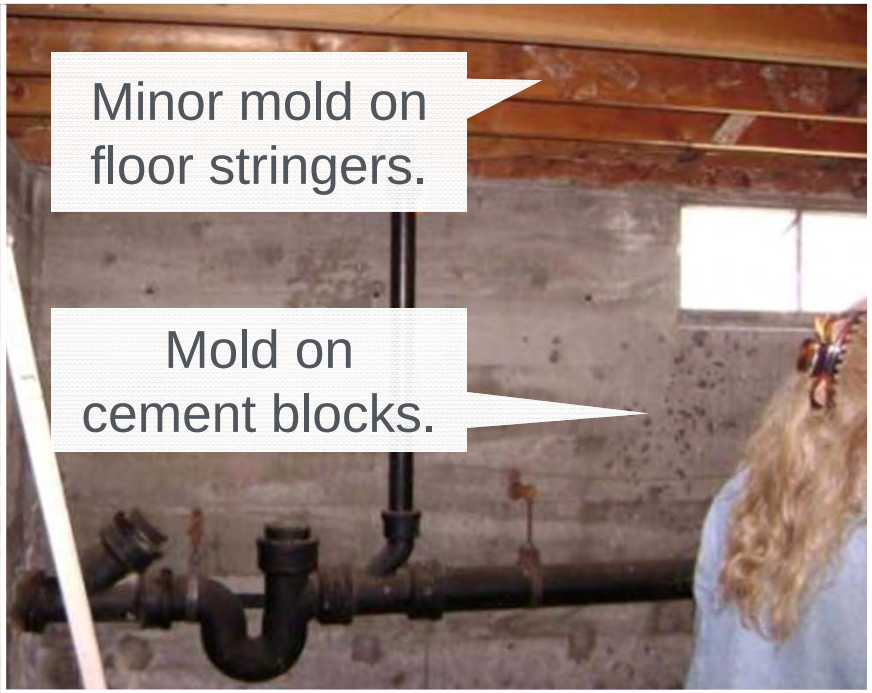
Photo courtesy of The US Department of Energy

Sealed Chimney Bypass

Photos courtesy of The US Department of Energy

In the Basement





Photos courtesy of The US Department of Energy

Plumbing and Wire Opening

Photos courtesy of The US Department of Energy

Under the Tub

Photos courtesy of The US Department of Energy

Another Tub

Photos courtesy of The US Department of Energy

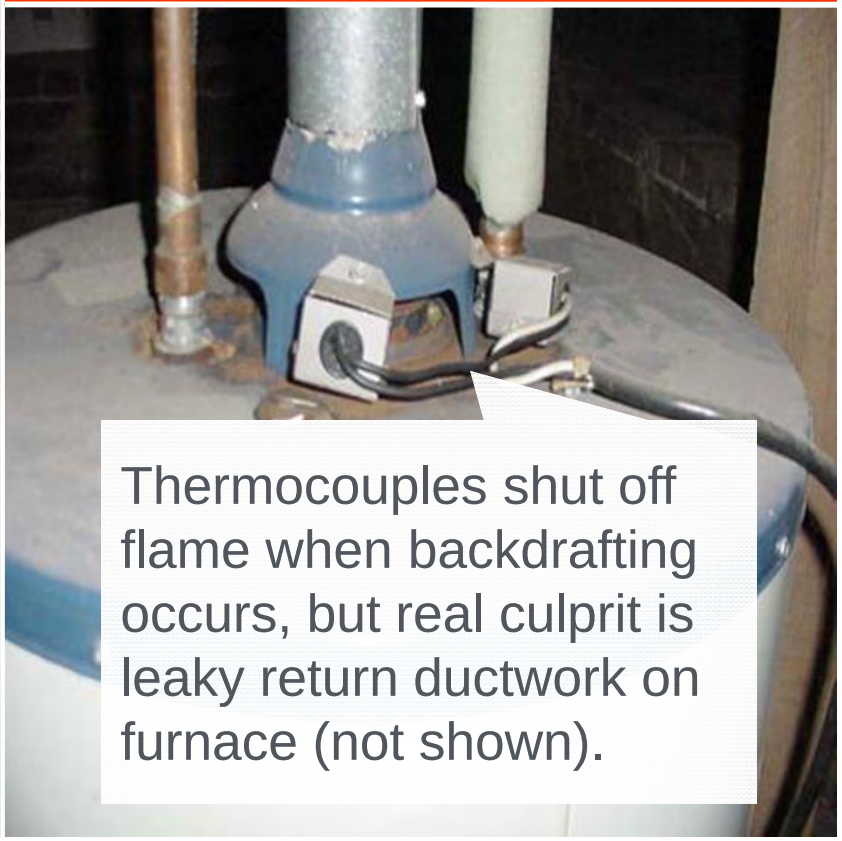
More in the Basement

Top of connection between heat delivery plenum and main trunk.

