



PROOF IS POSSIBLE:

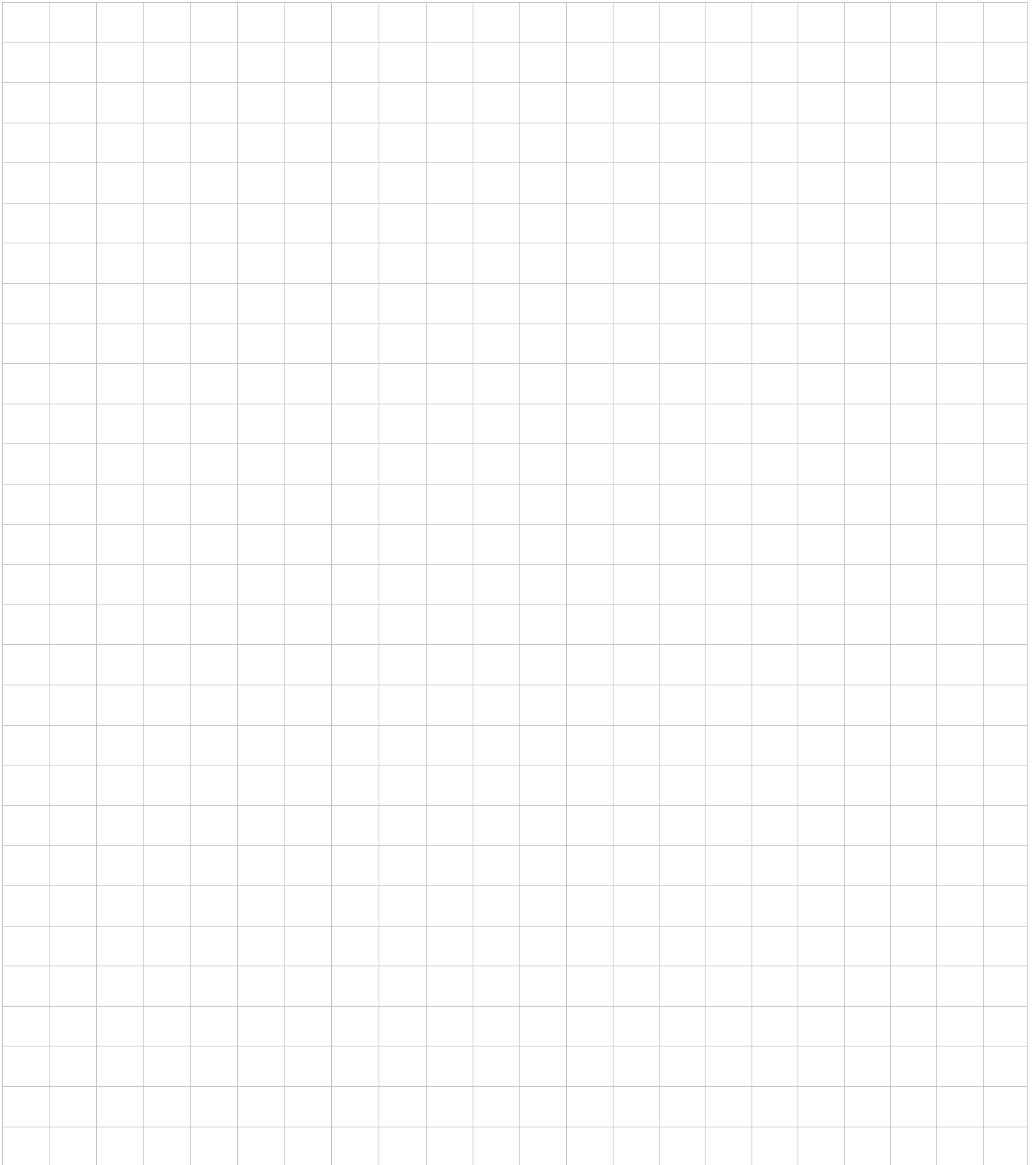


HOW TO KEEP AN EYE
ON YOUR NEW HOME
CONSTRUCTION OR
HOME IMPROVEMENT



by Corbett and Grace Lunsford
founders of the Building Performance Workshop

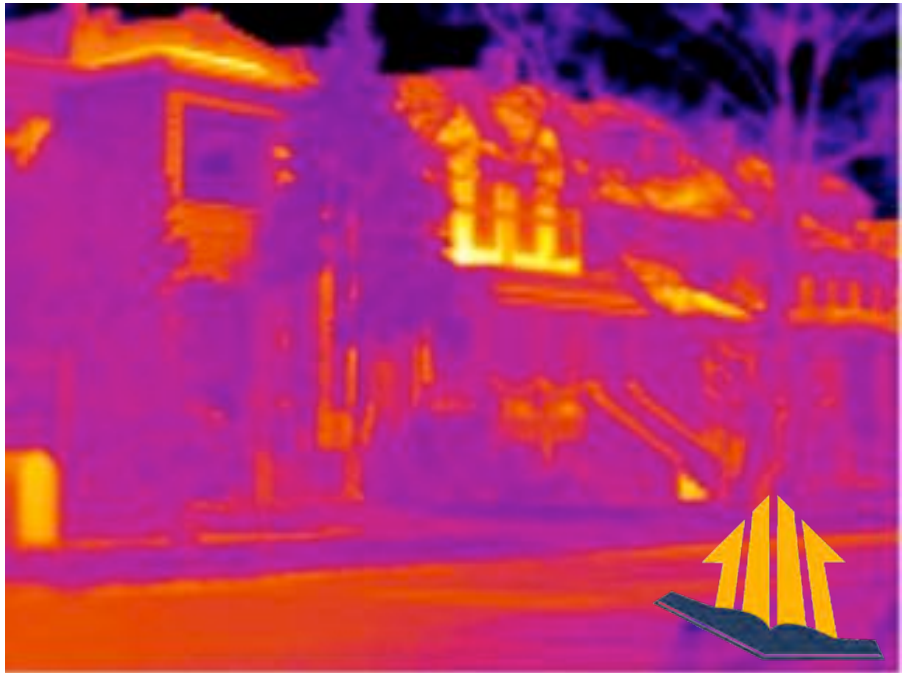
DIAGRAM YOUR HOME'S FLOORPLAN:



WHAT ARE YOUR HOME'S VITALS?

HAVE YOU HAD YOUR HOME'S PULSE, BLOOD PRESSURE & TEMPERATURE MEASURED?

BEFORE YOU SPEND HARD-EARNED MONEY ON YOUR HOME, IT SHOULD HAVE A PHYSICAL EXAM FIRST.



IF YOU'VE EVER FELT LOST WHILE PRIORITIZING HOME UPGRADES, OR WASTED \$1000'S ON IMPROVEMENTS WHICH DIDN'T PERFORM AS PROMISED, OR BOUGHT A BRAND NEW HOME THAT ACTED LIKE IT WAS OLD...
HELP IS HERE.

Just like your body or your car, **your home is a system** of interacting and interdependent parts, which goes ENTIRELY against what you may have been trained to think.

If you've ever found yourself with a problem at home (too dry, too wet, too icy, too stale, etc) and went to the store to buy a product off the shelf that you thought would 'fix the problem', that's the obsolete training kicking in.

The reality is that no one product fixes your home as a system, and any symptom you find might actually be an indication of a problem somewhere else in your home.

NOTHING CAN HIDE IN THE 21ST CENTURY

Great news! There are trained home performance professionals across the world who now have the ability to scientifically pinpoint the exact opportunities for improvement in your home so you **never flush another dollar down the drain.**

AND they can prove that the work was done correctly, so you **never worry about getting fleeced.**

Let's be real: owning and maintaining a home can be an expensive and frustrating experience. Anything you can do to make your family more comfortable, healthy and happy at home is awesome. Anything you can do to make your home more valuable and durable is awesome.

