



U.S. DEPARTMENT OF ENERGY
SOLAR DECATHLON

2011

LIVE IN



THIS



NOT

THAT!

Question:

What new technology will completely change housing?

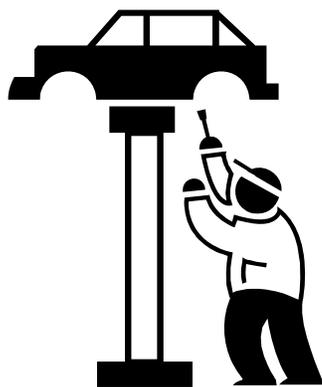
Hint: It has nothing to do with construction.

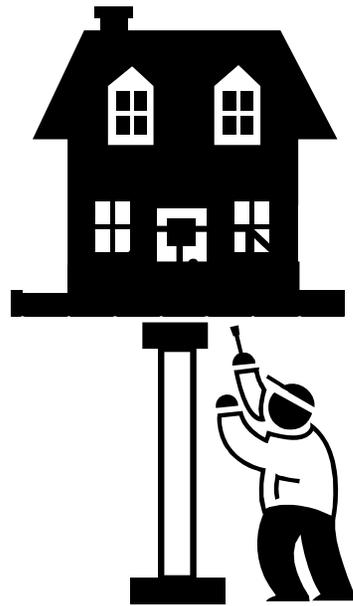
Low Cost Infrared Cameras



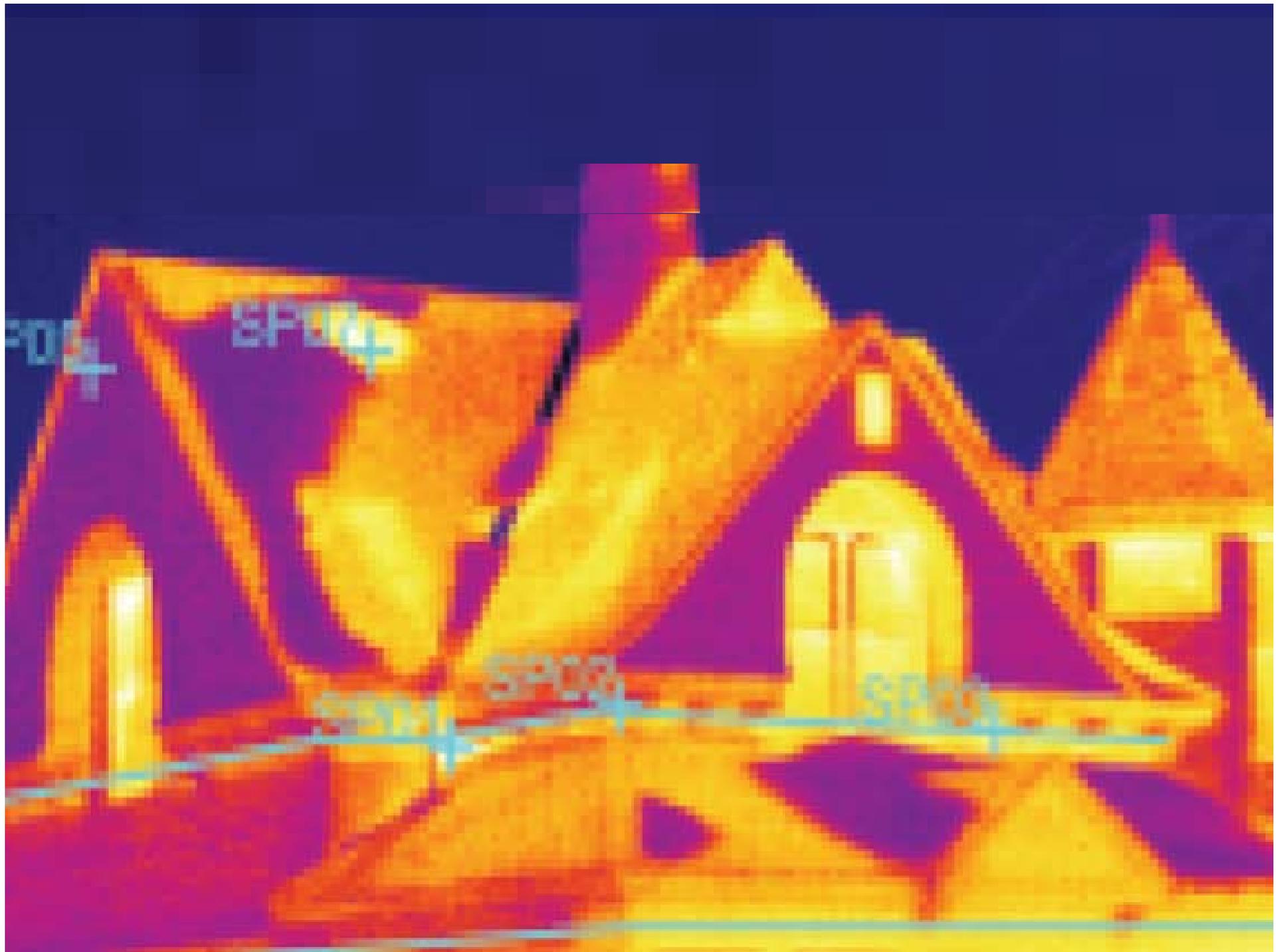
**FREE
Online
Training**

Your Price:
\$4,995.00









Four Key Ingredients to Health

Food

Fat

Sugar

Salt

Chemicals

Status Quo 95+% of Homes: "Houston, We Have a Problem"

Affordable
Comfortable
Healthy
Durable

1.
Control
Air Flow

2.
Control
Thermal Flow

3.
Control
Moisture Flow

4.
Control
Pollutants

INGREDIENT #1: CONTROL AIR FLOW

TWO CONDITIONS FOR AIR LEAKAGE:

- **Holes**
- **Weather**



Weather:
Wind/Heat/Moisture

AIR LEAKAGE CONTROL STRATEGY

1. Can't control weather
2. So control the holes
3. Since air will take path of least resistance through largest holes...

seal big holes first!

We're geniuses!



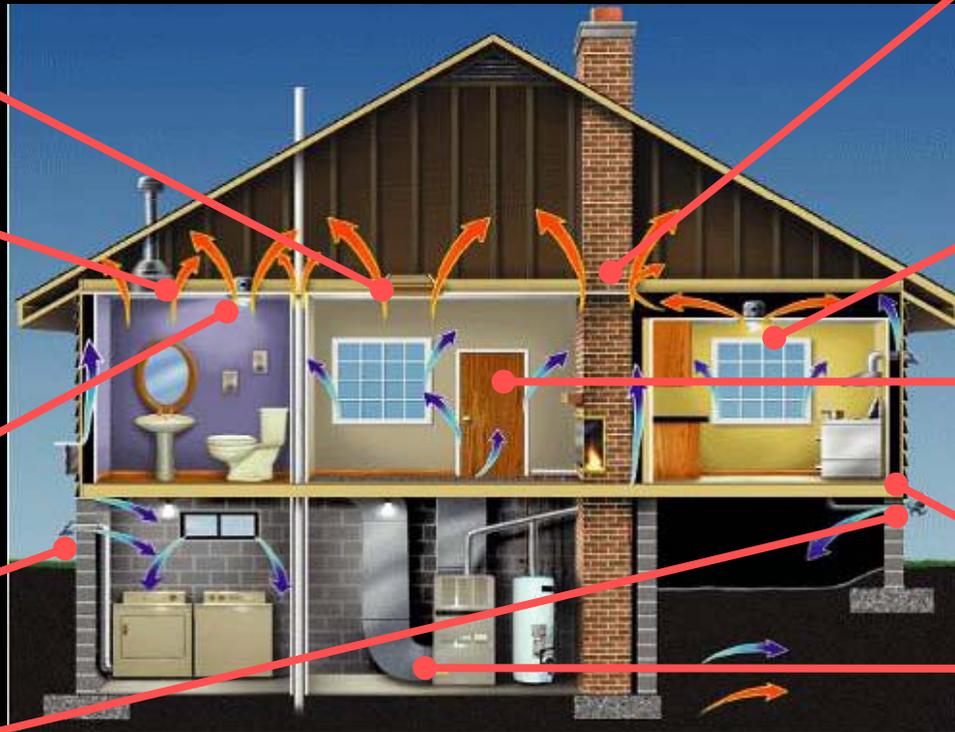
WE KNOW WHERE THE BIG HOLES ARE...

Access Panels

Drywall at Top Plate

Penetrations:

- Ceiling Fixtures
- Vents
- Plumbing



Chases

Cracks:

- Window Openings
- Door Openings
- Sill Plates

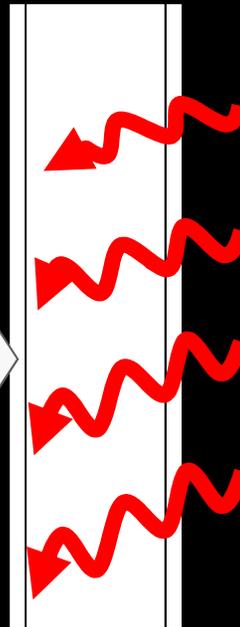
Ducts

WHY OLD BUILDINGS LAST SO LONG NO INSULATION = WARM WALL

Without Insulation:

Outside:
30°F

55°F
Cold
Surface



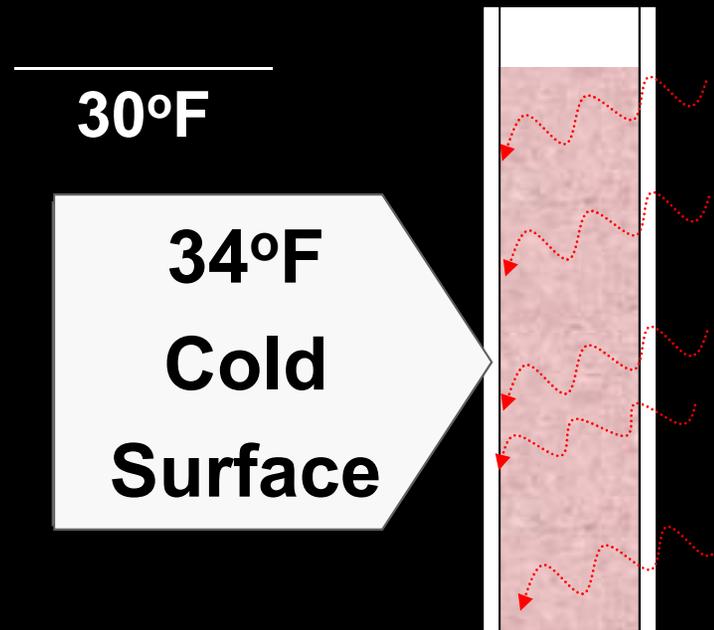
Inside:
70°F, 45°F Dew Pt.

**No
Condensation
Problem!**

**High Bills,
Comfort,
Health
Problems!**

WHY NEW HOMES MOISTURE PROBLEMS INSULATION = COLD WALLS

With Insulation:

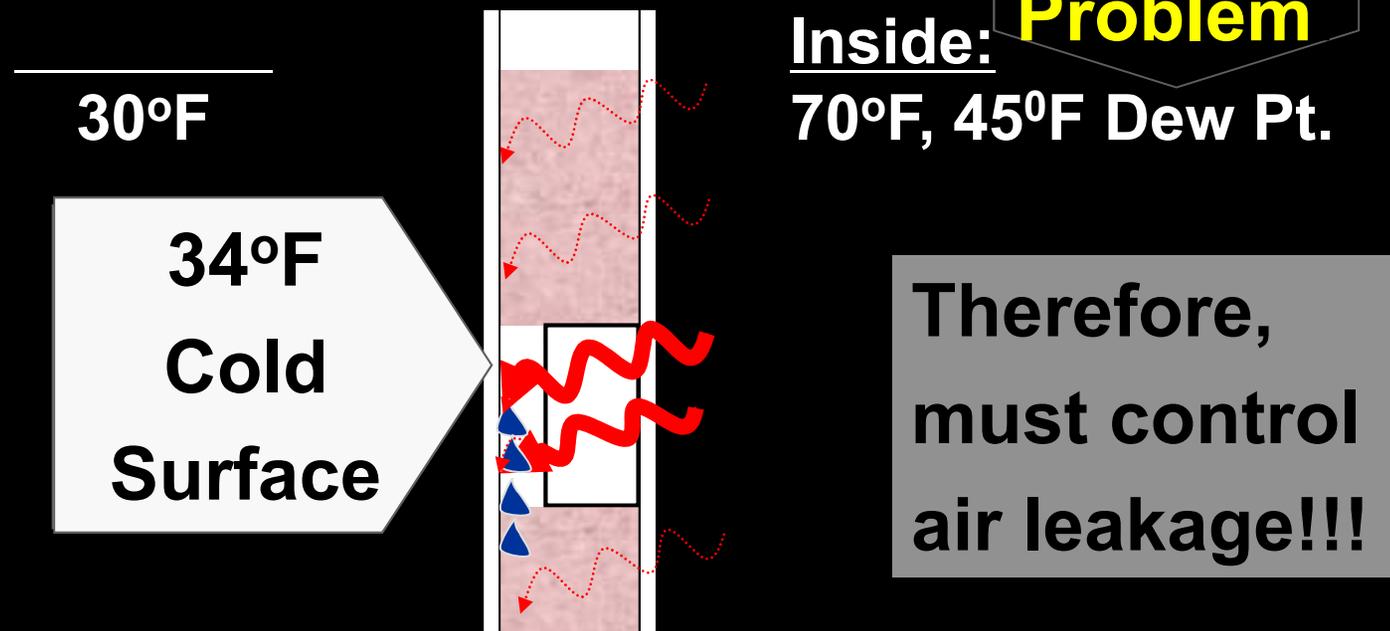


**Inside:
70°F, 45°F Dew Pt.**

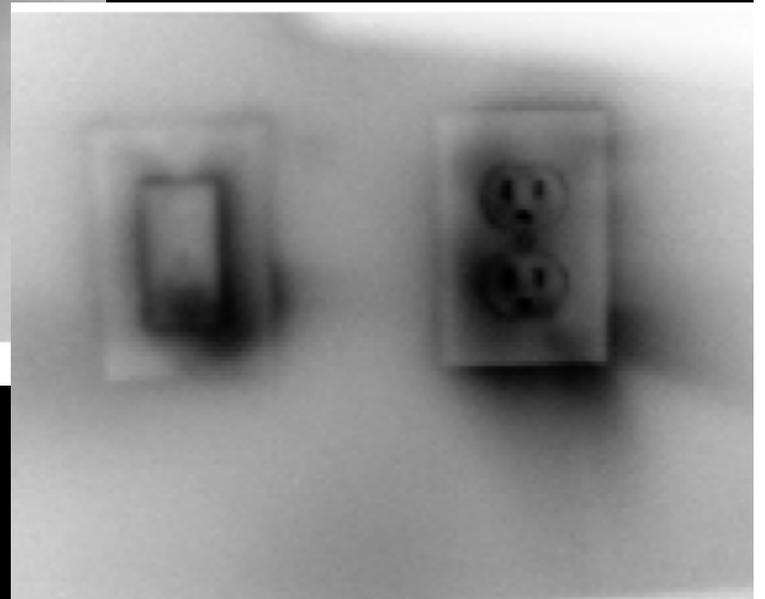
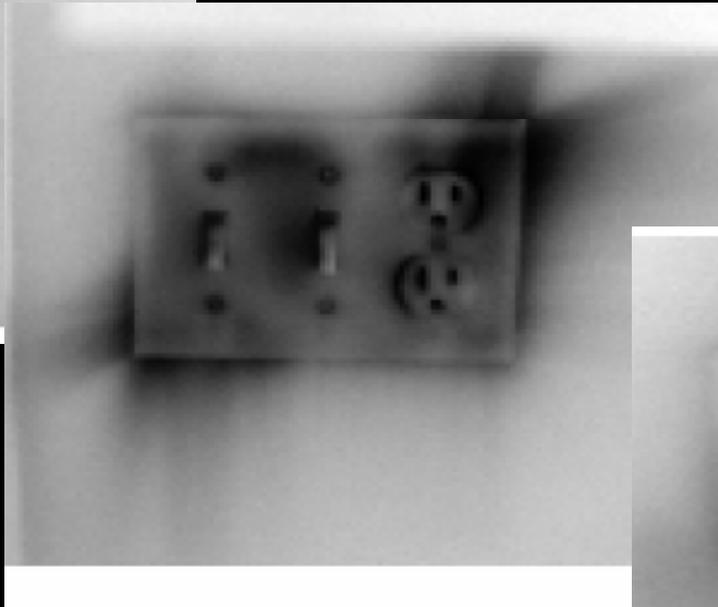
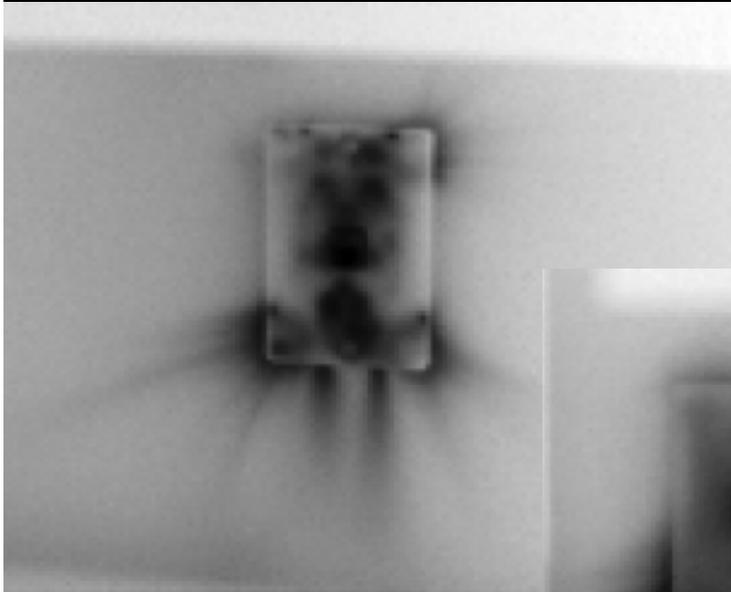
**Potential
Condensation
Problem**

WHY NEW HOMES HAVE MOISTURE PROBLEMS

With Insulation:



DO ELECTRIC OUTLETS/SWITCHES LEAK?



WHY CONTROL AIR FLOW?



Courtesy of Building Science Corp.

INGREDIENT #2: CONTROL THERMAL FLOW

TWO-PART SOLUTION

- First Control Air Flow
(see Ingredient #1)
- Then provide an effective
'Insulation System'!