Photos courtesy of The US Department of Energy

More in the Basement

Danger!



Photos courtesy of The US Department of Energy

In the Garage

Photo courtesy of The US Department of Energy

In the Kitchen and Bathroom

Photos courtesy of The US Department of Energy

In the Living Room

Fireplaces “net cool” all but the smallest spaces.

Photos courtesy of The US Department of Energy

Unvented Space Heaters

Photo courtesy of The US Department of Energy

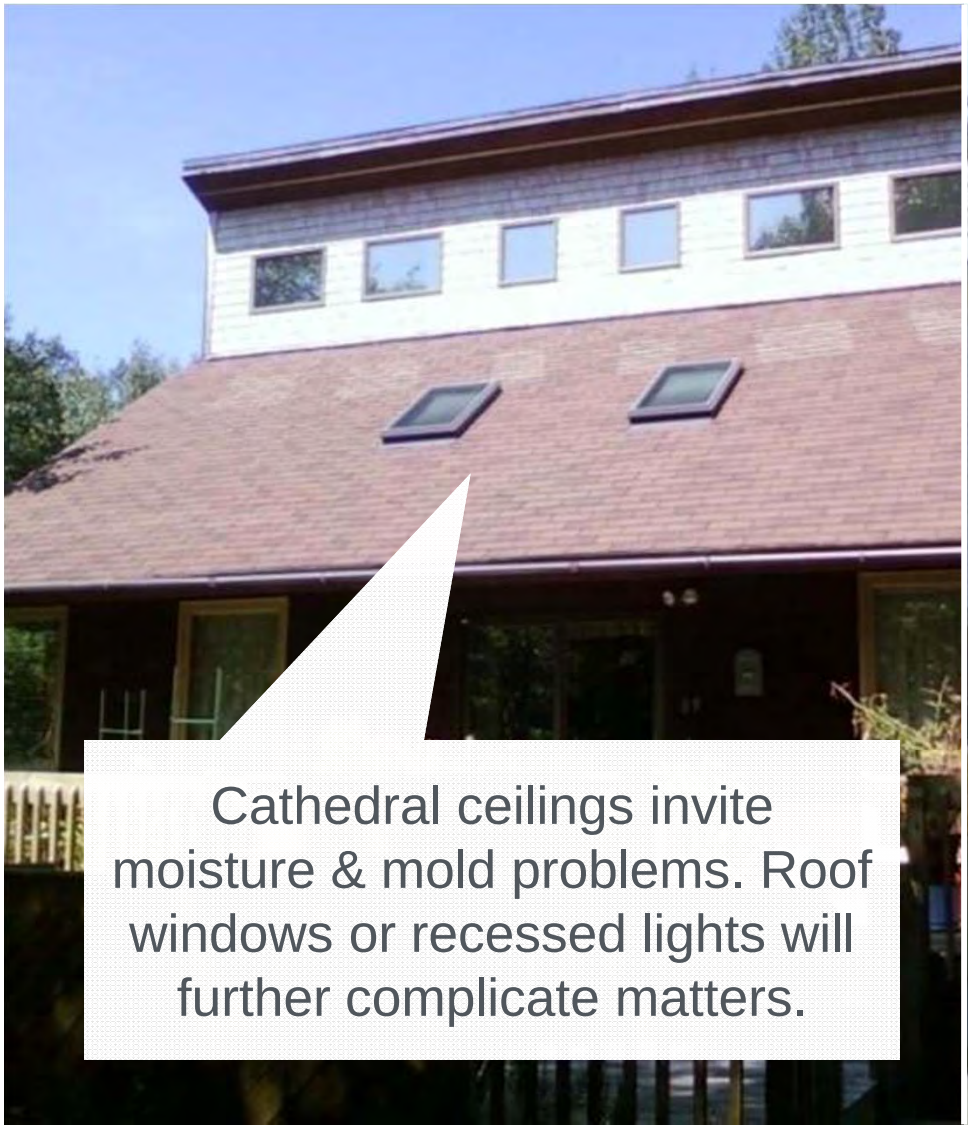
And then there are

VENT FREE fireplaces!