AWESOMENESS = PROOF OF QUALITY

When you shop for a car, I bet you want one that's not going to bleed your wallet dry with repairs, gas guzzling and breakdowns. I'm a happily married man, so I know very well that if the family car breaks down in the rain, my bride is going to be unhappy, which makes me unhappy. Happy wife, happy life.

You've invested at least 10 times more in your home than in your car, so shouldn't we all be demanding a guarantee of workmanship in our homes?

This is the promise of home performance:

A GUARANTEE OF CONTROLLED COMFORT, GREAT AIR QUALITY, DURABILITY, LOW MAINTENANCE, & ENERGY EFFICIENCY

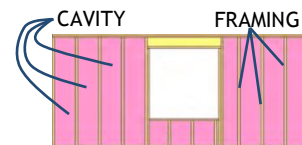
ELEMENTS	SIGNS	TEST WITH	CONTROL WITH
HEAT FLOW (LOSSES / GAINS) CONVECTION CONDUCTION RADIATION	DRAFTS DISCOMFORT CONDENSATION HIGH ENERGY BILLS	TESTING FANS INFRARED CAMERA THERMOMETER LOW-E DETECTOR	AIR SEALING INSULATION RADIANT BARRIER, LOW-E GLASS
AIRFLOW & PRESSURE (EXFILTRATION / INFILTRATION) STACK HVAC WEATHER	DRAFTS DISCOMFORT TEMPERATURE VARIATIONS PRESSURE IMBALANCES	TESTING FANS MANOMETER ANEMOMETER PRESSURE PAN	AIR SEALING DUCT SEALING BALANCING FANS
MOISTURE VAPOR LIQUID CONDENSATION DIFFUSION DRAINAGE CAPILLARY	DETERIORATION DISCOLORATION HIGH HUMIDITY ODORS INSECTS/SPIDERS	SURFACE METER MATERIAL METER HYGROMETER INFRARED CAMERA	AIR SEALING INSULATION PROPER DRAINAGE PROPER FLASHING CAPILLARY BREAKS
AIR QUALITY ORGANIC PARTICLE VAPOR FUNGUS BYPRODUCT CHEMICAL COMBUSTION SOIL GAS RESPIRATORY ISSUES NAUSEA/HEADACHES ODORS MOLD/MILDEW CO ALARM	DETERIORATION DISCOLORATION HIGH HUMIDITY ODORS INSECTS/SPIDERS	PARTICLE METER COMBUSTION PROBE SNIFFER RADON/MOLD TEST LEAD/ASBESTOS TEST	POLLUTANT REDUCTION AIR SEALING INSULATION MECHANICAL VENTILATION