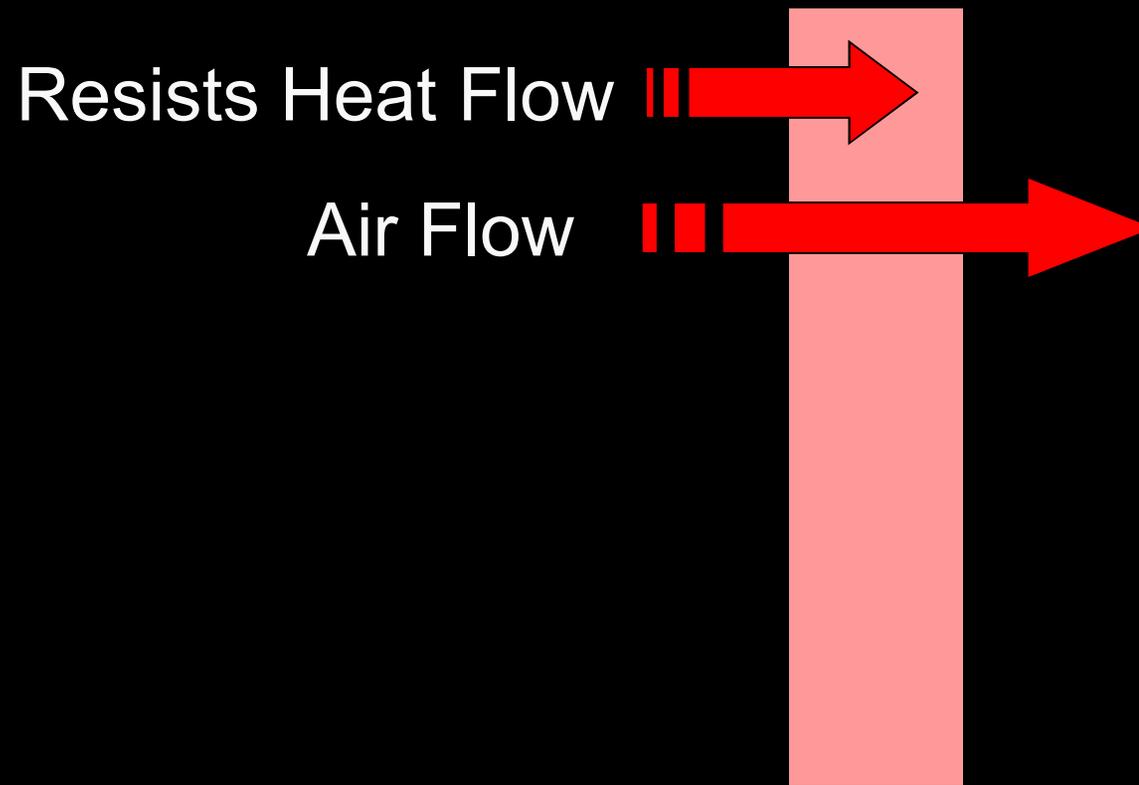
WHAT IS A COMPLETE INSULATION SYSTEM

1. Proper Amount
2. Complete Air Barriers
3. Proper Installation
4. Minimal Thermal Bridging

WHAT IS PROPER AMOUNT OF INSULATION?

- At least minimum code
- Recommend 50% above minimum code

WHY INSULATION NEEDS AN AIR BARRIER



INSULATION IS NOT AN AIR BARRIER



Courtesy of
Blue Grass
Energy

INSULATION IS NOT AN AIR BARRIER



WHAT IS AN AIR BARRIER

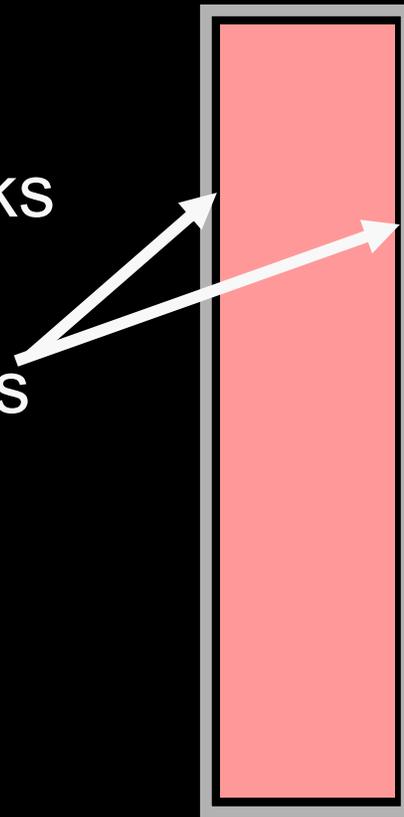
Air Barrier is...

any solid material that blocks
air flow...

...including sealing at edges
and seams

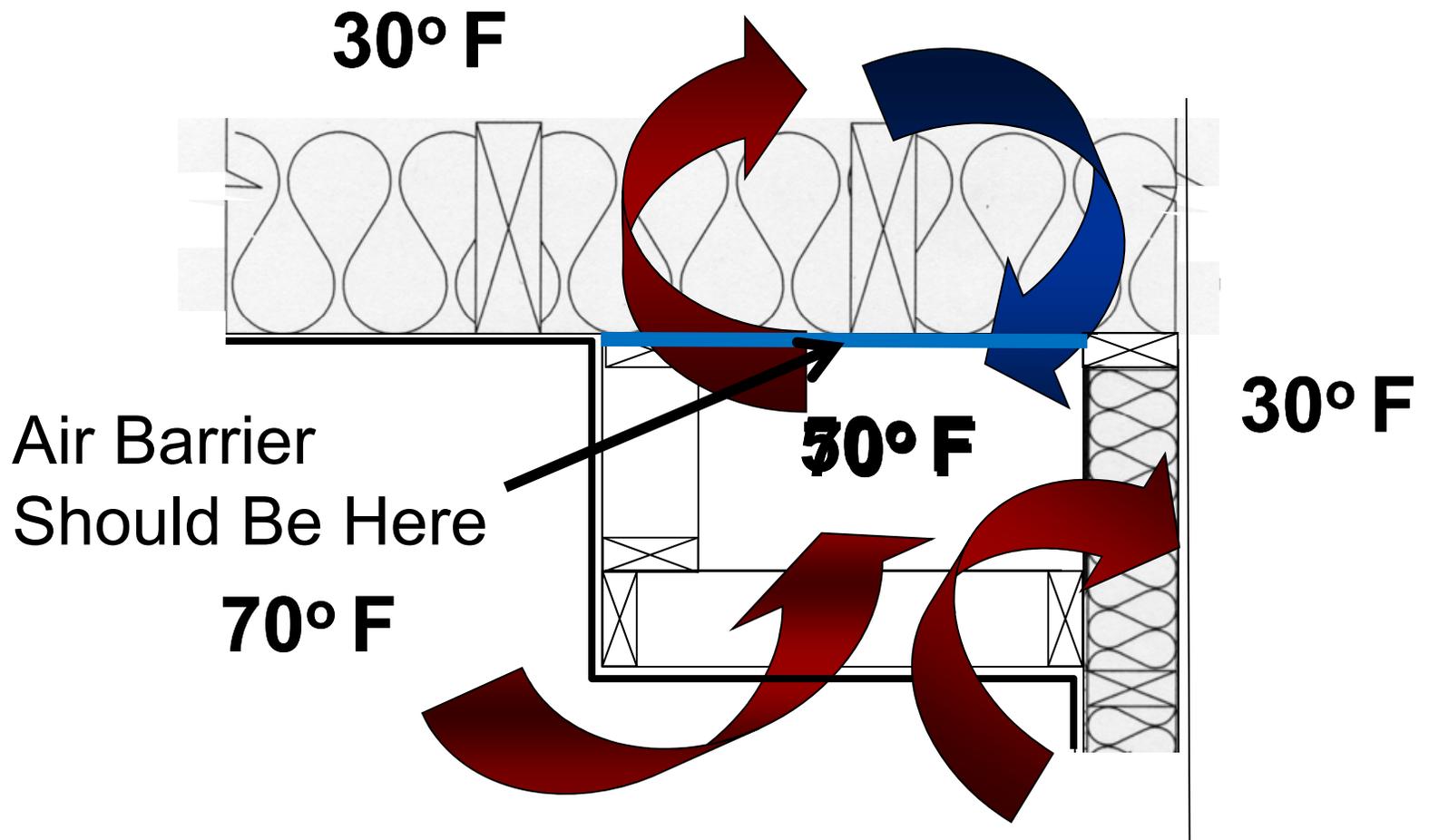
...on all six sides

...in direct contact with
insulation (no air spaces)



BUILDING SCIENCE

WHY COMPLETE AIR BARRIER

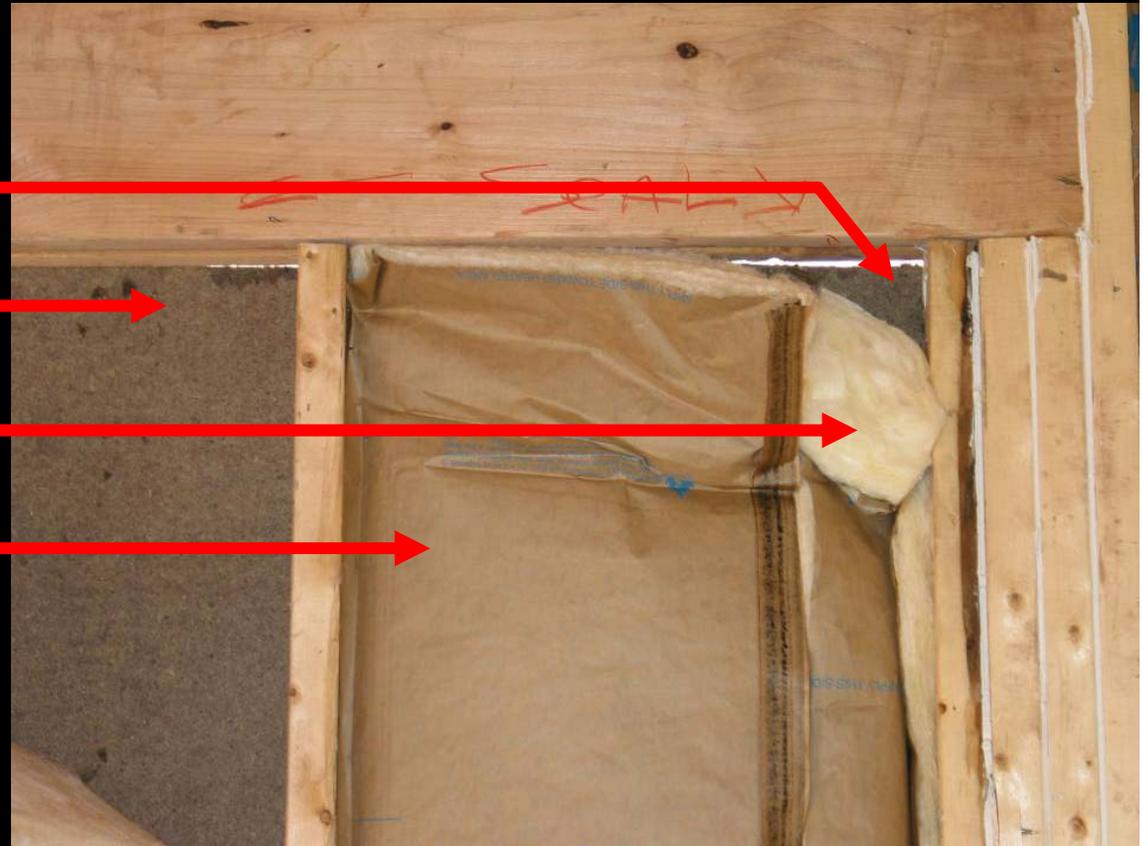




PROPER INSULATION INSTALLATION

Insulation must be installed with no:

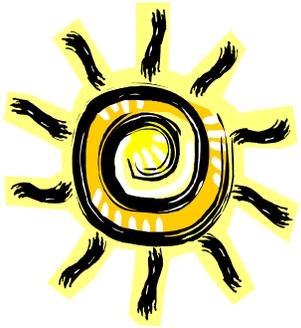
- gaps
- voids
- compression
- air spaces



WHAT IS THERMAL BRIDGING



SURFACE TEMPERATURES AND COMFORT



30 °F



SURFACE TEMPERATURES AND COMFORT

**If you lose control of
surface temperatures,
you lose control of
comfort!**

30 °F



INGREDIENT #3: CONTROL MOISTURE FLOW

MOISTURE COMES IN TWO FORMS

- **Vapor** (humid air); and
- **Bulk** (the wet stuff)

WHY CONTROL MOISTURE FLOW?



CONTROLLING MOISTURE VAPOR:

THIS GETS COMPLICATED

- First control air flow
(sound familiar...go see Ingredient #1)...
yes air flow is really important!
- Remember controlling thermal flow creates cold surfaces... this makes bulk moisture (e.g., water) flow really important... unless you like mold and dry rot.

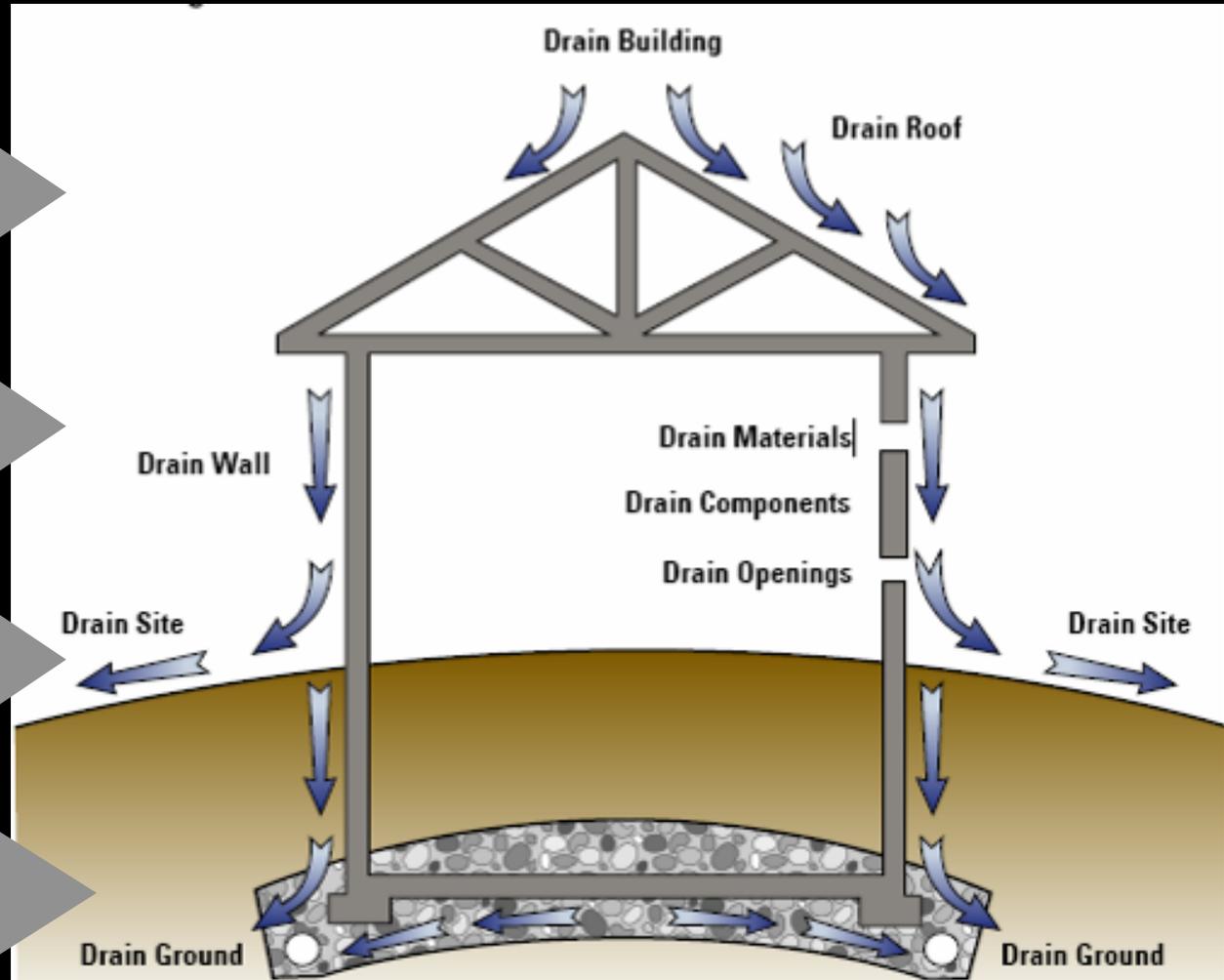
CONTROLLING BULK MOISTURE: DRAIN HOMES COMPLETELY

Drain
Roofs

Drain
Walls

Protect/Select
Materials

Drain
Foundations



INGREDIENT #4: CONTROL POLLUTANTS

MAJOR POLLUTANTS

- **Chemicals (VOC's/Formaldehyde)**
[paints, carpets, carpet pads, board products, cabinets, adhesives]
- **Moisture**
[mold, mustiness]
- **Biological**
[dust mites, pests]
- **Combustion Gases**
[gravity exhaust equipment, fireplaces, candles]
- **Radon**

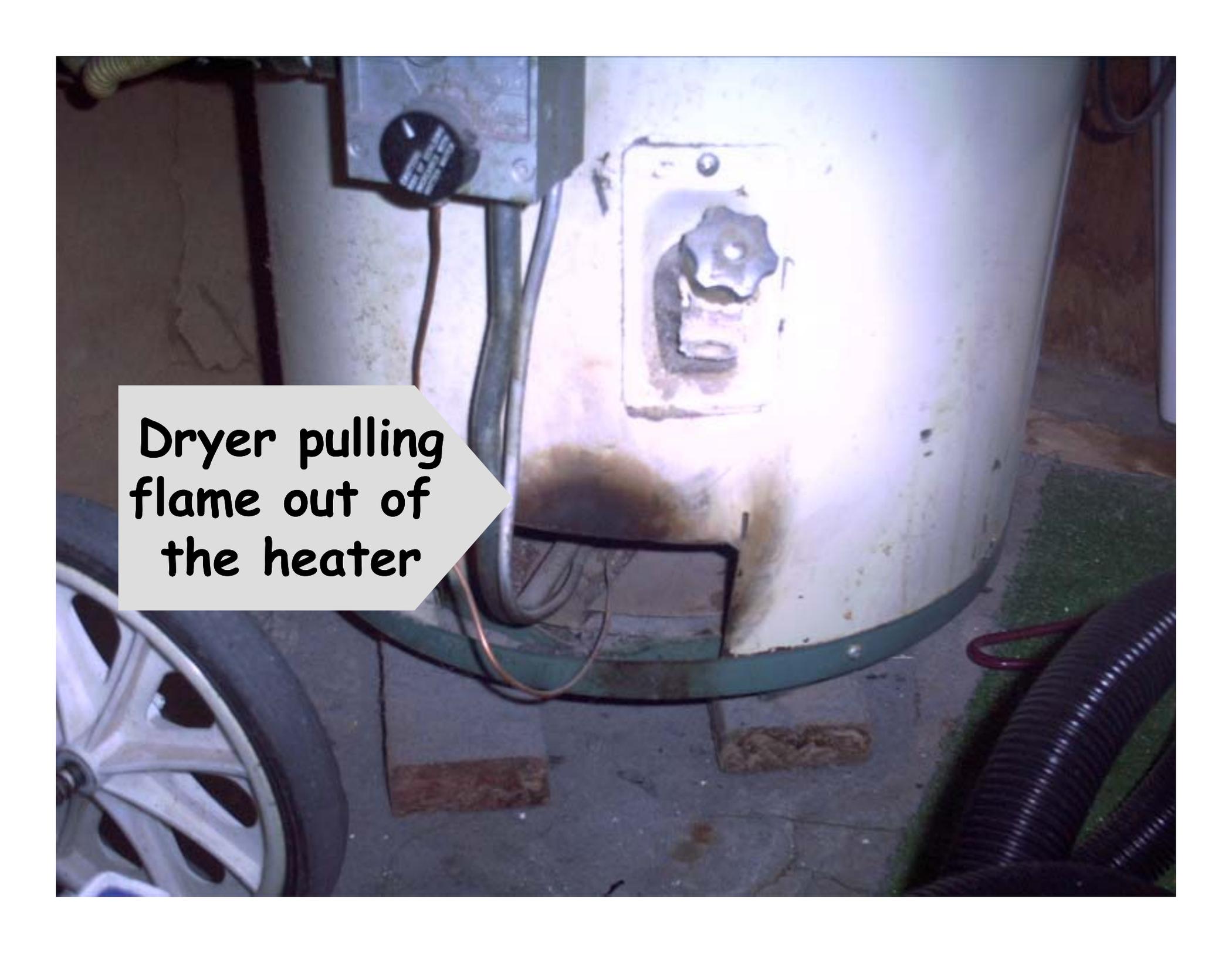
If That's Why Homes
Work and Fail...