& kerosene heaters

& homemade stuff.

Outside


Cathedral ceilings invite moisture & mold problems. Roof windows or recessed lights will further complicate matters.


Trees & bushes against a building prevent wall assemblies from drying.
Photos courtesy of The US Department of Energy

All exhaust appliances “suck” on the house.

Photos courtesy of The US Department of Energy

Occupant Behavior

Photos courtesy of The US Department of Energy

What's Going On?

Photo courtesy of The US Department of Energy

What Should Be Done?

- Add a storm window.
- Replace the entire window unit.
- Advise the homeowner to run the ceiling fan.
- Get rid of the plants.

Photo courtesy of The US Department of Energy

It Depends!

Houses:

- Are tighter.
- Have more exhaust appliances.
- Have “weaker” natural draft combustion appliances.
- Have less drying potential.

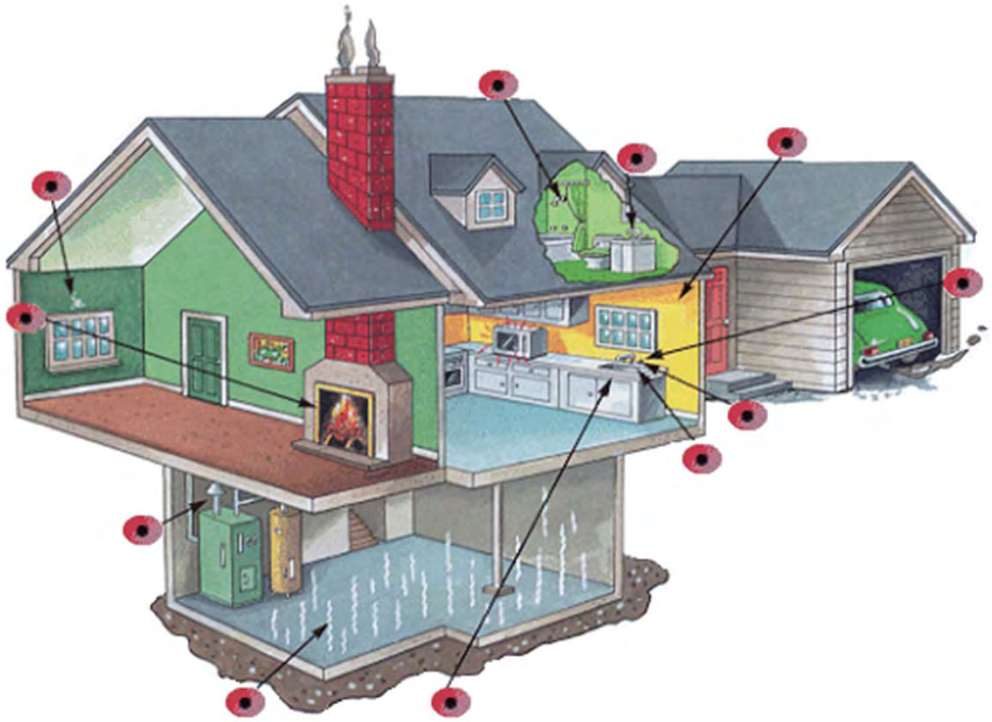
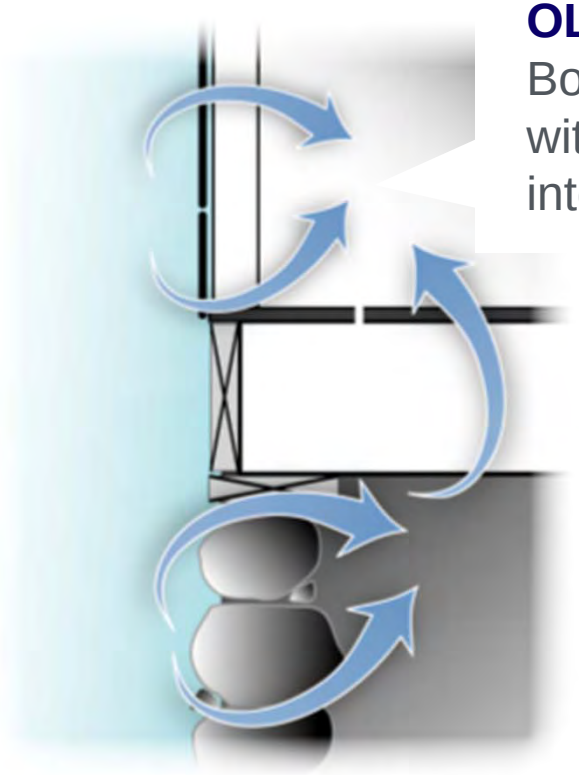
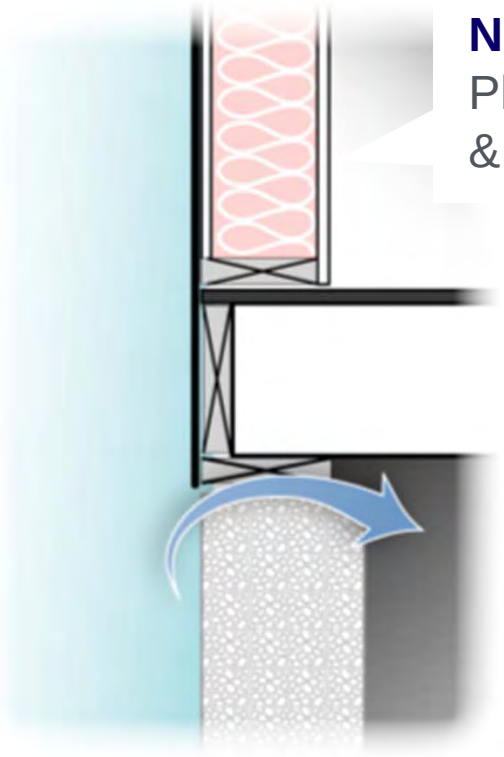