THERE ARE 4 ELEMENTS OF HOME PERFORMANCE

#4: HEAT FLOW

If you've ever thought your home would be more comfortable with new windows or more insulation, you're definitely not alone, though neither of those is a one-and-done solution. Check this out (don't memorize it, I just want you to know there is math that insulation professionals use):

$$U_{Total} = \frac{(U_{cavity} \times Area_{cavity}) + (U_{framing} \times Area_{framing})}{Area_{Total}}$$



What that calculation means is that the difference between a 100% perfect insulation job and a 99% perfect one is a total disaster- a 30% drop in the overall insulation effectiveness. 'Not bad' jobs won't cut it. Be willing to expect and pay for 100% perfect.

#3: AIR FLOW AND PRESSURE

If you've ever had a door slam shut when the air conditioner turns on, or felt a draft of outside air inside your home, then you've seen this element at work. Very few construction professionals understand this one at all. There are 3 drivers of air leakage and pressure imbalances in your home at this very moment:

- Stack Effect (warm air rises and cool air sinks)
- Forced Air Systems (furnaces/air conditioners pushing and pulling air)
- Wind

#2: MOISTURE

As you can see, these elements are *increasing* in importance- that's because the last two elements are the most important on the list. Moisture can tear your house apart quicker than most other things, and it can be bad for your family, too. At this point, we've left energy efficiency in the dust, and we're talking about health and safety.

#1 MOST IMPORTANT ELEMENT: AIR QUALITY

If your family isn't breathing healthy air, nothing else matters. You would be stunned by how often we find air quality issues from crawlspaces or combustion appliances. Fresh air ventilation should be planned into homes that are reasonably airtight.



MOST OF THE IMPORTANT PARTS OF YOUR HOME HAVE BEEN COVERED UP.

YOU DESERVE TO KNOW WHAT'S HIDDEN.

THERE ARE 3 OPPORTUNITIES FOR IMPROVEMENT

#1 Opportunity: AIR SEALING

Cheap, fast, one-time fix that draws no energy. And if it's not done, neither of the other two will work.

#2 Opportunity: INSULATION

Cheap, fast, one-time fix that draws no energy. Defeated by air leakage.

#3 Opportunity: MECHANICAL SYSTEM UPGRADES

Heating, cooling, and ventilation. Expensive, laborious, energy intensive fix requiring maintenance and replacement. Defeated by air leakage and insulation deficiencies.

Notice that renewable energy systems are not on my list at all. If the three items above aren't taken care of, you'll have to install a big, bloated 'green energy' system that will be impossible to pay off.

THERE ARE 2 HOME SYSTEMS

#1: THE ENCLOSURE (air sealing & insulation)

This is the jacket around your home- the air sealing and insulation layer. If it's uneven or full of holes, it obviously won't be comfortable to live in.

Often, the enclosure isn't where it appears to be. For example, an attached garage or ventilated crawlspace should always be outside the enclosure, but we often find that's just not the case when put to the test, since air leakage always defeats the insulation layer.

#2: THE ENGINE (HVAC- heating & cooling)

Anything that moves heat or air around makes up this system, and it can only work properly when the enclosure works, and the two are 'tuned' together.

Along with windows, HVAC is the most expensive part of your home, so it's a big deal when things aren't working properly. Especially when it might endanger your family, as in a fuel-burning appliance.



THERE IS 1 GOAL OF HOME PERFORMANCE

The goal is CONTROL.

When you have full control over the heat flow, air flow, pressures, moisture, and air quality of your home, then your home is high performance.

Congratulations on your Olympian athlete of a home, when you finally get there! You'll also stop throwing money away on energy waste, decay, and tons of avoidable maintenance.

THE ONLY WAY TO PROVE YOU HAVE CONTROL IS THROUGH PERFORMANCE TESTING

When you get a BEFORE and AFTER comparison of your home's improvement process, you not only get bragging rights at neighborhood get-togethers; you get peace of mind.

Measured performance-based contracting is a business model used by contractors far & wide, so finding the pros who know how to get proven results should be simple now that you know what to ask for.

PERFORMANCE TESTING: THE INS AND OUTS

You must set **measurable goals** for your home. When you go out to eat at a restaurant, you have certain expectations: the food will be hot and taste good, not have any hairs in it, and be exactly what you ordered. Home improvements and new home construction are no different, except for the fact that most homeowners haven't been educated on **what our expectations should be**.



Your measurable goals should be guaranteed by your contractor based on **airtightness, temperature consistency, moisture/humidity, forced airflows**, and other **equipment performance** as compared to what the equipment says on the label.

Don't let anyone tell you that it's 'unrealistic' to expect perfect control, or that it's 'too hard' to achieve. If you're looking for an example of perfect control delivered 100% of the time, look no further than the airplanes in which we all travel. As big as a house, they must be airtight, insulated, moisture controlled, and have excellent air quality, AND they are exposed to much greater pressures, winds, rains, temperature variance, and odor and contaminant problems than homes.