LIVE IN THIS,
NOT THAT!





**Big
Remaining
Hole!**

A photograph showing the internal components of a dryer, specifically the heater assembly. The heater is a cylindrical metal unit with a central burner and a flame sensor. A text overlay in the bottom left corner reads "Dryer pulling flame out of the heater". The dryer is mounted on a concrete floor, and a white wheel is visible in the bottom left corner. A black corrugated vent hose is visible in the bottom right corner. The heater assembly is mounted on a metal panel, and there are some wires and a black knob visible on the left side.

**Dryer pulling
flame out of
the heater**

COMBUSTION SAFE EQUIPMENT:

Key Ingredient: **Air Flow**

Solution: **Direct Vented Equipment**

LIVE IN →
THIS



← **NOT**
THAT!

COMBUSTION SAFE EQUIPMENT:

Key Ingredient: **Air Flow**

Solution: **Direct Vented Equipment**

LIVE IN
THIS



NOT
THAT!

DROPPED CEILING:

Key Ingredient: **Air, Thermal, and Moisture Flow**
Solution: **Air Barrier**

LIVE IN →
THIS

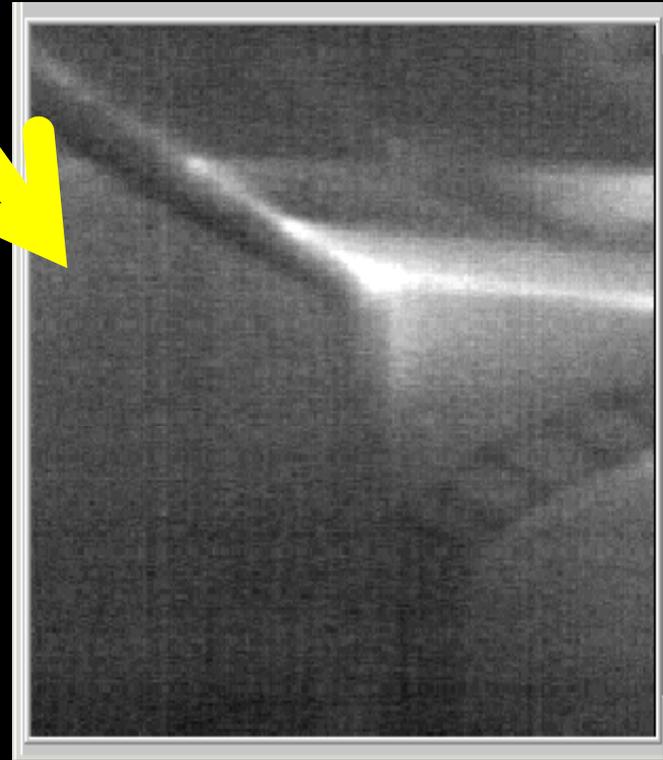


NOT
THAT!

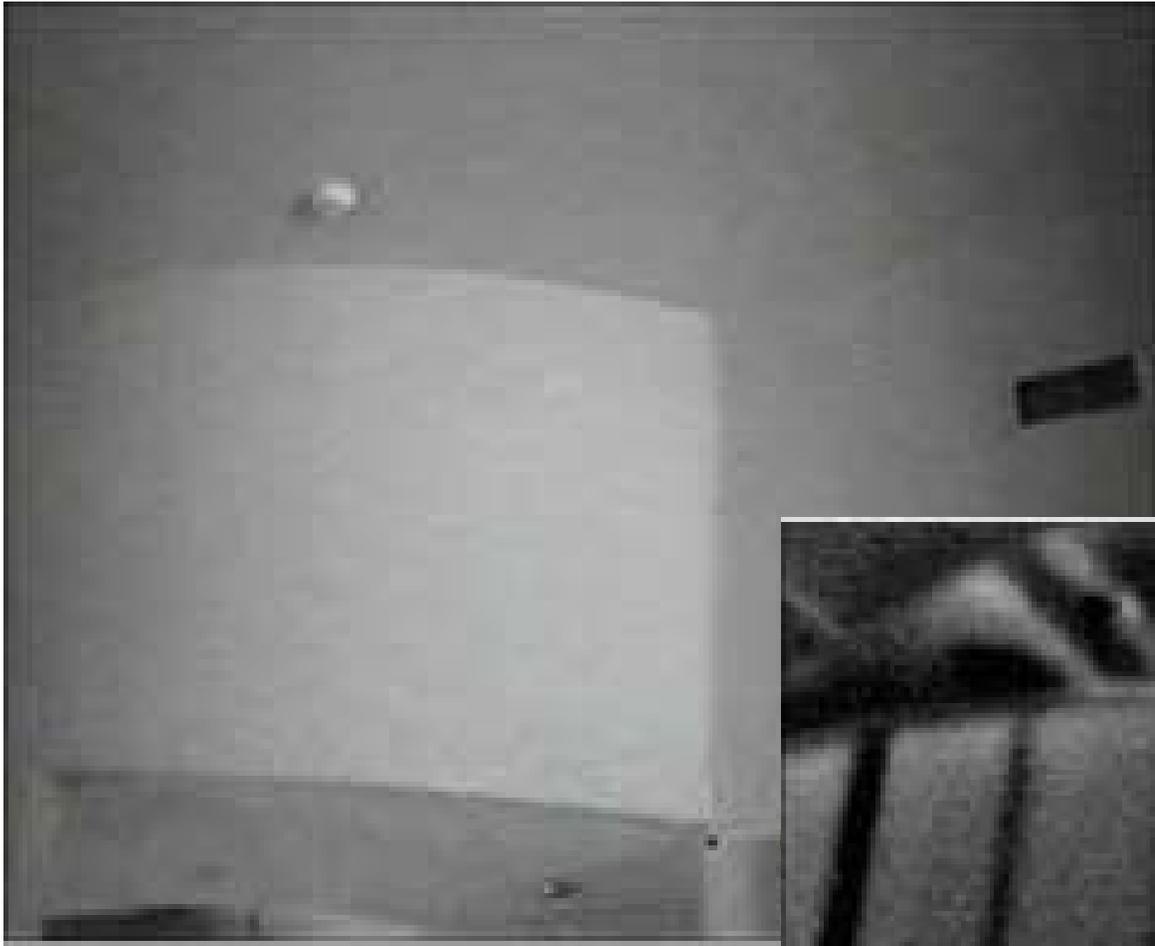
DROPPED CEILING:

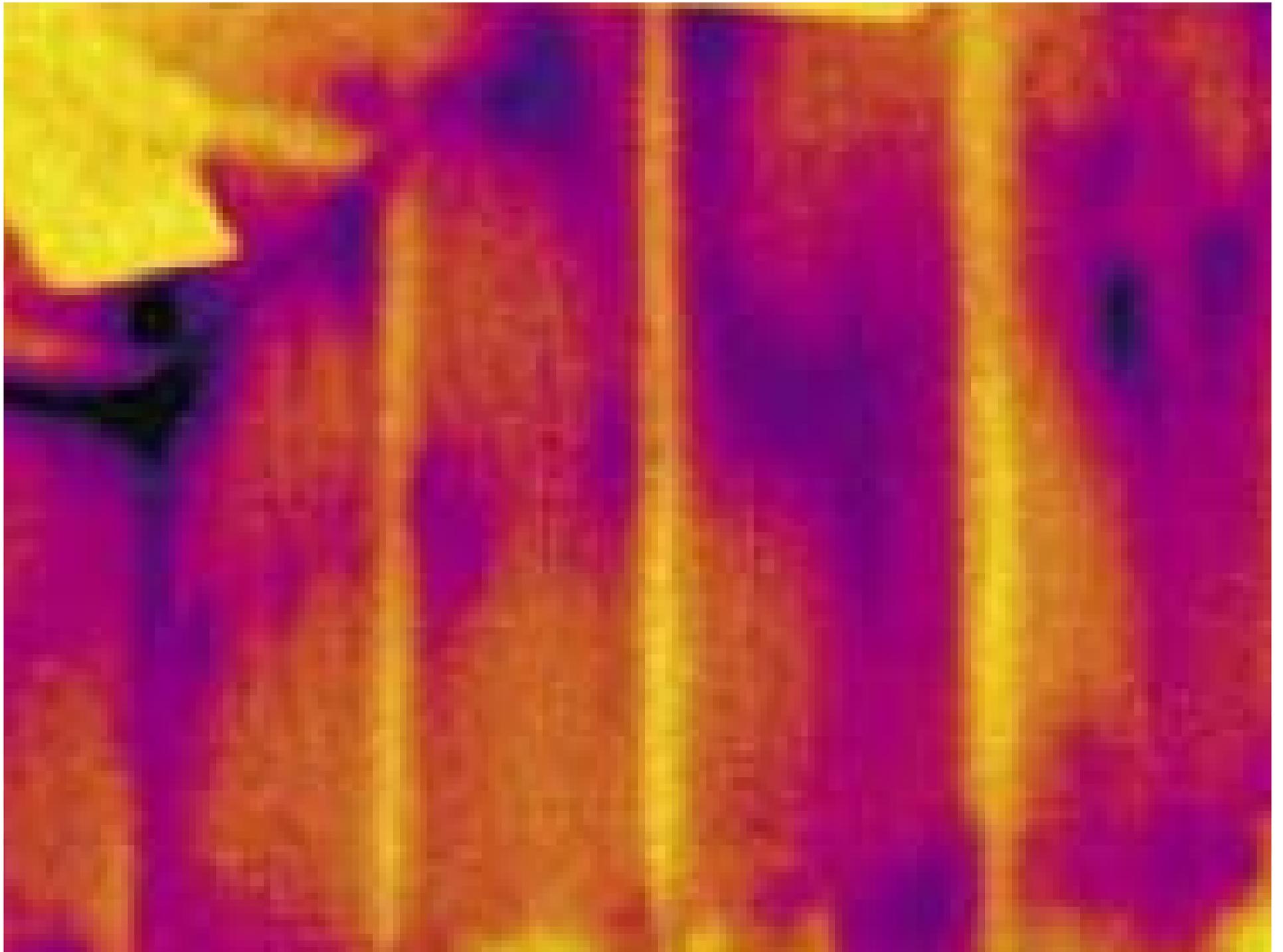
Key Ingredient: **Air, Thermal, and Moisture Flow**
Solution: **Air Barrier**

LIVE IN →
THIS



← **NOT**
THAT!





ATTIC KNEE WALL:

Key Ingredient: **Air, Thermal, and Moisture Flow**
Solution: **Air Barrier**

LIVE IN →
THIS



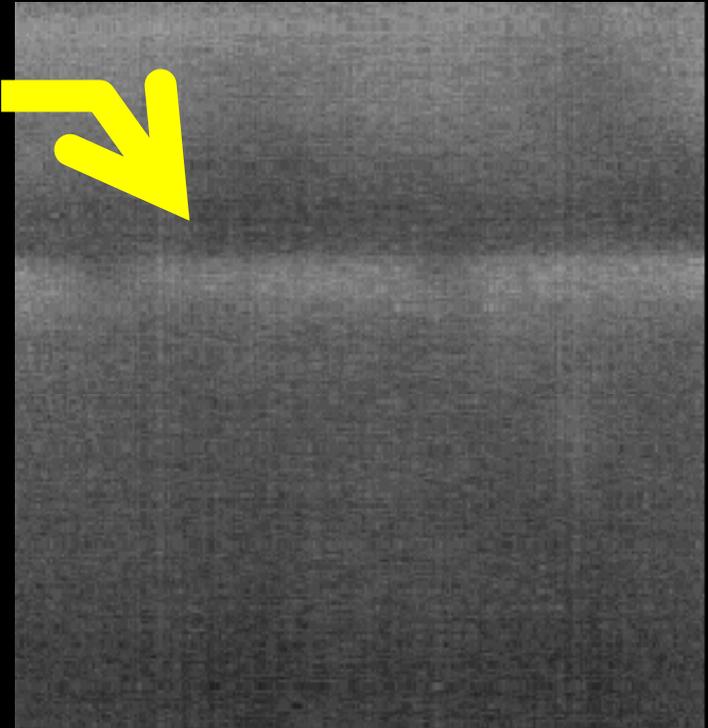
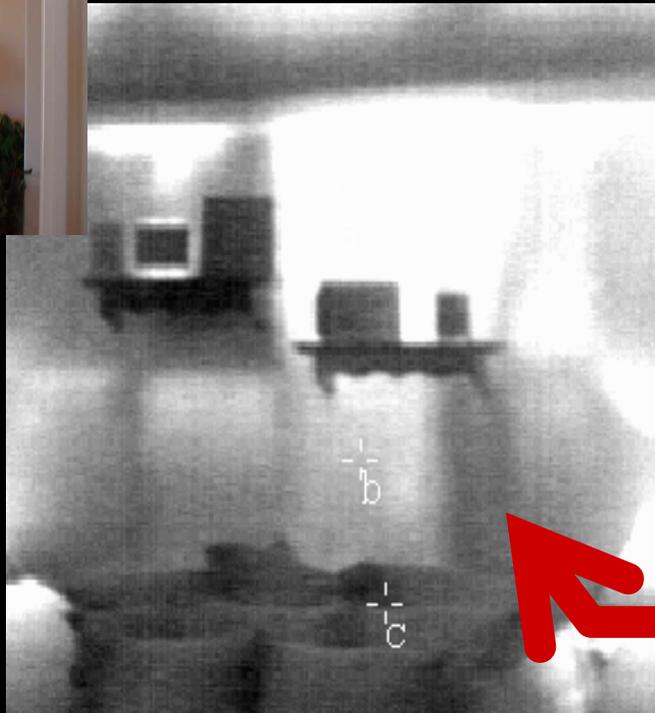
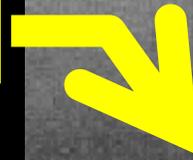
NOT
THAT!

ATTIC KNEE WALL:

Key Ingredient: **Air, Thermal, and Moisture Flow**
Solution: **Air Barrier**



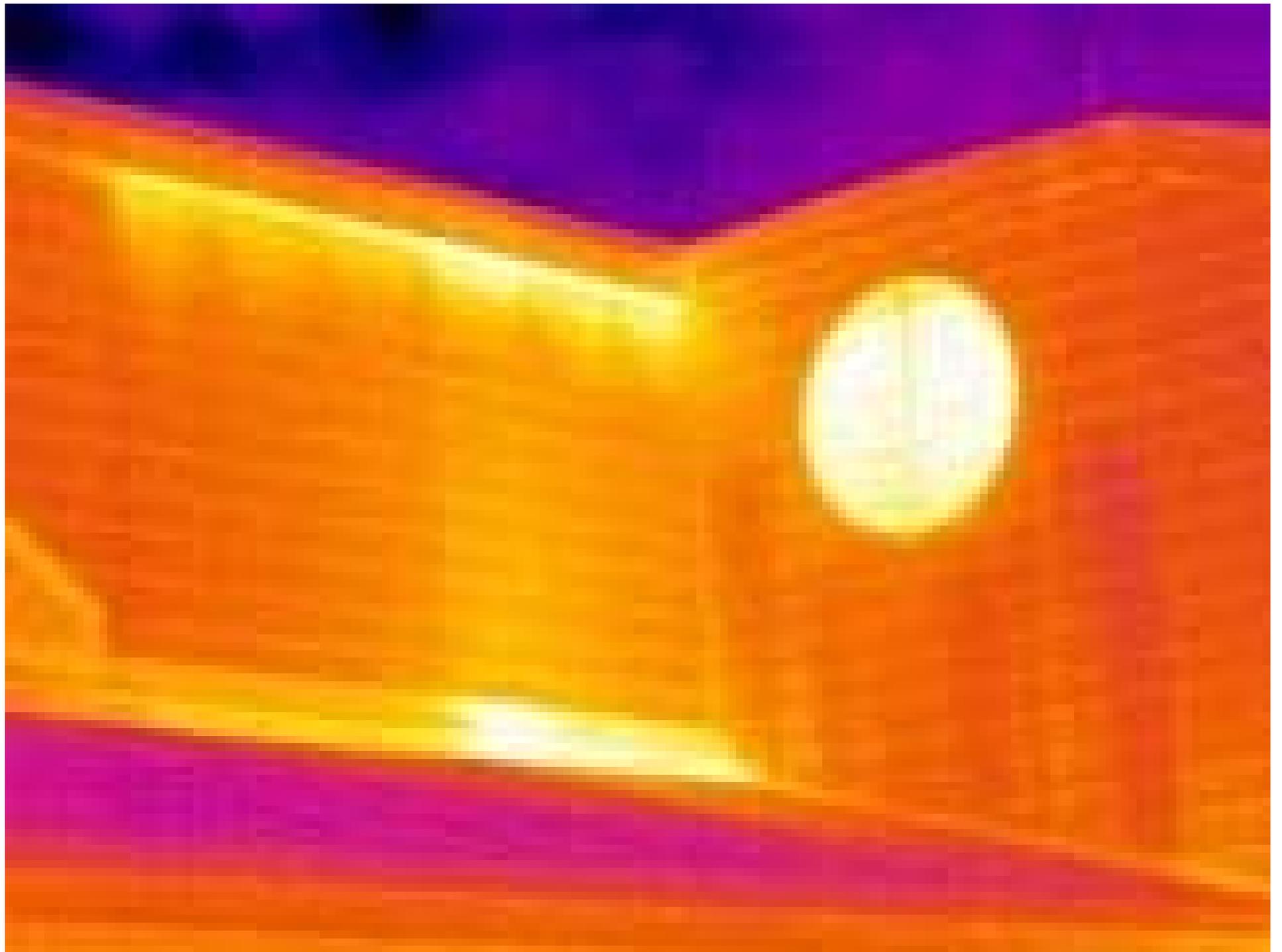
LIVE IN
THIS



NOT
THAT!