Diagram courtesy of John Tooley

Today's Houses Are Tighter



OLD
Boarded exterior with lath & plaster interior walls.



NEW
Plywood & drywall.

Today's Houses Have More and Bigger Fans

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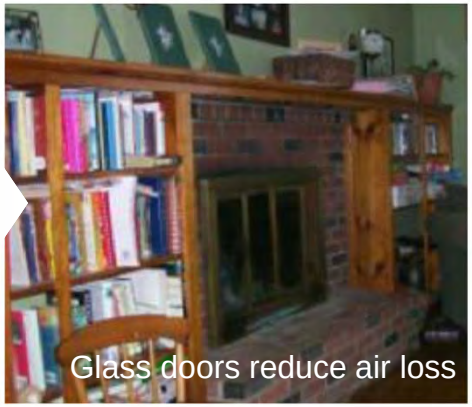
HOUSE AS A SYSTEM

Photos courtesy of The US Department of Energy

Today's Houses Have Weaker Draft Appliances

The weaker the draft (i.e., the higher the efficiency), the less air moves through the heating system & therefore the house.


Open fireplaces


Glass doors reduce air loss


Air Tight Wood Stove
Kuma Stoves kumastoves.com


System 2000™ 90+%


High Mass drybase boiler 80%


Converted coal boiler 50%

Photos courtesy of The US Department of Energy

Today's Houses Have Less Drying Potential

The **old house** got wet in the summer (humid) & dried in the winter (low humidity).

Older Home:

- Balloon-framed two-story home (lots of stack effect).
- Boards, plaster & lathe.
- No insulation.
- Construction style and materials inherently leaky.

The **new house** gets just as wet but can't dry; therefore poor IAQ and mold/mildew.

Newer Home:

- Low (little stack effect).
- Plywood & drywall.
- Construction style and materials inherently tighter than older home.

Lifestyle Changes

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HOUSE AS A SYSTEM

Summary

- We build very differently than we did as little as 40 years ago.
- Economic pressure is driving the move to tighter houses with smaller margins of safety.
- The tighter a house is, the more influence individual components have on the others.
- All pollutants inside the pressure boundary will eventually be dispersed over the entire area.
- Altering a building or its mechanicals can have unexpected consequences.