Nevertheless, if control is not perfect in an airplane, something terrible will happen. The jocular builders of airplanes are, on the whole, no different than the jocular builders of homes- they just understand the **consequences** of good and bad work, and they use checklists and testing to prove their work is effective. **Quality control** makes their work superior, and it's within our grasp in homes as well.

You can see demonstrations of the following at <http://YouTube.com/c/HomePerformance>. The enclosure should always be measurably airtight and insulated. Overall airtightness is

ENCLOSURE TESTING

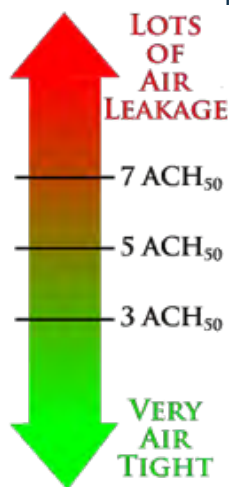
tested by the **blower door**, which sucks air into or out of the home until a standard pressure is reached (50 Pascals). Since we know how much air is flowing through the fan, we know how much is leaking through the gaps and cracks in the home's enclosure.



The blower door's reading will be in Cubic Feet per Minute (CFM) at 50 Pa, which can be divided by either the home's volume or enclosure surface area to show leakage in Air Changes per Hour (ACH50) or CFM per Square Foot of Surface Area (CFM/ft²). You can also estimate the **cumulative size of the hole in the enclosure**.

At present, ACH50 is more popular- 3 ACH50 max is the current International Energy Conservation Code (IECC) requirement that we can all easily aim for. By 2017, new homes in all 50 U.S. states must be built to 7 ACH50 or less whether they like it or not.

YOUR TARGET: **3 ACH50 or less** (for excellent control, future-proofing, and all the energy efficiency benefits)



PERFORMANCE TESTING IS THE SIMPLE PROCESS OF FINDING OUT EXACTLY WHAT YOU'RE GETTING INTO, & CHECKING THAT THE EFFORT PAID OFF AND EVERYTHING ACTUALLY WORKS AS PLANNED AT THE END.

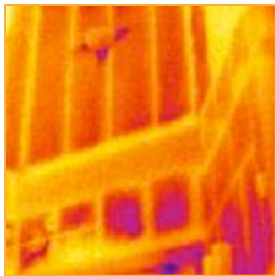


PINPOINTING ENCLOSURE ISSUES

Zonal pressure testing is a critical part of locating the source of air leakage. While the house is under blower door pressure, we can see how much pressure relief happens in any room (or 'zone') when it's closed or opened to the house.



Every room of your home (including the attic, garage, and crawlspace) should be **either 100% inside or 100% outside** the enclosure based on its **Zonal Pressure Proportion (ZPP)**. Anything in between shows an opportunity for improvement through pinpointed air sealing. If the attic shows a 60% ZPP before a much-needed airsealing of the attic floor plane, then the ZPP should be much closer to 100% after the improvement. If you airsealed and insulated between the attic and outdoors, it should have moved in the opposite direction- closer to 0% when completed.



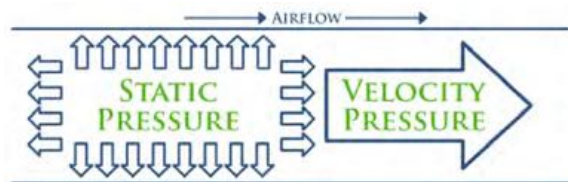
Infrared thermal photography is another excellent tool for visually locating areas of heat bleed because of missing/uneven insulation or air leakage. Because infrared is cool and sexy, you'll see this tool a lot. But be careful: pretty colors are dangerous. They can sell you anything.

In a photo like this one, **light colors mean warm** temperatures, and **dark means cold**- this color palette is called 'Iron', and it's generally the best for seeing heat bleed while also not getting confused. If you're trying to locate air leakage, **you need a blower door running**- otherwise, the infrared camera will miss most of the leakage that's happening (because of stack effect).

HVAC TESTING

The HVAC's job is to move heat and air around, and it's possible to prove that the **correct amount of heat and air are delivered** with **airflow and temperature testing, pressure pan testing, or duct tightness testing.**

Your forced air furnace or A/C is like your body's circulatory system. The 'heart' of the system is the **air handler**, the fan that moves all the air. Like your own heart, it can be helped or hurt by the valves and arteries it's connected to, and it has a limited amount of power. It pushes against two types of pressure: **static pressure** and **velocity pressure.** There's only so much pressure to go around, and static pressure is stronger. The higher it



is, the lower the velocity pressure, which means lower airflow. You want a low static pressure so that you can have a higher velocity pressure and get the right amount of air moving through the system as a whole.

At the supply registers, the air velocity (speed) should be fast enough to hit the air in the room like a bowling ball hitting the pins, which circulates the room's air pleasantly. This is between 500-700 feet per minute (fpm); any slower and the air won't circulate, any faster and you can hear the air whistling.

Exhaust fan testing is also essential: every bath fan should be located over the shower and be exhausting at least 50 cubic feet per minute (CFM, the standard way all airflow is measured), your kitchen exhaust should be proven to empty outdoors, and the exhausts **shouldn't create major suction** inside the house for **carbon monoxide safety** reasons.