INSET STAPLING = AIR SPACES





WALL INSULATION:

Key Ingredient: Thermal Flow

Solution: Insulation Proper Installation

LIVE IN →
THIS



NOT
THAT!

WALL INSTALLATION:

Key Ingredient: Thermal Flow

Solution: Insulation Proper Installation

LIVE IN →
THIS



NOT
← **THAT!**

WALL INSTALLATION:

Key Ingredient: Thermal Flow

Solution: Insulation Proper Installation

LIVE IN →
THIS



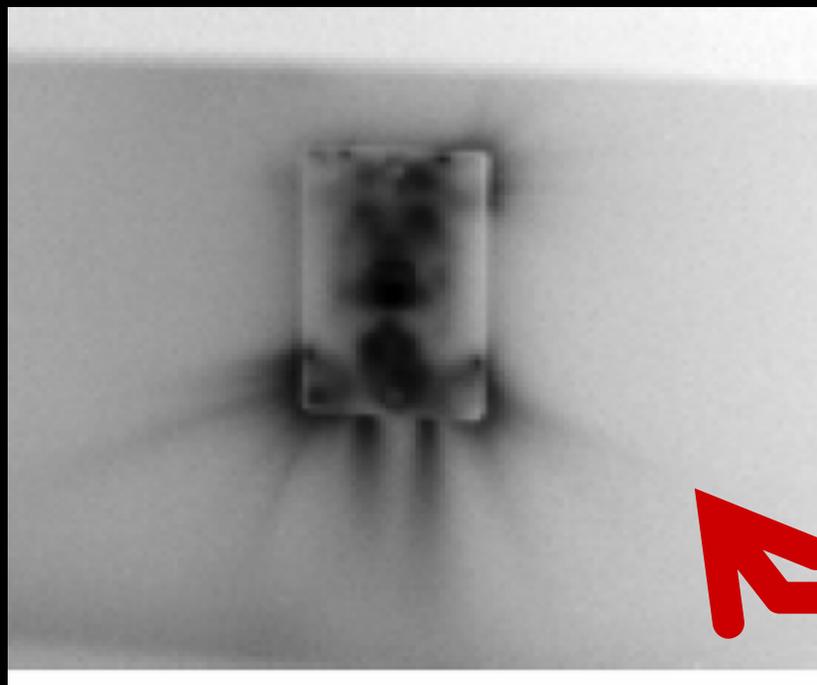
NOT
THAT!

OUTLET/SWITCHES WALL PENETRATIONS:

Key Ingredient: **Air Flow**

Solution: **Air Sealing**

LIVE IN →
THIS



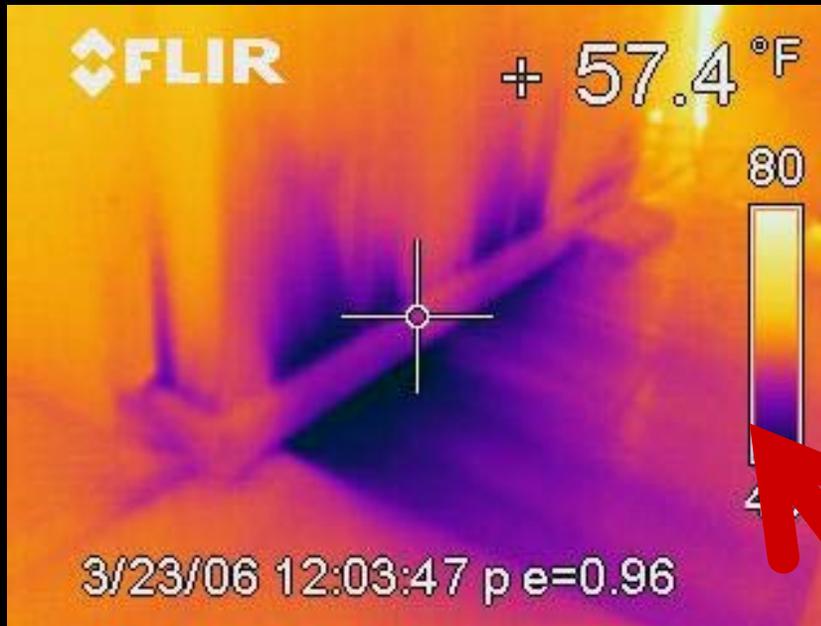
← **NOT**
THAT!

SILL PLATES:

Key Ingredient: **Air Flow**

Solution: **Air Sealing, Foam Sill Sealer**

LIVE IN →
THIS



NOT
THAT!

WINDOW/DOOR OPENINGS:

Key Ingredient: **Air Flow**

Solution: **Non-Expanding Foam Seal**

LIVE IN →
THIS



NOT
THAT!

PLUMBING PENETRATIONS:

Key Ingredient: **Air Flow**

Solution: **Foam/Flashing as Required**

LIVE IN →
THIS



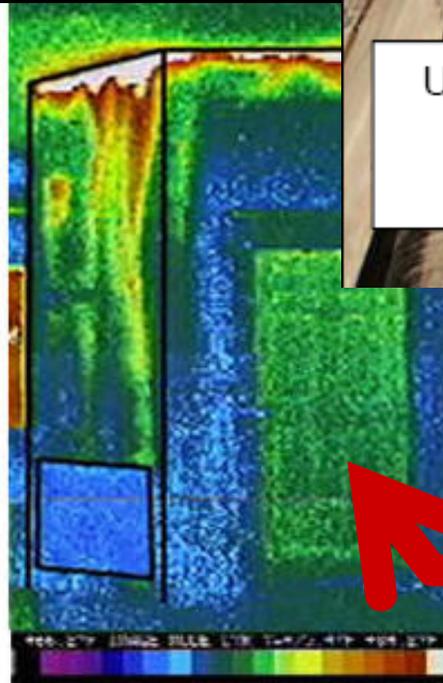
NOT
THAT!

DUCT SHAFTS:

Key Ingredient: **Air Flow**

Solution: **Air Barriers and Sealing**

LIVE IN →
THIS



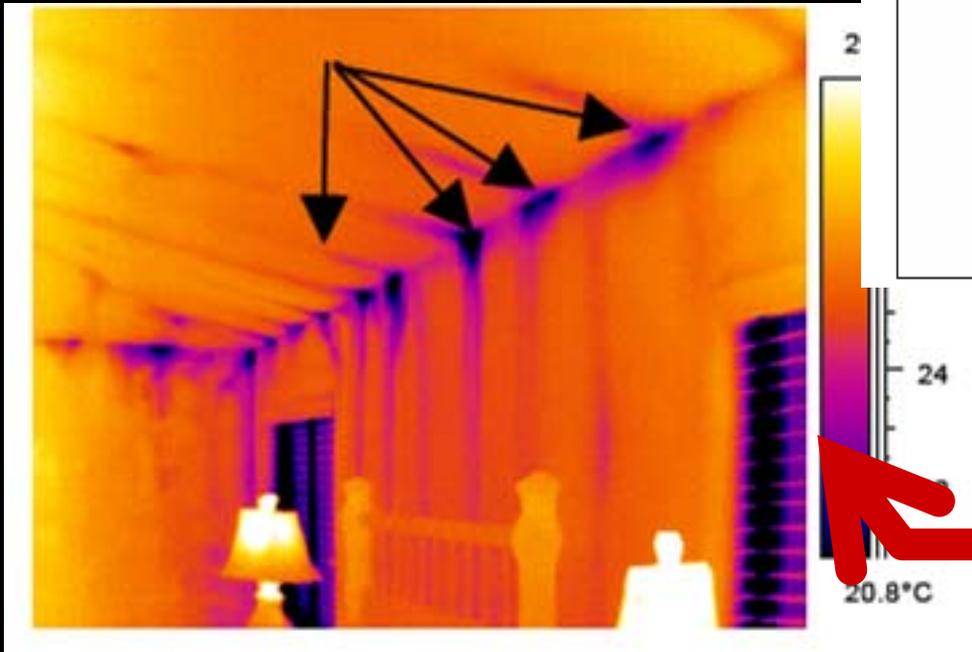
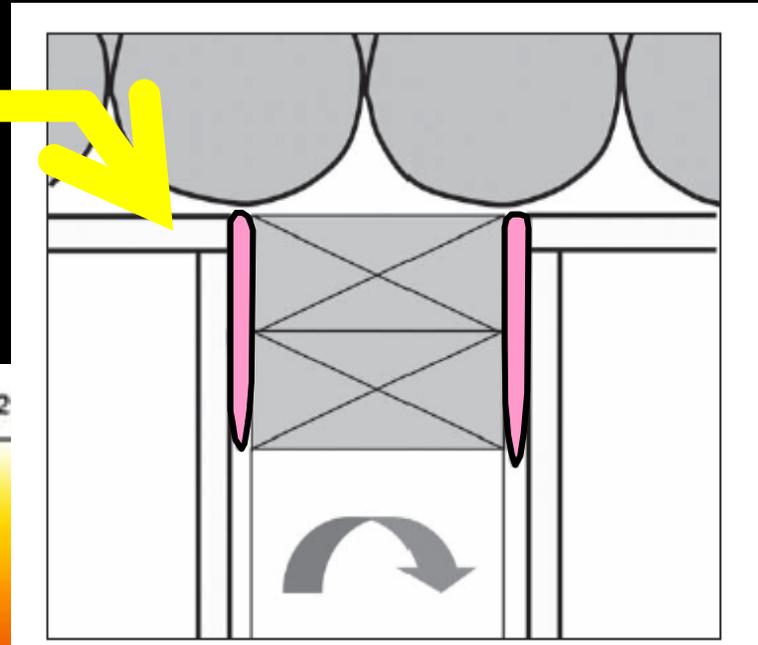
NOT
THAT!

DRYWALL AT TOP PLATE BELOW ATTIC:

Key Ingredient: **Air Flow**

Solution: **Air Sealing**

LIVE IN →
THIS



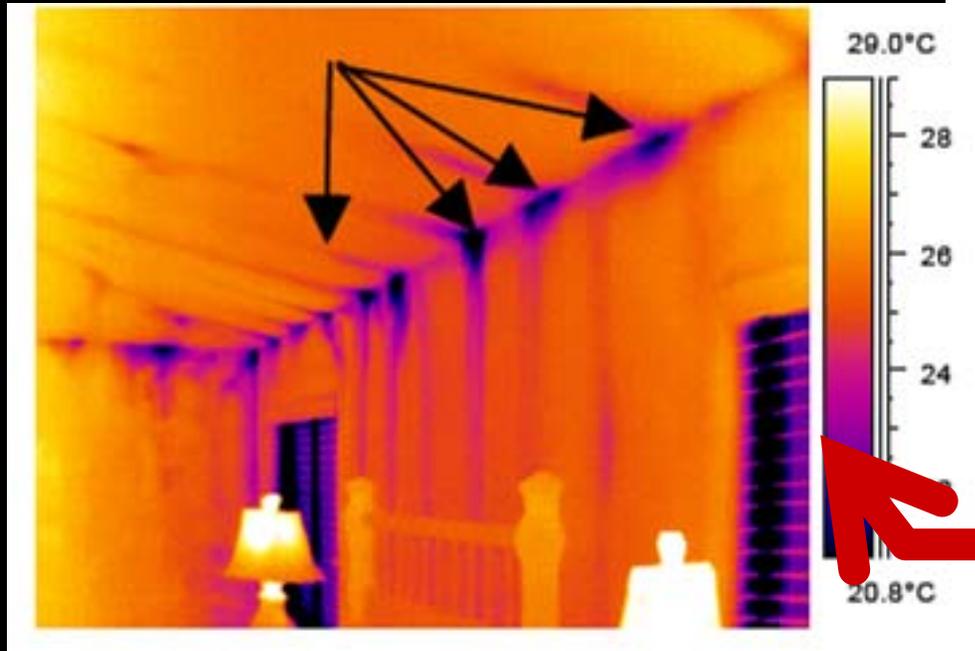
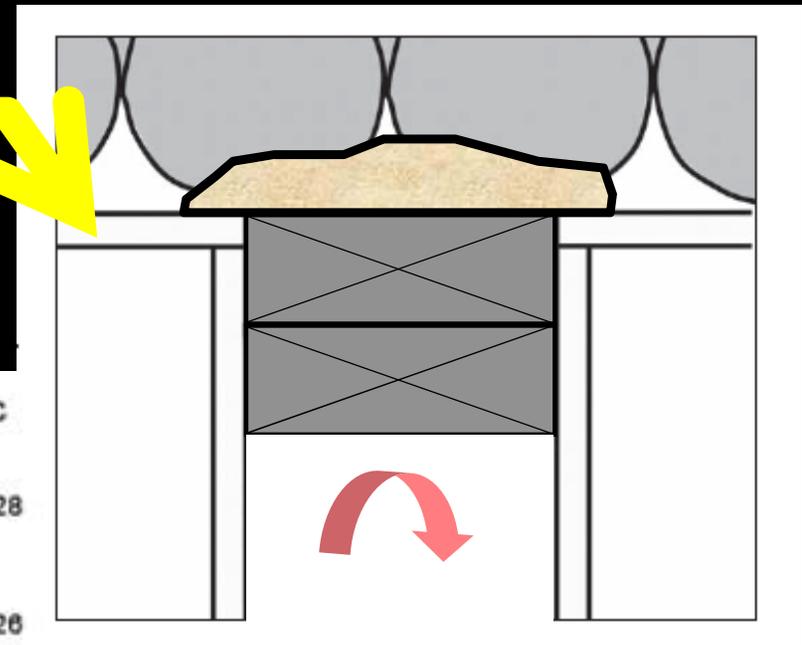
NOT
THAT!

DRYWALL AT TOP PLATE BELOW ATTIC:

Key Ingredient: **Air Flow**

Solution: **Air Sealing**

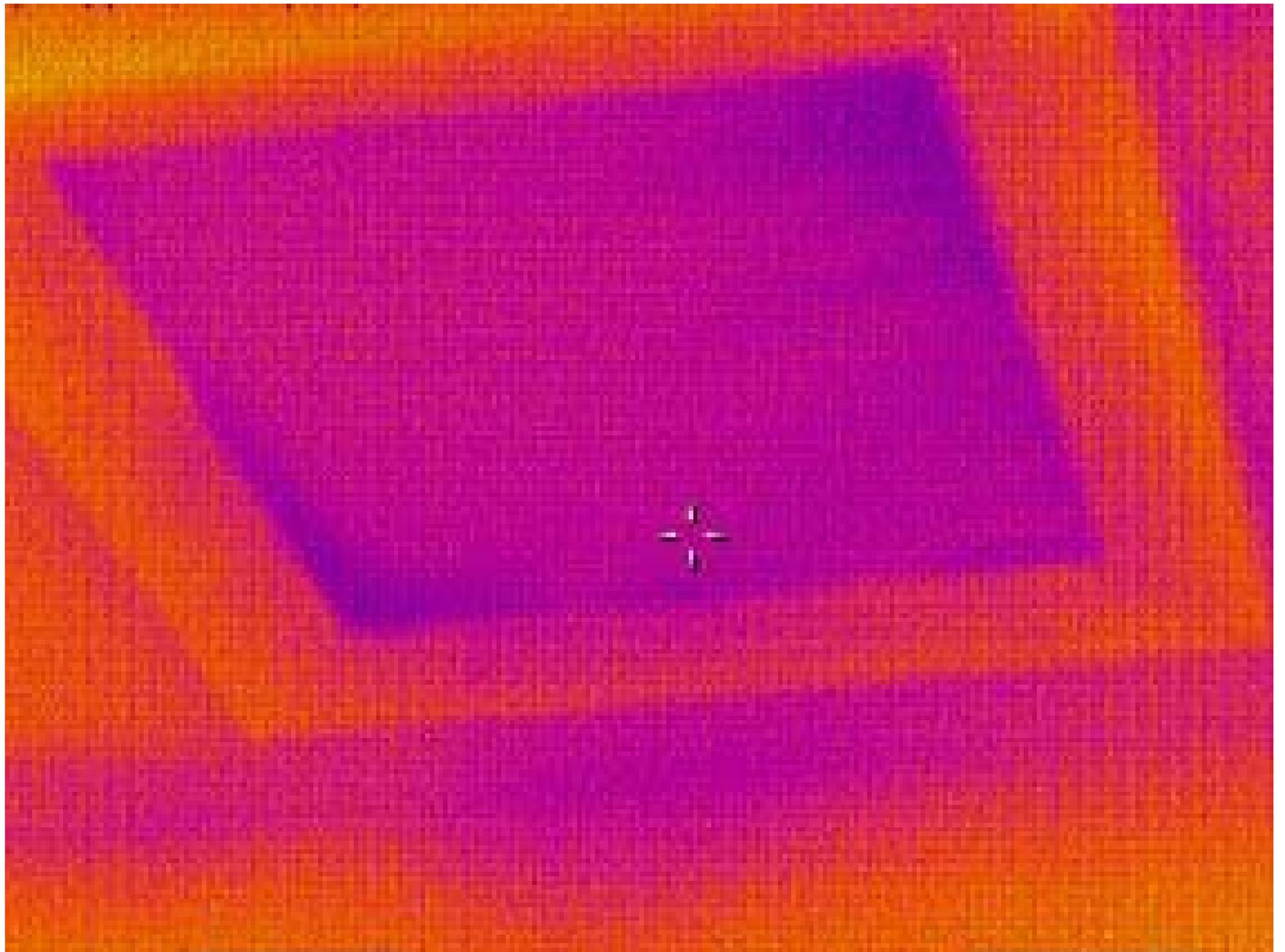
LIVE IN →
THIS

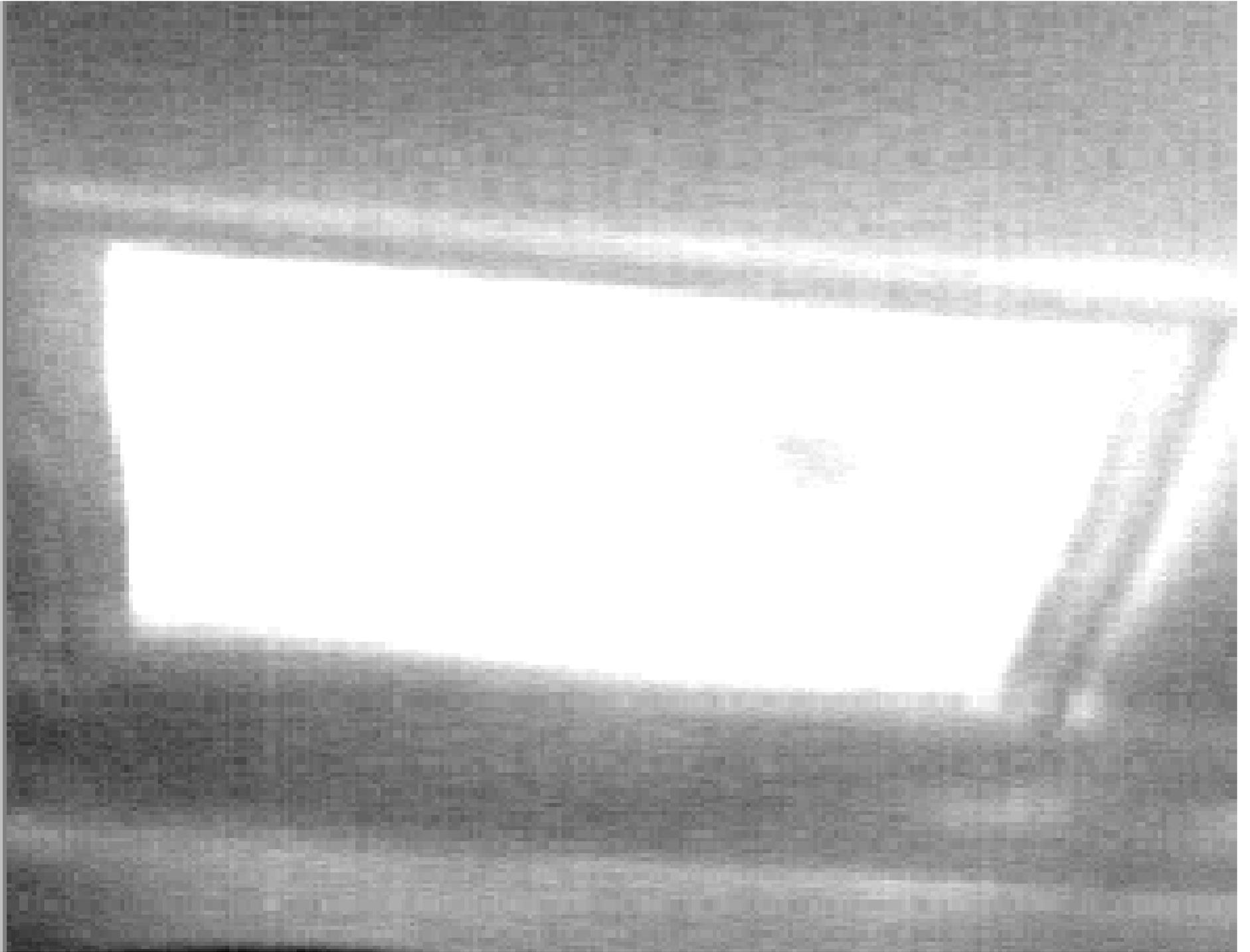


NOT
THAT!





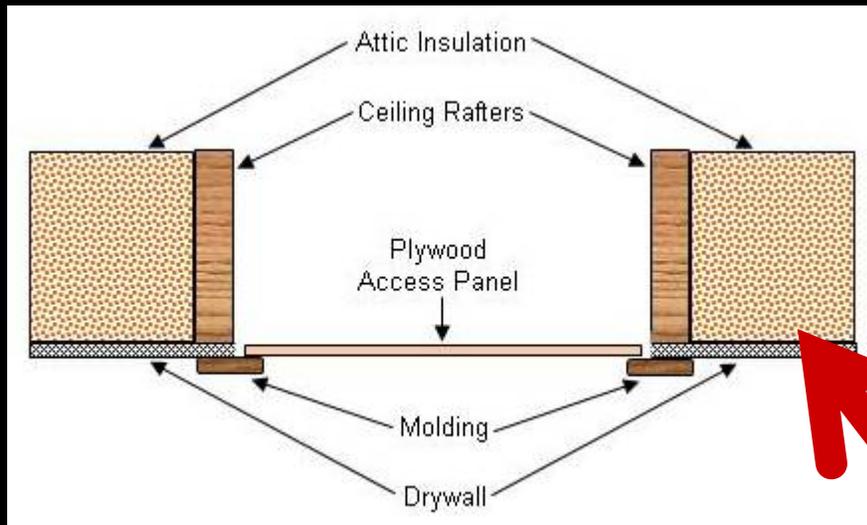
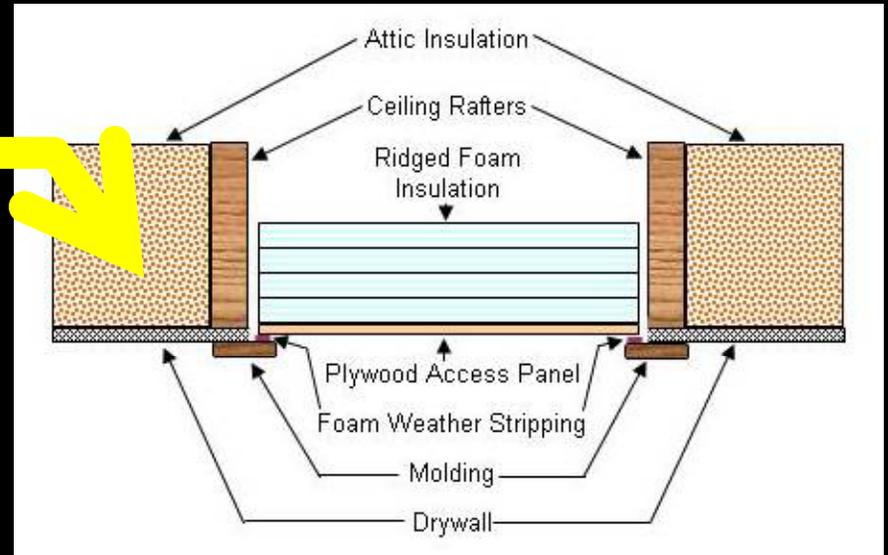




AIR ACCESS PANEL:

Key Ingredient: **Air and Thermal Flow**
Solution: **Insulation and Gaskets**

LIVE IN →
THIS



NOT
THAT!

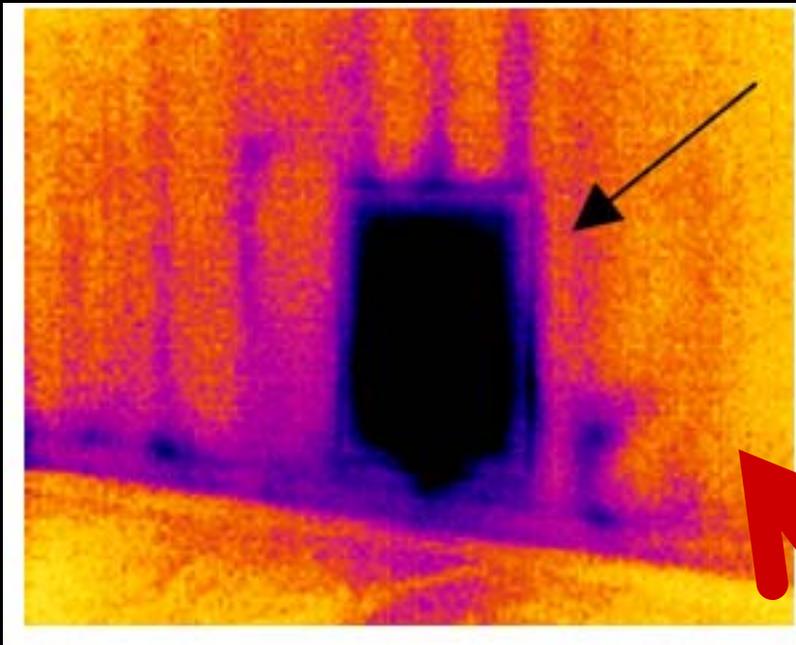
ATTIC KNEE WALL ACCESS DOOR:

Key Ingredient: **Air and Thermal Flow**

Solution: **Insulated Door and Gasket**

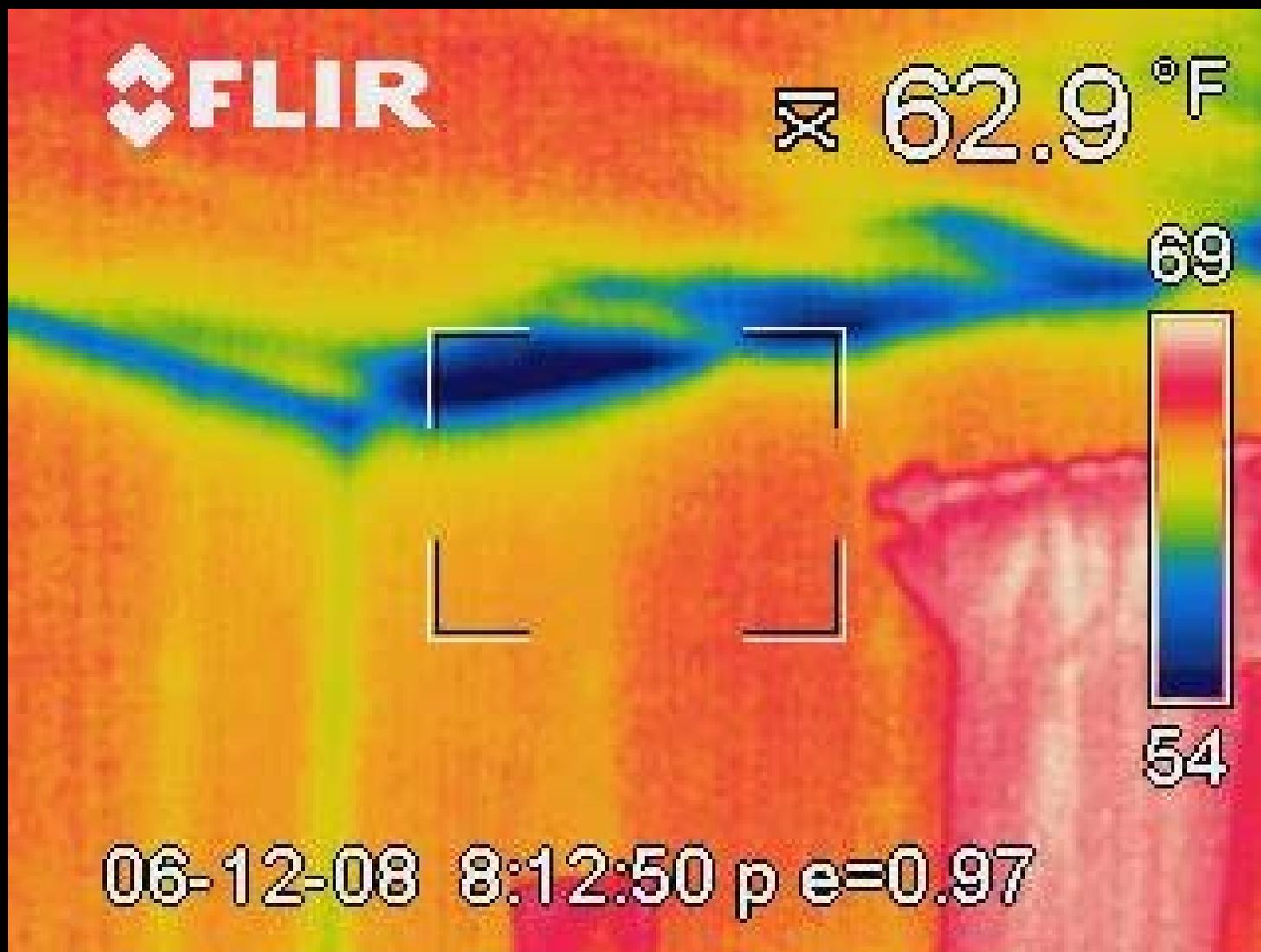
LIVE IN

THIS



**NOT
THAT!**

ATTIC EAVE WIND WASHING



(392.0)

Solution? Space age material



Perimeter radiant heating?
No, wind intrusion.

91.4

89.9

88.4

86.9

85.4

83.9

82.4

80.9

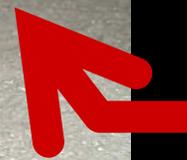
79.4

INSULATION AT ATTIC EAVE:

Key Ingredient: **Air and Thermal Flow**

Solution: **Wind Baffles**

LIVE IN
THIS



NOT
THAT!

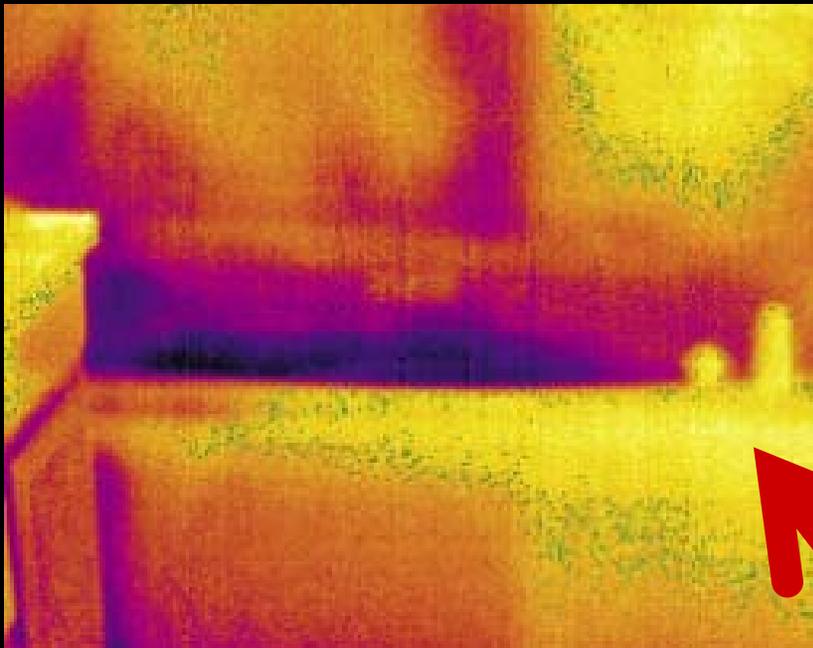
QUESTION: HOW WILL BUILDER INSULATE AND INSTALL AIR BARRIER BEHIND THIS TUB?



TUBS/SHOWERS AT EXTERIOR WALLS:

Key Ingredient: **Air, Thermal, and Moisture Flow**
Solution: **Air Barrier**

LIVE IN →
THIS



NOT
← **THAT!**

FIREPLACE INSERTS AT EXTERIOR WALLS:

Key Ingredient: **Air, Thermal, and Moisture Flow**
Solution: **Air Barrier**

LIVE IN →
THIS

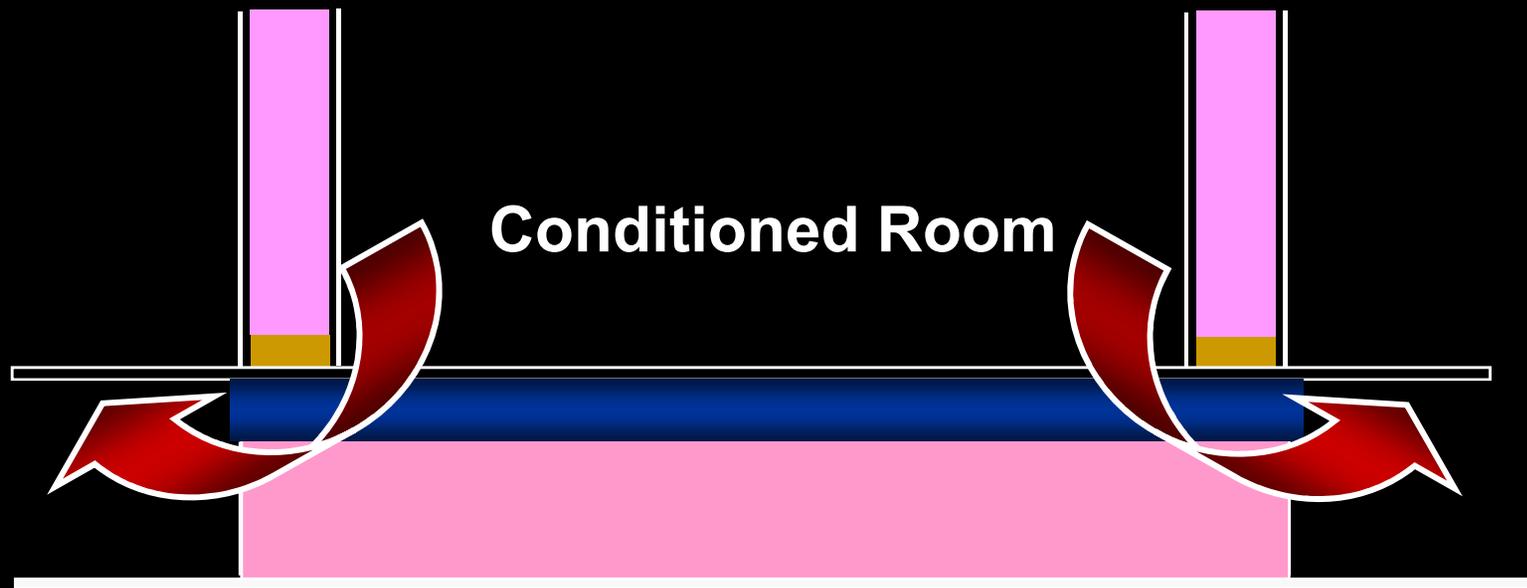


NOT
THAT!

GRAVITY MAKES THINGS FALL...
WHO KNEW?