ALL FUEL-BURNING APPLIANCES CREATE CARBON MONOXIDE (CO)

MOST CO DETECTORS WON'T PROTECT YOUR FAMILY FROM LOW LEVELS OF THIS LETHAL, ODORLESS GAS

THEY'RE DESIGNED TO TOTALLY IGNORE ANYTHING UNDER 70 PPM, AND THEY SAY THAT CLEARLY IN THE MANUAL

I WOULDN'T TRUST THIS THING TO PROTECT MY BRIDE & BABY- WOULD YOU?

NOW: UNDERSTANDING HEATING & COOLING



The question is: how much heating or cooling should I install in my home to make it comfortable and cost-effective? Great question! To illustrate:

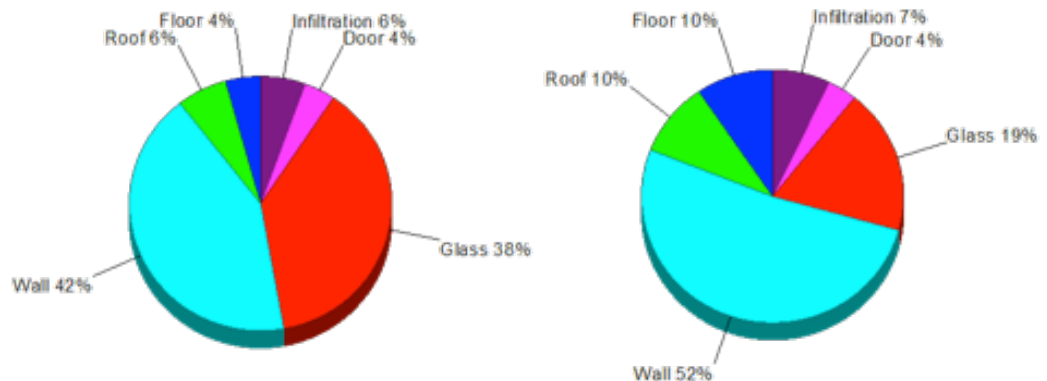
Imagine installing Arnold Schwarzenegger in your house to give your kids access to the cookie jar on the shelf: "One cookie per day is your allowance," you say.

Arnold lifts your children up much too fast and much too high- "NO, put me down!" your children cry as their heads bump the ceiling. Then he drops them much too fast, and they ask to be lifted to the cookie jar again,

and the cycle repeats. Pretty soon you have throw-up on the kitchen floor even though zero cookies have actually been eaten.

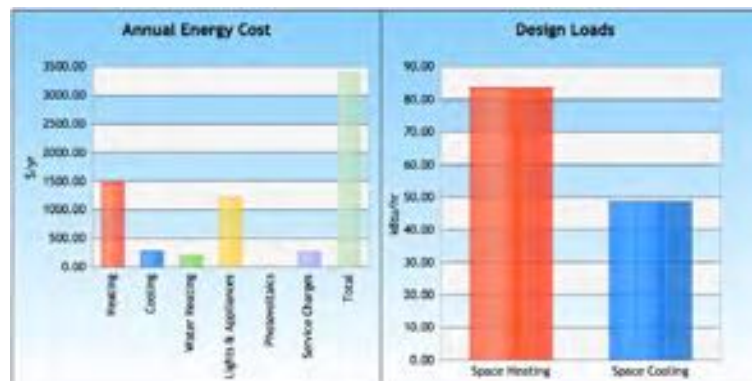
This analogy is strange and disgusting, but it **is** 100% accurate. Your house only needs a **specific amount** of heating and cooling, and equipment that's tailored to fit your home perfectly. If you install too much, the equipment starts up and shuts off a lot- it's called '**Short Cycling**', and the result in hot weather is indoor air that's cold and clammy, and in all seasons you get worn-down equipment.

There are very precise design calculations for this spelled out in *ASHRAE Fundamentals* and in *Manual J* from the Air Conditioning Contractors of America. You take detailed information about **weaknesses in the home's enclosure** (called the '**load**') and put it into a computer.



Doing an HVAC load calculation by hand isn't good enough in most homes because you need an **hour-by-hour analysis** of the sun's effect on the home. This calculation gives you a very specific amount of heating and cooling that a home needs on the **design day**, which is 99% as cold and hot as it gets in your neighborhood. Avoid 'block load' calcs- you should know the requirements of **each unique room**, since they're all different.

You don't need to add any safety margins, because the calculations were written by engineers, who are very cautious and conservative people- **they've added all the safety margins already** to make sure you'll be comfortable.



THE SECRET TO GETTING WHAT YOU PAY FOR IN HVAC:

ALL SYSTEMS CAREFULLY DESIGNED

ALL COMPONENTS CAREFULLY SELECTED

THE FINAL INSTALLATION TESTED AND PROVEN TO PERFORM AS PLANNED



Next question: how are we going to deliver the warm or cool air evenly everywhere in my home? Wow, what a great question! Guess what? There's a calculation for that too!

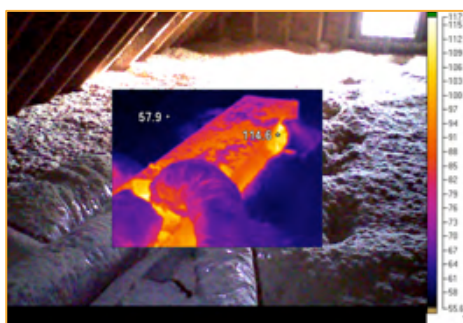
Again, *ASHRAE Fundamentals* or *Manual D* will tell you exactly how the ducts should be designed and installed so that every single room feels comfortable and refreshing, which is possible in every climate, for every home, new and old alike. If you'd like to make this part easy, choose a **ductless mini-split system**, which has the ability to deliver conditioned air without ducts, and with almost limitless room-to-room zoning control.



Now that we know exactly how much heating and cooling your home needs, we have to buy an engine that can create it. **Here's where most people make a big mistake:** they buy an engine that's too big.

These people may think that they need a little extra power for when the weather is really crazy. Don't do this. Remember a few paragraphs ago, with the cookies and the throw up? That's about to be you.

Last step: we test the **tightness of the duct system**. A duct system is plumbing for air; you **do not** want it leaking. You might think if the ducts are all inside the enclosure and they leak air here or there, it's not such a big deal. It IS a big deal, and here's why:



If we spend time and energy calculating exactly how much heating and cooling each room needs, exactly how the duct system needs to be designed and installed, and pick out the perfect heat pump or furnace...

...all of that gets flushed down the toilet if the conditioned air doesn't actually go to the rooms where you need it.

Last question: what about fresh air? Isn't that a thing? Yes it is, and you get extra credit for asking!

There's a myth that you don't want a home to be 'too tight'. That's nonsense- you want as much control as possible over your home's air leakage. Build tight, **and ventilate right**. The people who say their home is 'too tight' really mean that they forgot to install a fresh air ventilation system.

This can be as thoughtful and efficient as an Energy/Heat Recovery Ventilator (**ERV** or **HRV**) or as simple as running a bath exhaust fan nonstop. You want these systems to be as **quiet** as possible and to be **proven** to move the right amount of air- not too much,

not too little. Most homes only require between 30-150 CFM of fresh air continuously.



If you're going to spend money, time, and energy on your home, make sure it will give you back what you put into it. **Proof Is Possible**, and careful planning and performance testing are the keys. Your home won't need rescuing if you do it right the first time.