GARAGE/CANTILEVER FLOOR

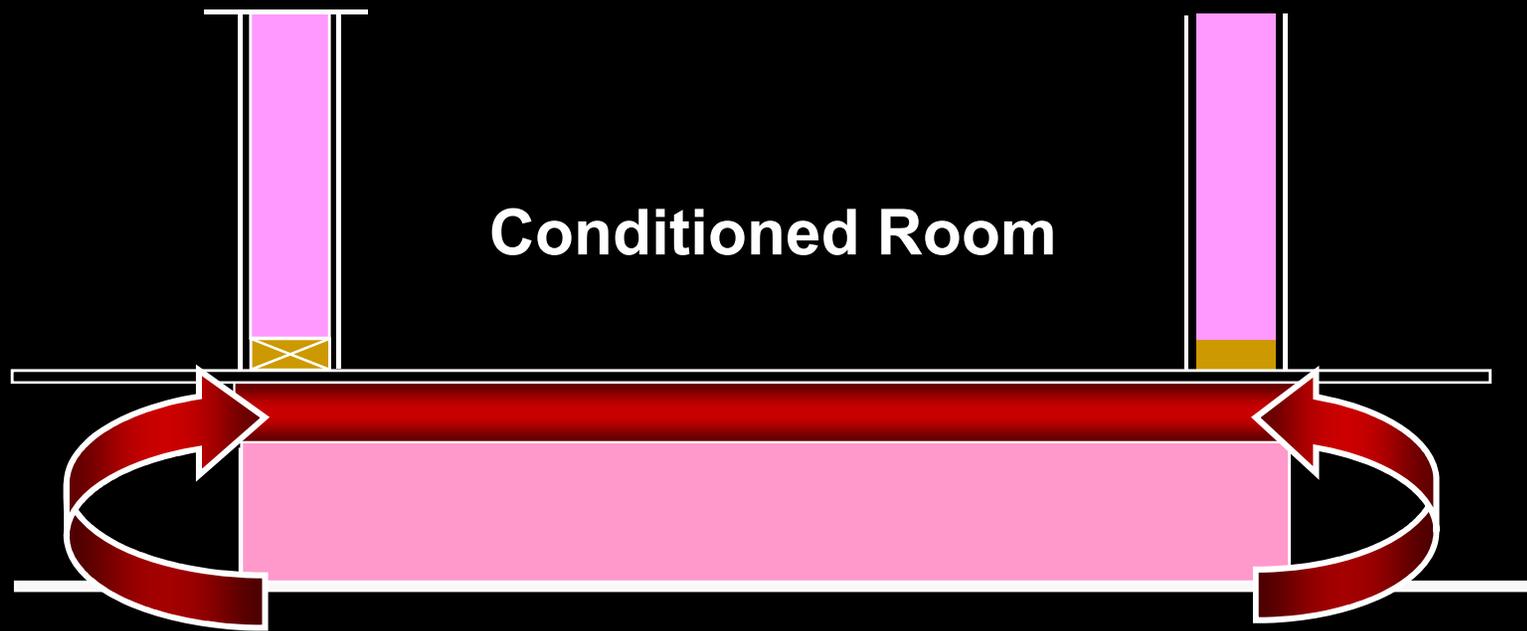


Conditioned Room

Garage Ceiling

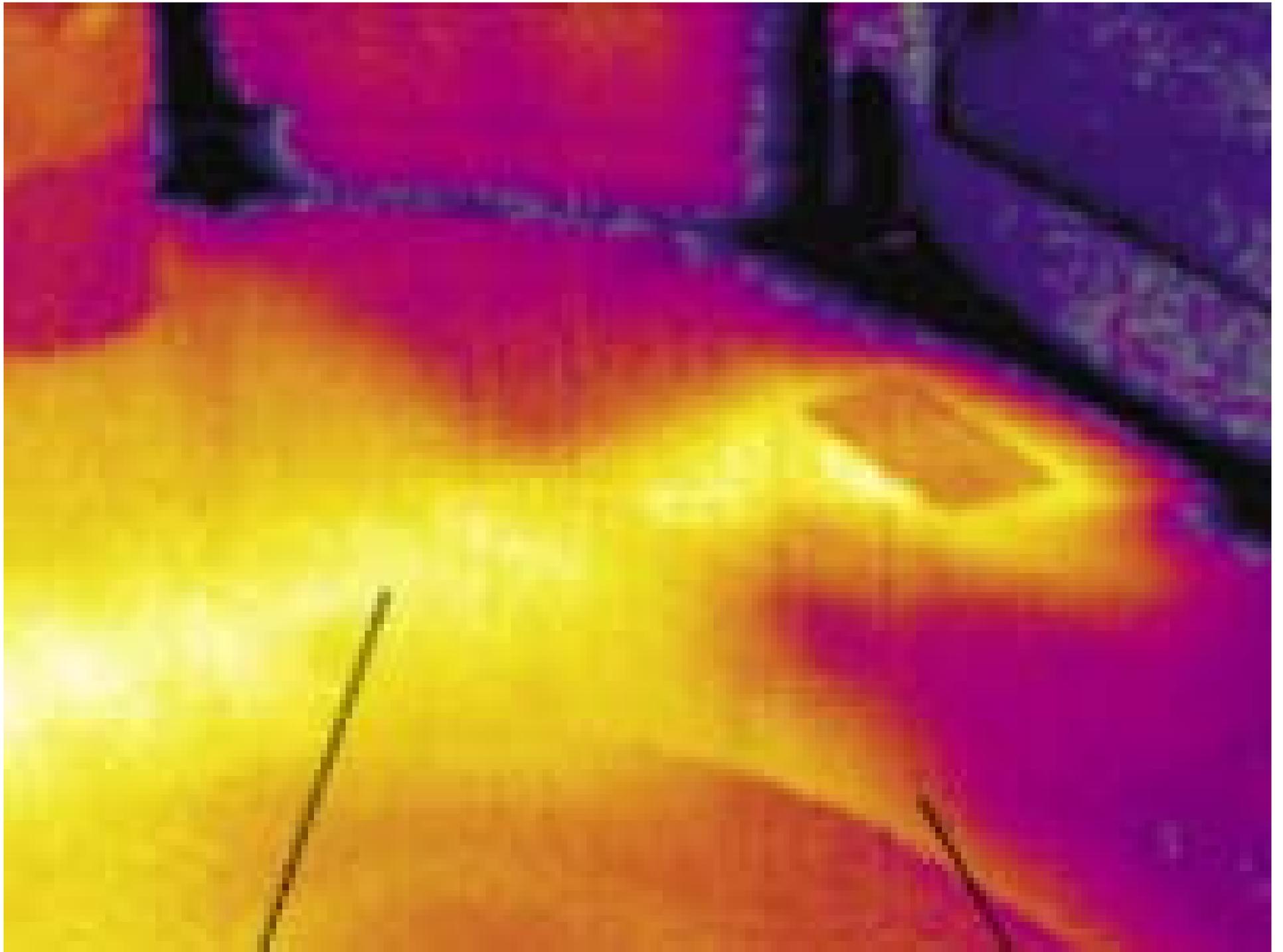
Winter

GARAGE/CANTILEVER FLOOR



Garage Ceiling

Summer



INSULATED FLOOR AT GARAGE/CANTILEVER:

Key Ingredient: **Thermal Flow**

Solution: **Insulation Proper Installation**

LIVE IN →
THIS



← **NOT**
THAT!

INSULATED FLOOR AT GARAGE/CANTILEVER:

Key Ingredient: **Thermal Flow**

Solution: **Insulation Proper Installation**

LIVE IN
THIS



NOT
THAT!

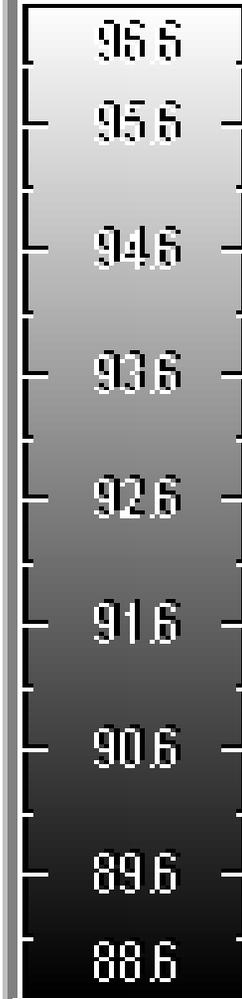
CH1: MA510019.TMP TH5104

RG:1 E:0.94 SC:NORM

02/06/13

15:36:41

(392.0)



(14.0)

**Will be there for the
life of the building!**

WALL INSTALLATION:

Key Ingredient: **Thermal Flow**

Solution: **Insulation Proper Insulation**

LIVE IN →
THIS



NOT
THAT! ←

WALL CORNERS:

Key Ingredient: **Thermal Flow**
Solution: **Two-Stud Corners**

LIVE IN →
THIS



NOT
THAT!

EXTERIOR/INTERIOR WALL INTERSECTIONS:

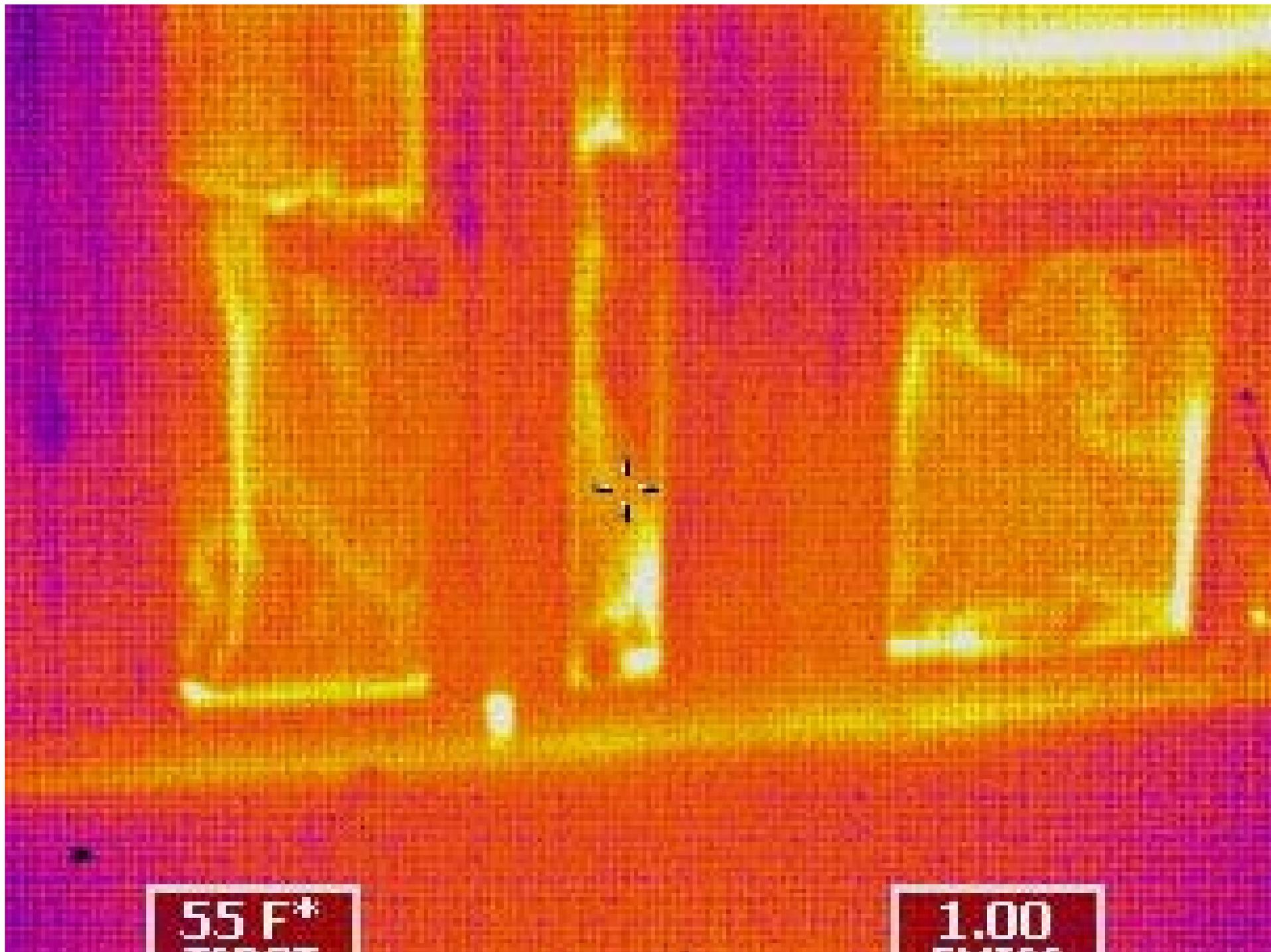
Key Ingredient: Thermal Flow

Solution: Lattice Framing

LIVE IN
THIS



NOT
THAT!



55 F*
TARGET

1.00
EMISS

WALL THERMAL BRIDGING:

Key Ingredient: Thermal Flow
Solution: **Advanced Framing**

LIVE IN →
THIS



NOT
THAT!

WALL THERMAL BRIDGING:

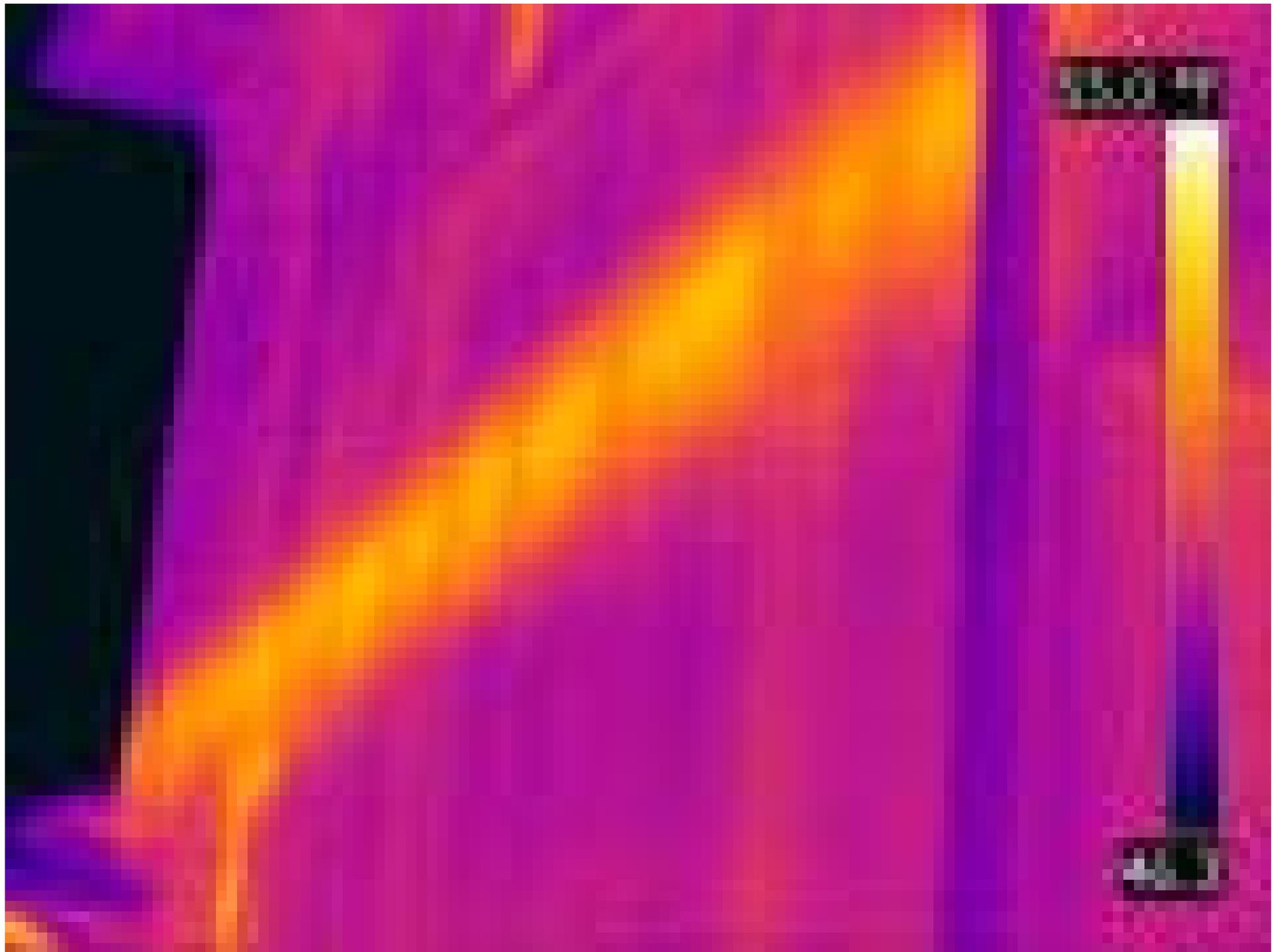
Key Ingredient: Thermal Flow

Solution: Rigid Insulation Sheathing

LIVE IN →
THIS



← **NOT**
THAT!



BAND JOISTS:

Key Ingredient: **Thermal Flow**

Solution: **Insulation Proper Installation**

LIVE IN →
THIS



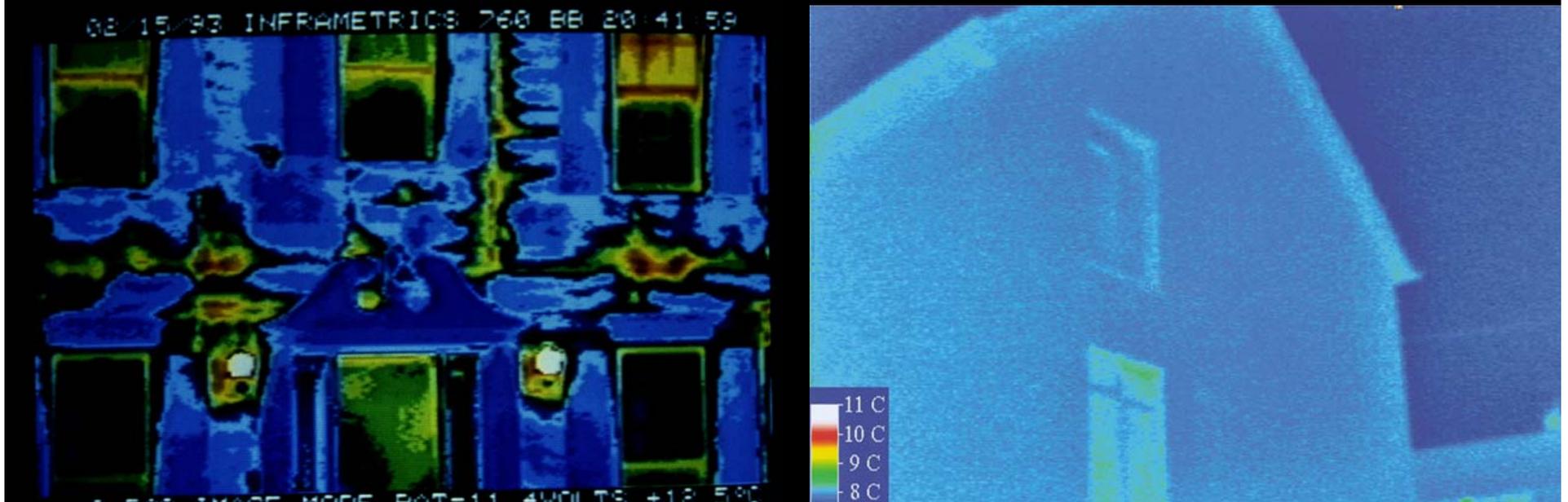
NOT
THAT!