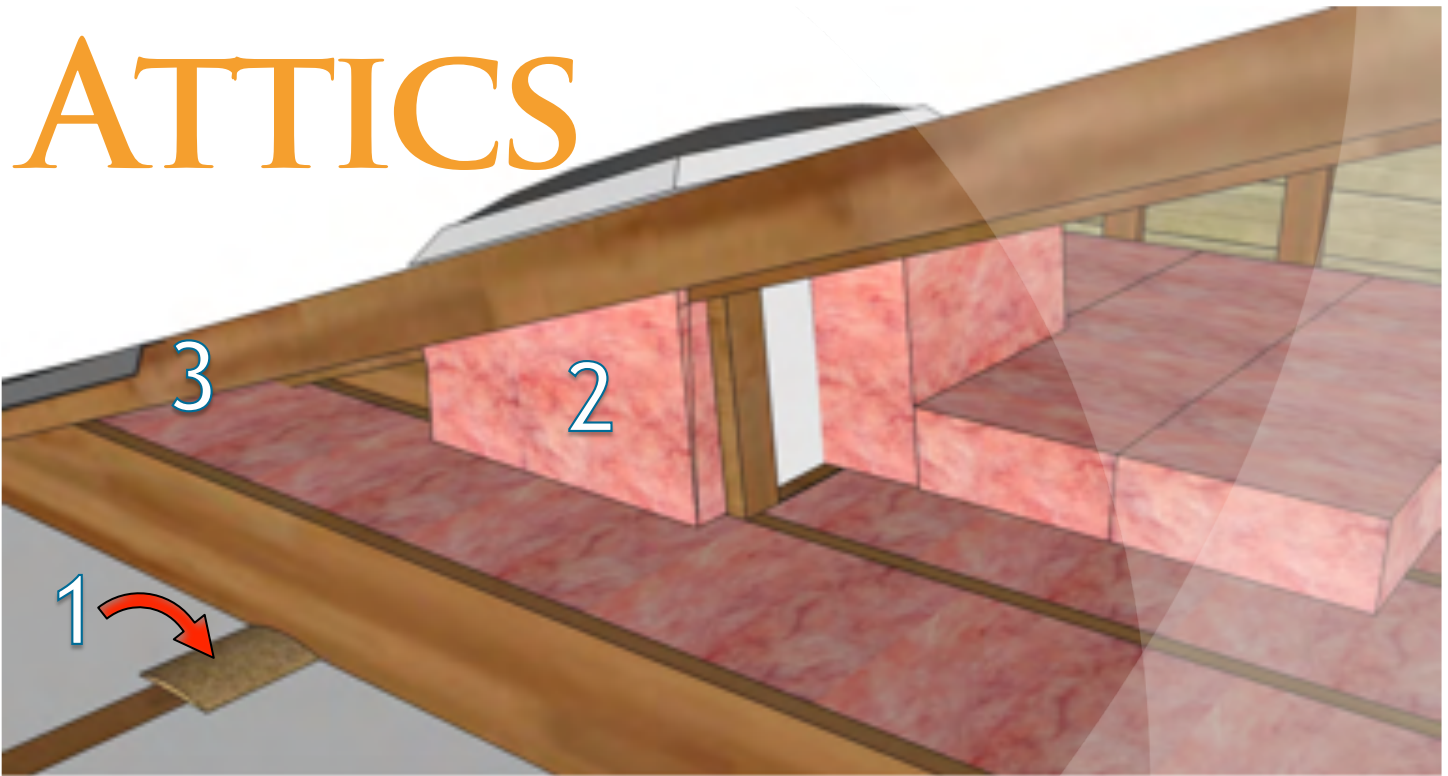


OLD-TIMEY
"RULE OF
THUMB":
1 TON OF A/C
PER 500 FT²

ACTUAL NEW
HOME
ESTIMATION:
1 TON OF A/C
PER 1400 FT²

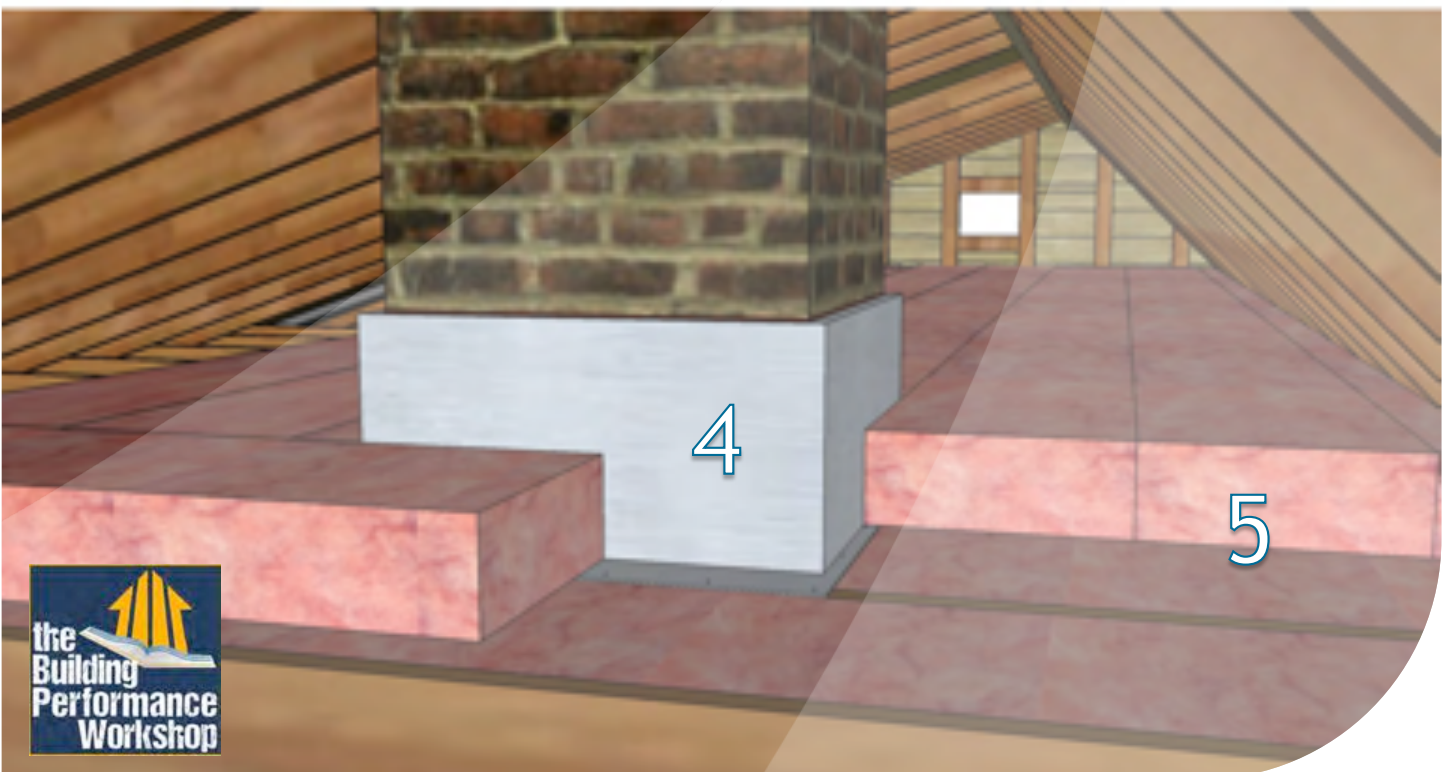
RULES OF
THUMB
DON'T WORK

ATTICS



AND FINALLY, TAKE A LOOK AT HOW A HOME SHOULD BE BUILT.