LIVE IN **THIS** NOT **THAT**
ADVANCED INSULATION VALUE QUESTIONS

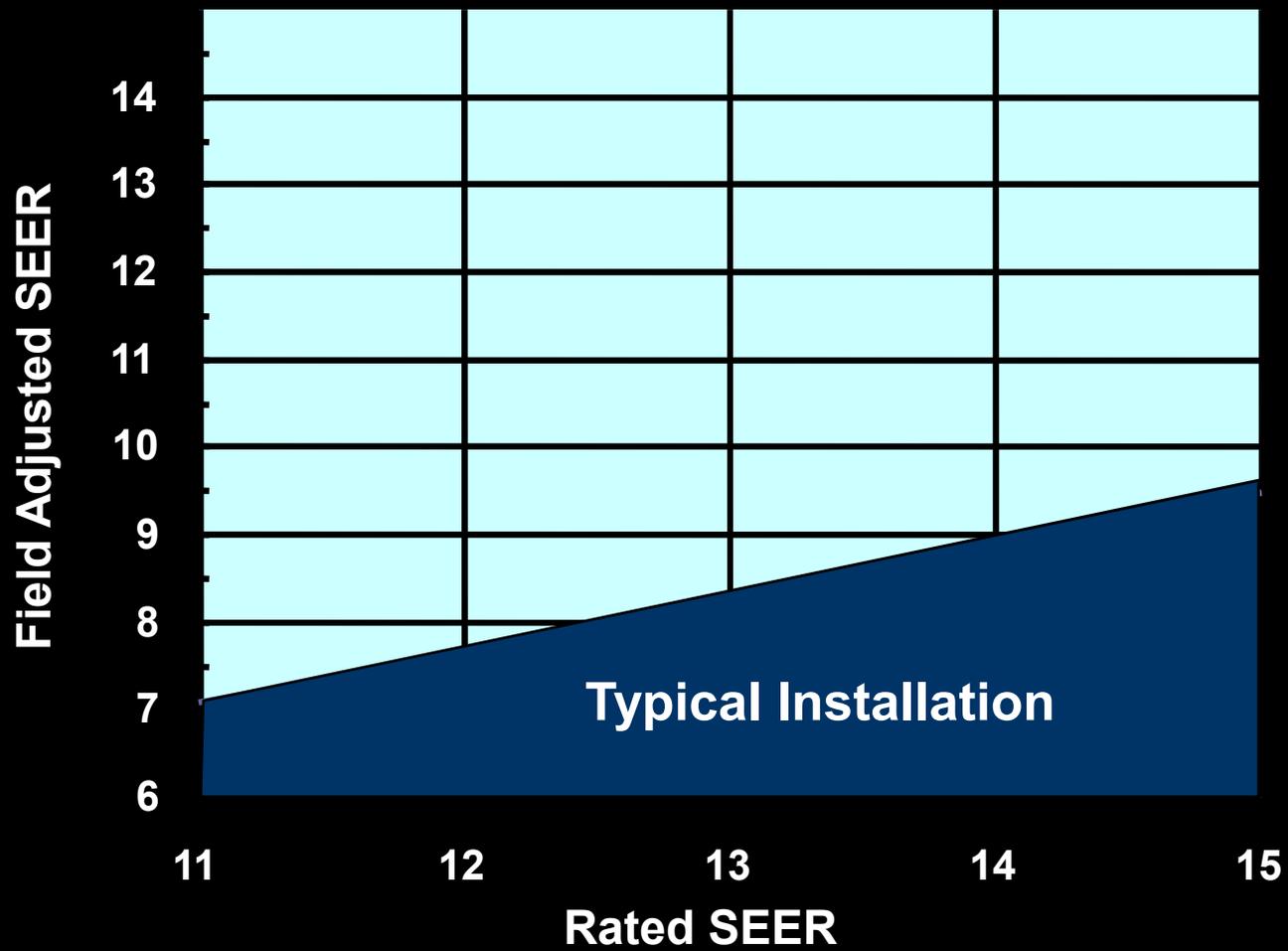
How many **quality defects** do you want?

Would you pay less for more **comfort & health?**

Which house would you rather **resell?**

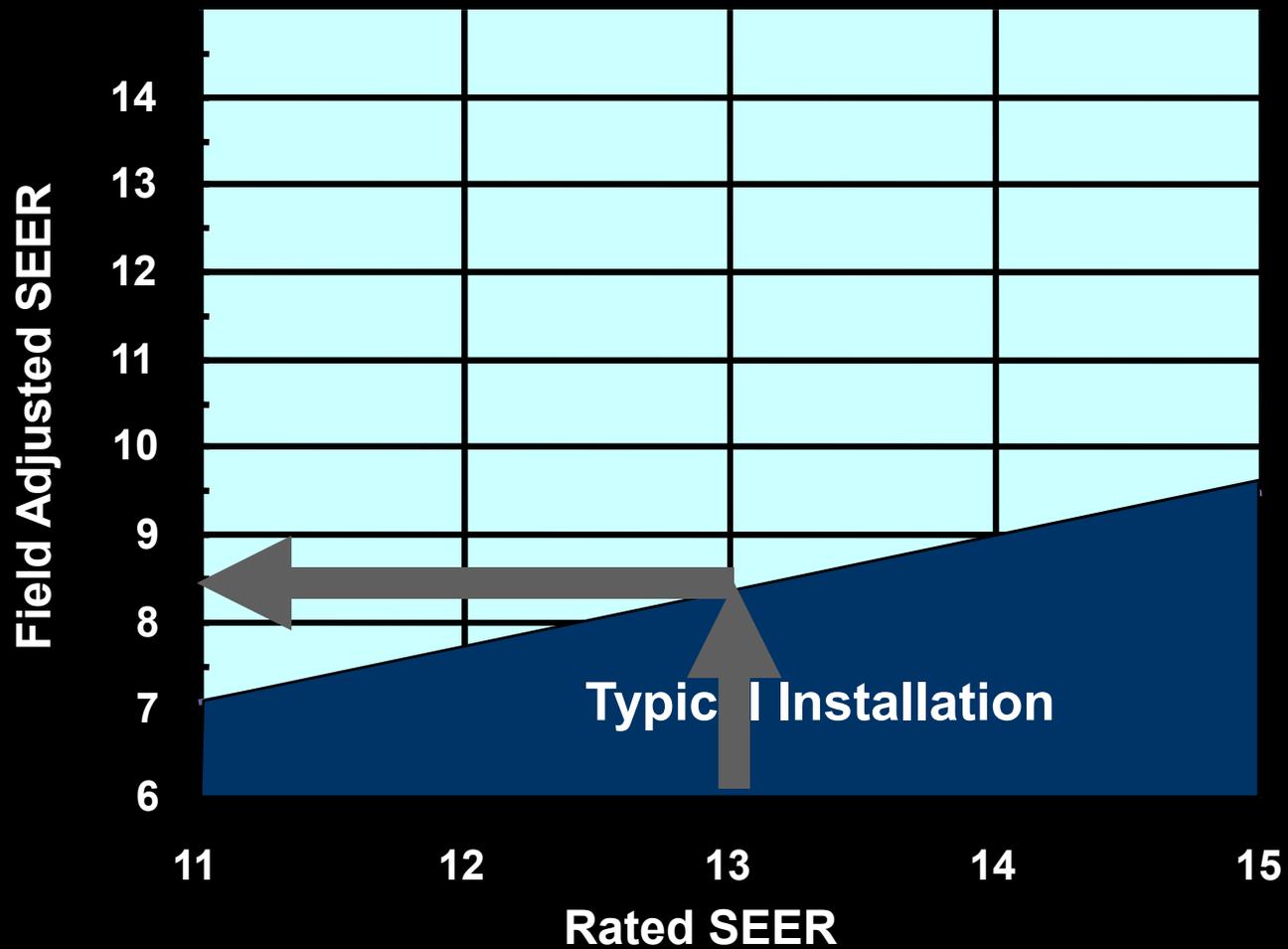


HVAC SYSTEM QUALITY INSTALLATION



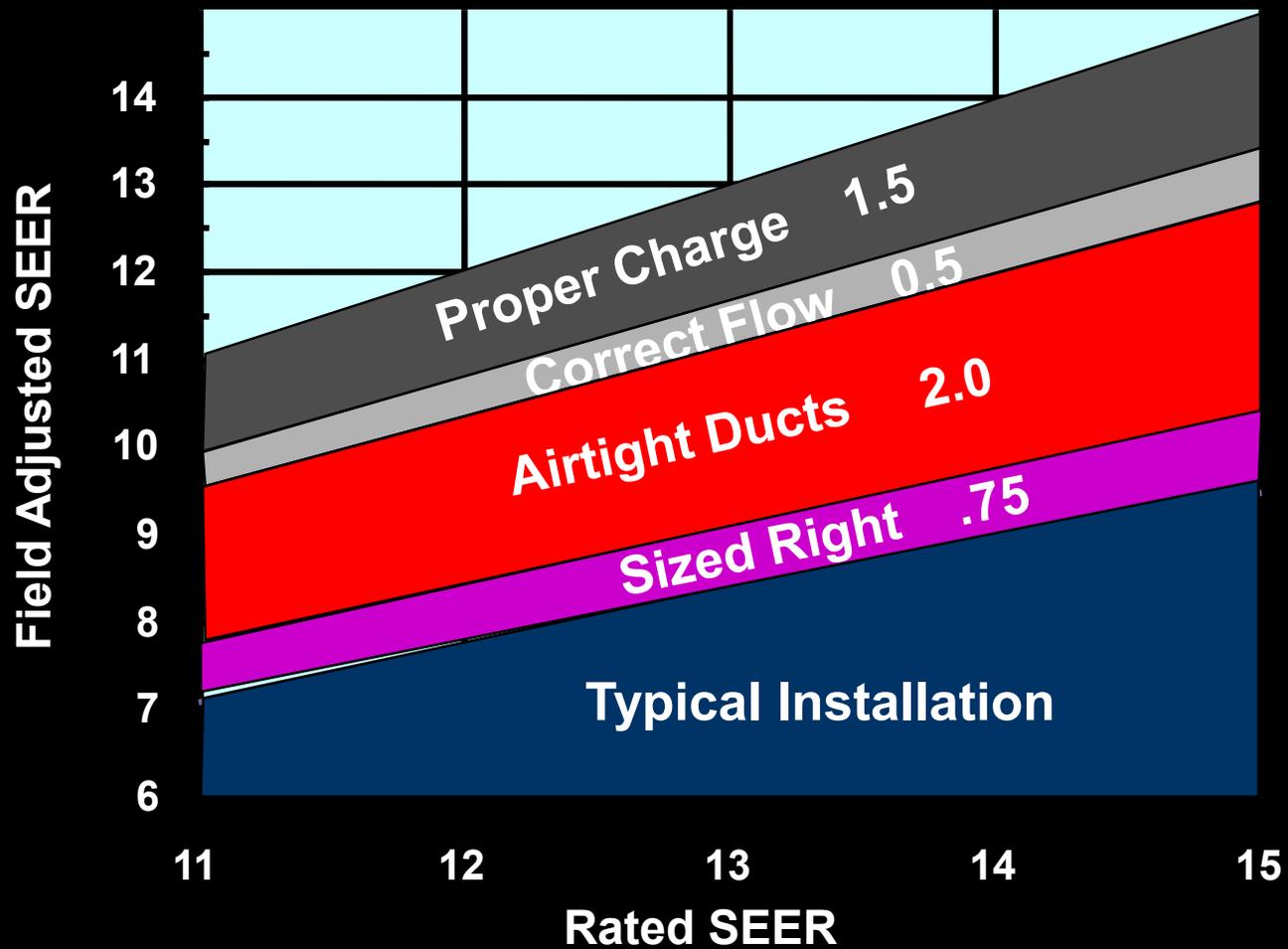
Courtesy of Advanced Energy Corp.

HVAC SYSTEM QUALITY INSTALLATION



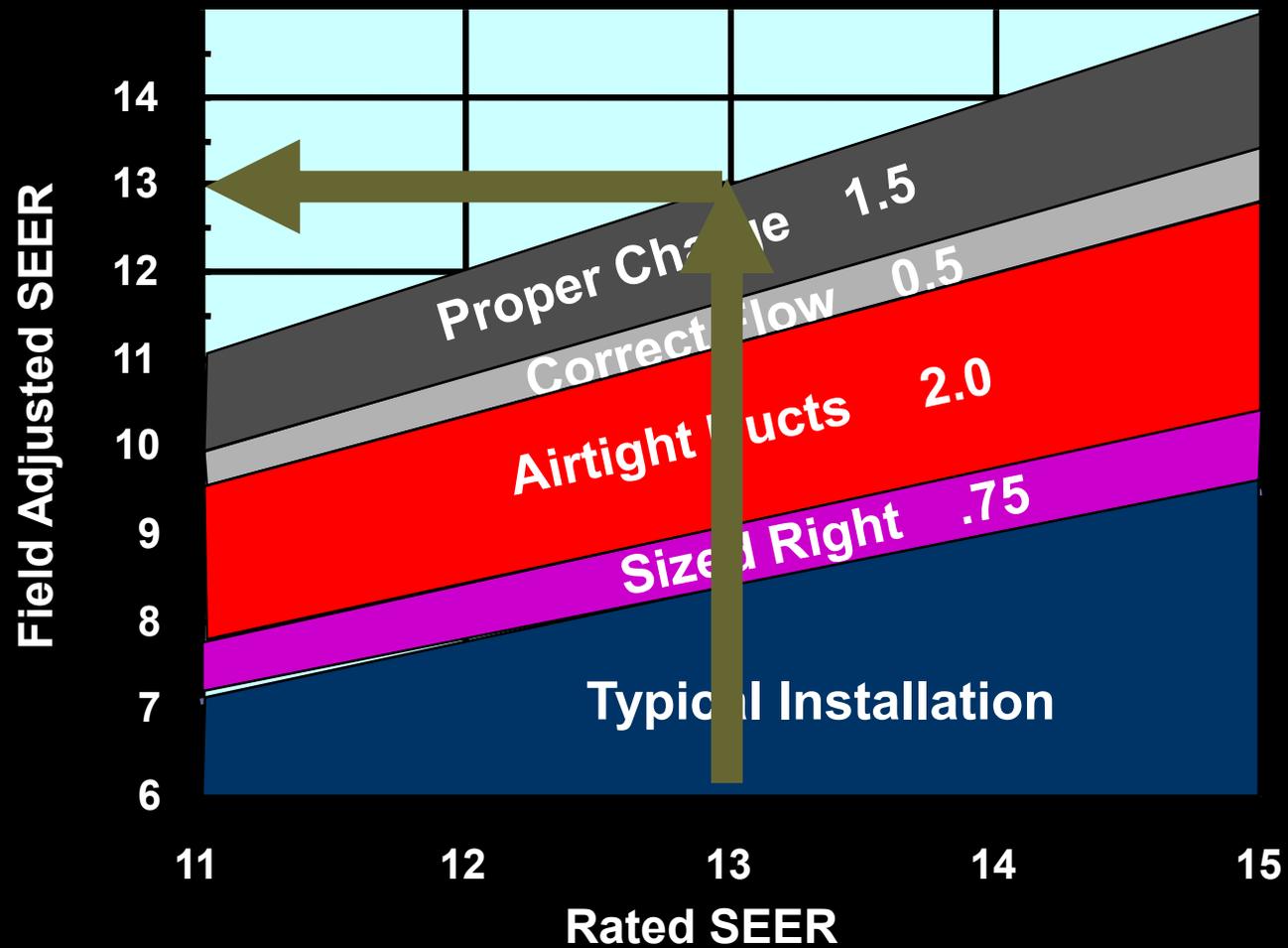
Courtesy of Advanced Energy Corp.

HVAC SYSTEM QUALITY INSTALLATION



Courtesy of Advanced Energy Corp.

HVAC SYSTEM QUALITY INSTALLATION

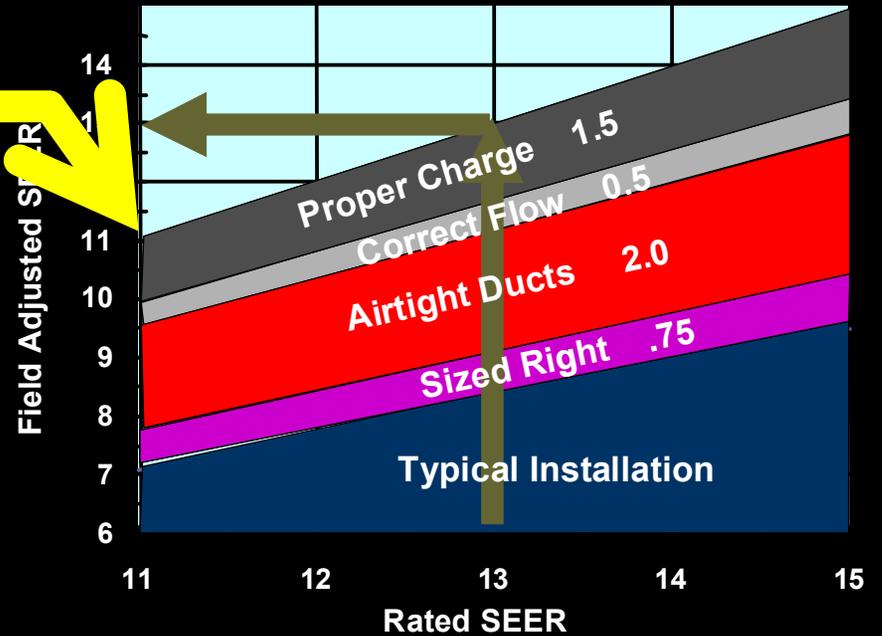
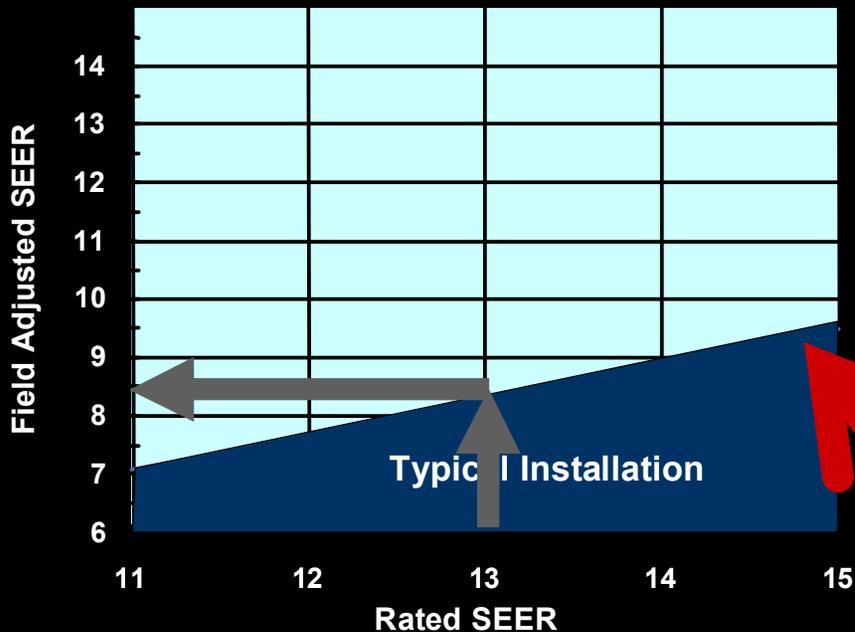


Courtesy of Advanced Energy Corp.

COMFORT SYSTEM:

Key Ingredient: Air and Moisture Flow
Solution: HVAC Quality Installation

LIVE IN THIS



NOT THAT!

PRESSURE BALANCED HVAC SYSTEM:

Key Ingredient: Air and Moisture Flow
Solution: Jump Ducts

**LIVE IN
THIS**



**NOT
THAT!**

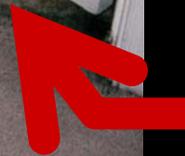
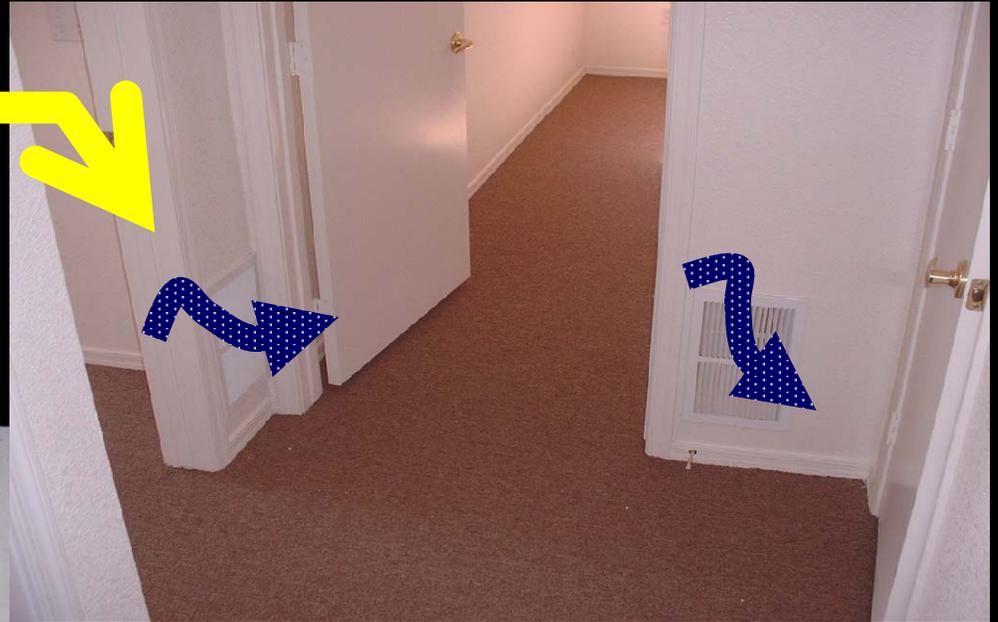
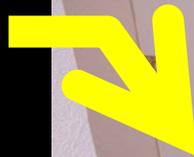
PRESSURE BALANCED HVAC SYSTEM

Key Ingredient: Air and Moisture Flow

Solution: Transfer Grills

LIVE IN

THIS



NOT

THAT!

DILLUTION OF POLLUTANTS:

Key Ingredient: Air and Moisture Flow
Solution: Fresh Air System

LIVE IN
THIS



NOT
THAT!

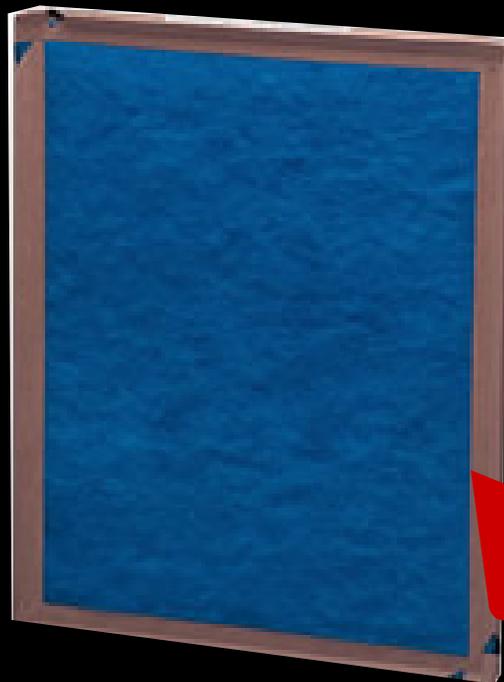
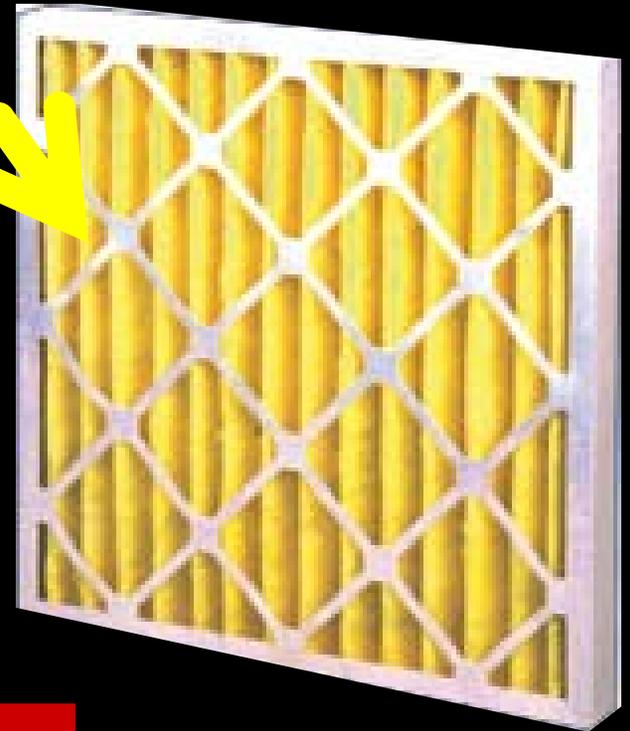
FILTRATION OF POLLUTANTS:

Key Ingredient: **Air and Moisture Flow**

Solution: **Effective Filter**

LIVE IN

THIS



NOT

THAT!



LIVE IN **THIS** NOT **THAT**
QUALITY INSTALLED HVAC VALUE QUESTIONS

- How much energy do you want to **waste?**
- Which part of **comfort** is not important...
 - Thermal Control
 - Humidity Control
 - Noise Control
- Do you want **fresh, filtered air?**

WATER PROTECTION SYSTEM:

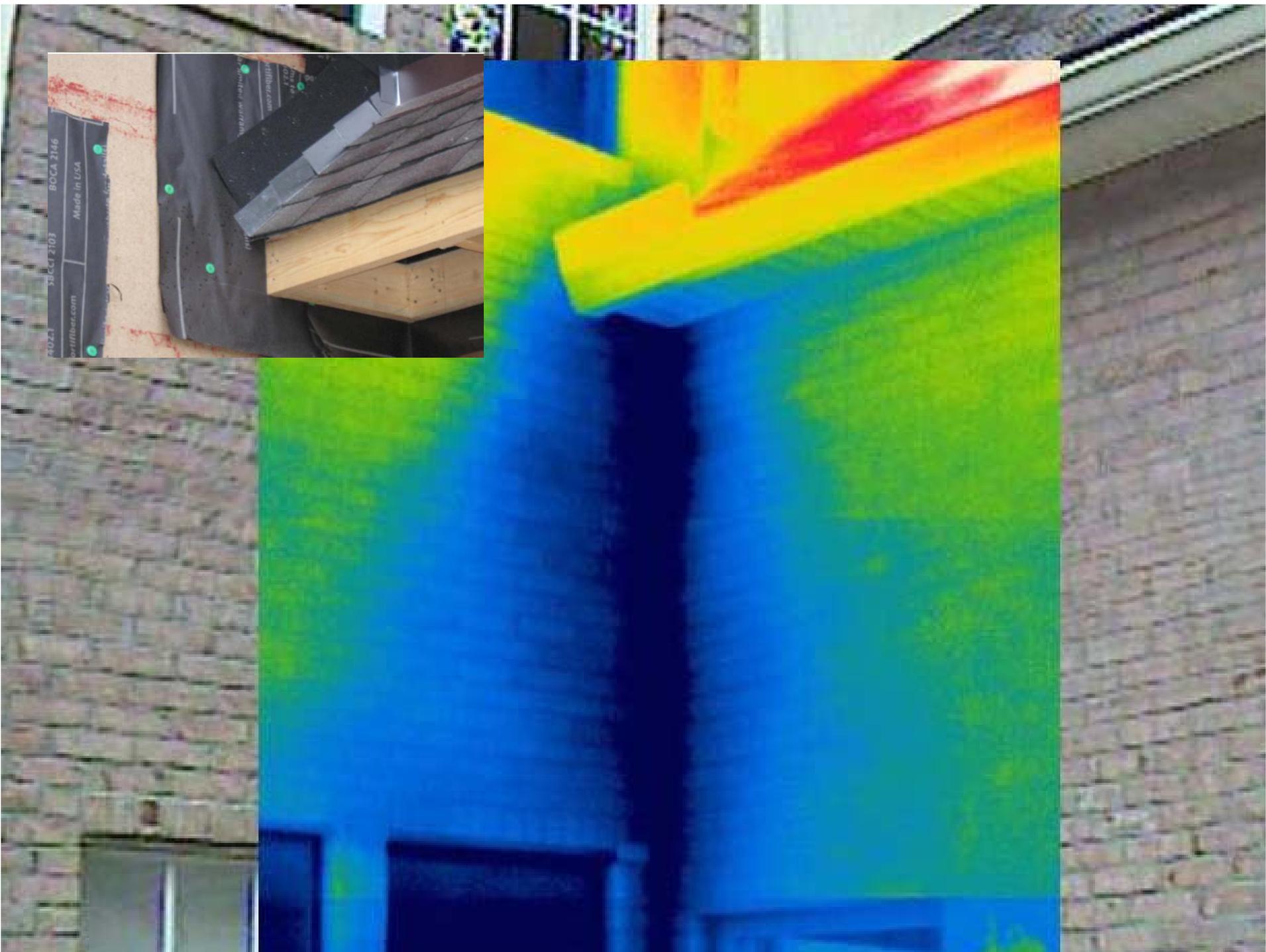
Key Ingredient: **Moisture Flow**

Solution: **Heavy Membrane Roof Valley Flashing**

**LIVE IN
THIS**



**NOT
THAT!**



WATER PROTECTION SYSTEM:

Key Ingredient: **Moisture Flow**

Solution: **Kick-Out Flashing**

LIVE IN →
THIS



NOT
THAT!

WATER PROTECTION SYSTEM:

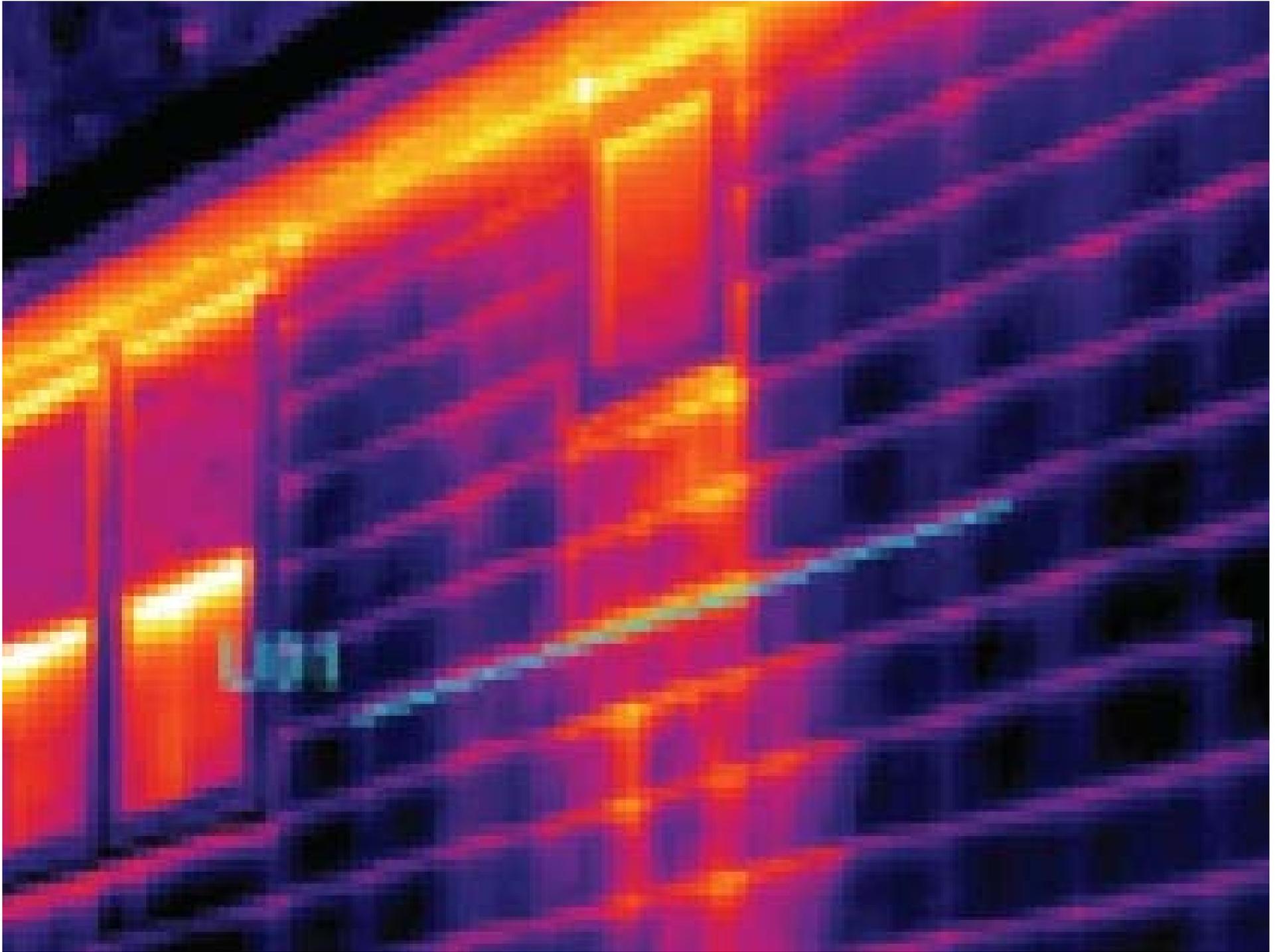
Key Ingredient: **Moisture Flow**

Solution: **Kick-Out Flashing**

LIVE IN →
THIS



NOT
THAT!



WATER PROTECTION SYSTEM:

Key Ingredient: **Moisture Flow**

Solution: **Window/Door Pan Flashing**

LIVE IN →
THIS



NOT
← **THAT!**



WATER PROTECTION SYSTEM:

Key Ingredient: **Moisture Flow**

Solution: **Foundation Capillary Break**

LIVE IN
THIS



NOT
THAT!

LIVE IN **THIS** NOT **THAT**
WATER MANAGEMENT VALUE QUESTIONS

What parts of your home do you want greater risk of **moisture and mold problems?**

Do you want more or less **maintenance?**

Do you want more or less assurance of a **healthy home?**



LIVE IN **THIS** NOT **THAT**
SUMMARY VALUE QUESTION

How much more risk do you want?



Why Homes That Work Have More Value

LOWER OWNERSHIP COST

	Monthly	Annual
Utility Savings	\$45	\$540
Added Mortgage	\$15	\$180
Cost Savings	\$30	\$360

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= \$1,000's for typical ownership period

BETTER PERFORMANCE

- **Comfort**

room-by-room, no drafts, noise

- **Health**

less moisture, dust, pollen, pests

- **Durability**

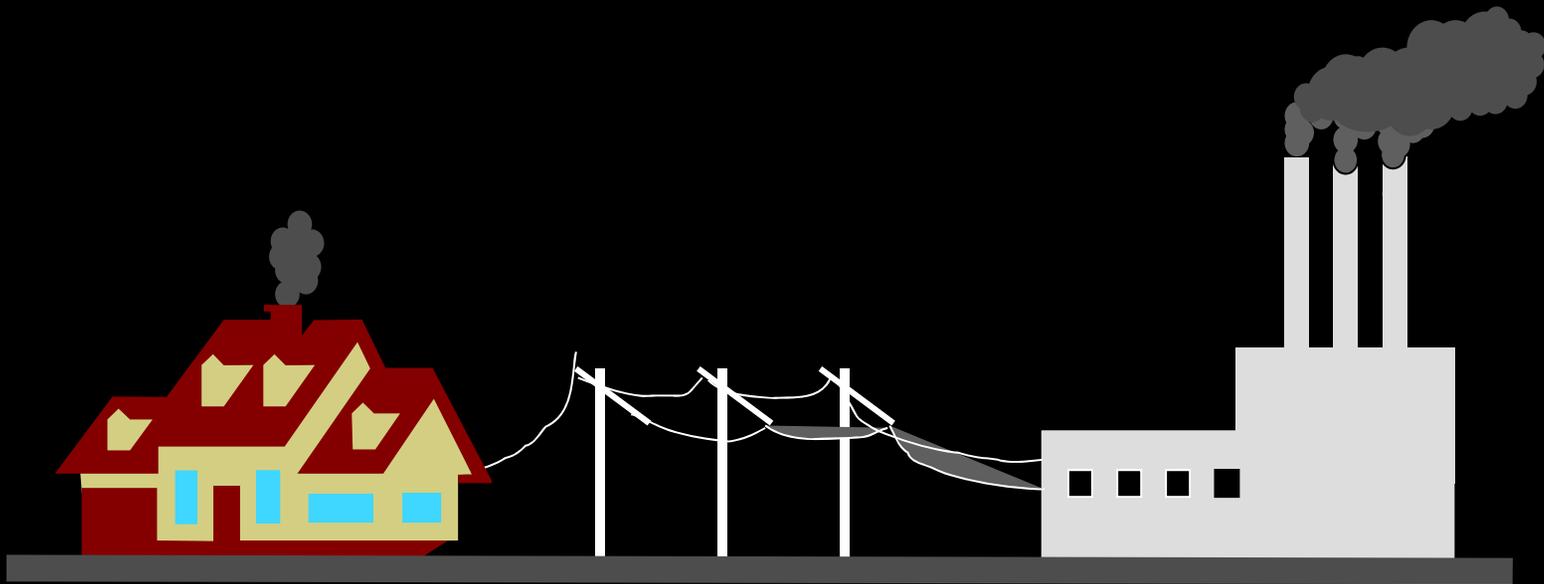
better protection, long-lived equipment, less moisture damage

BETTER RESALE VALUE

- track record of low bills
- reduced obsolescence
- perceptible comfort advantage

FEELS GOOD TO OWN

**Less Energy
Used = < Pollution
> National Security**



How to Recognize New Homes That Work

HOW CAN I LIVE IN A HOME THAT WORKS?

- **Existing Homes**
 - Home Performance Upgrade
[look for Home Performance w/ENERGY STAR and DOE Better Buildings Program]
 - Energy Efficient Remodel
 - Energy Efficient Component Replacement
- **New Homes**
 - ENERGY STAR Qualified Homes
 - DOE/EPA Builders Challenge Homes

HOW TO GET MORE INFORMATION

On the Web at:

<http://www.eere.energy.gov>