1. TOP PLATES of interior and exterior walls sealed airtight
2. SKYLIGHT SHAFTS sealed airtight and insulated continuously and uniformly
3. EAVE VENTILATION (if present) shielded with soffit baffles
4. CHIMNEYS AND CHASES sealed airtight with a rigid material, fire-safe materials where needed
5. ATTIC FLOOR insulated evenly and neatly, and deeply as feasible
 - PENETRATIONS sealed airtight (electric wires, plumbing pipes, etc)
 - RECESSED LIGHTS boxed airtight and insulated, where possible
 - ATTIC AIR CONNECTEDNESS to home tested & proven to be <5% Zonal Pressure Proportion



The #1 mistake people make with attics and roof cavities is assuming that more insulation will make everything better. At best, more insulation does NOTHING if it's not undergirded by a quality air sealing layer, and at worst, more insulation can cause an increase in moisture problems (like mildew, mold, and rot) if it's not **airsealed first**. Because the attic or roof cavity is at the top of your home, it's where all the **heated air wants to escape** to in heating season, and where your **home breathes in** after the A/C has fallen out of holes in the bottom during cooling season. If your home uses more heating than cooling, you should generally improve the attic before any other part of the house.



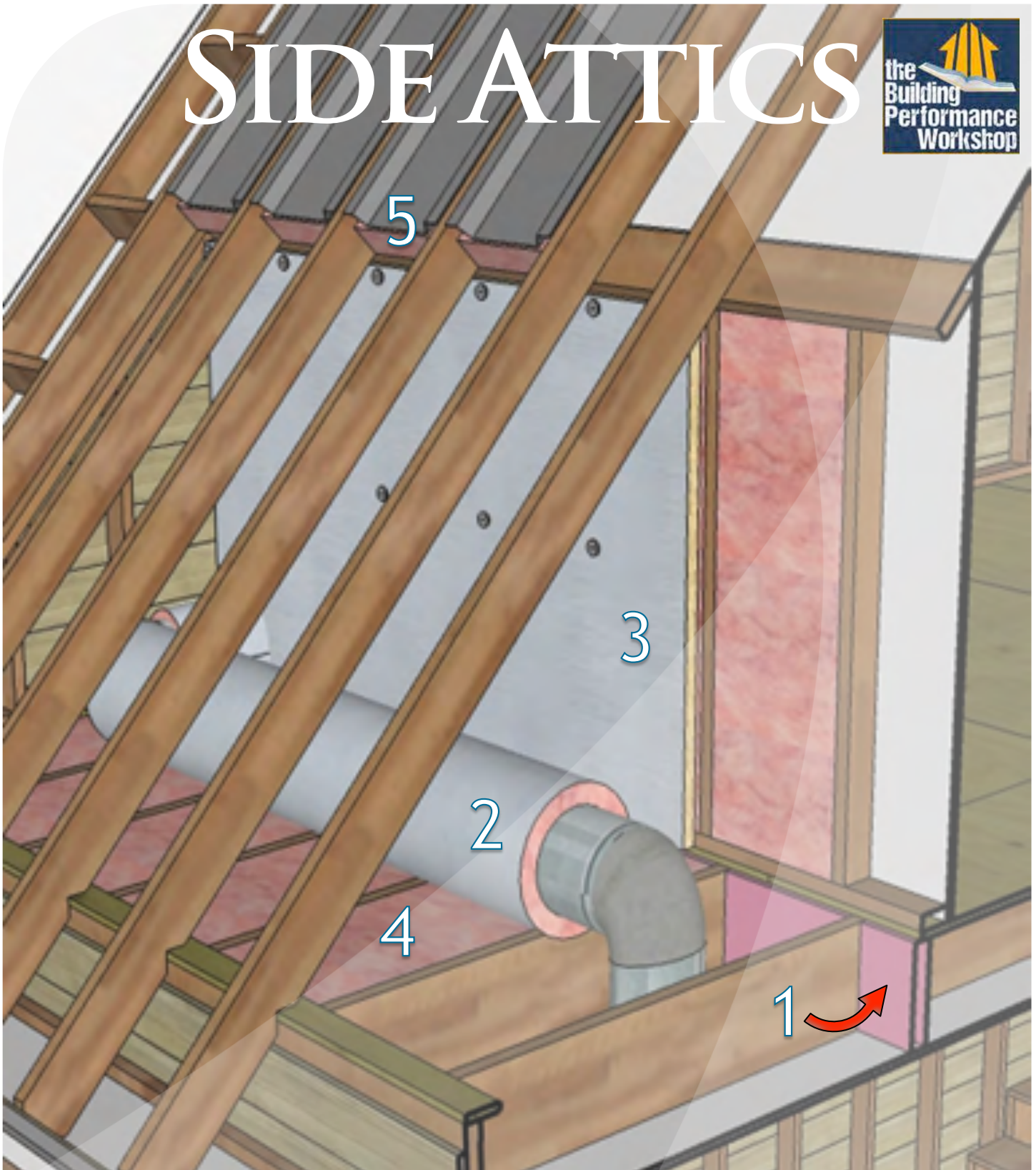
BAD



GOOD



SIDE ATTICS



1. FLOOR JOIST CAVITY blocked airtight at border of living space
 2. DUCTWORK sealed airtight & insulated to at least R-8 (more is better)
 3. KNEE WALLS sealed airtight at backside of drywall, insulated evenly & neatly, contained & sealed airtight w/ rigid foam insulation taped at seams
 4. ATTIC FLOOR insulated evenly and neatly, and deeply as possible
 5. EAVE VENTILATION shielded with soffit baffles
- ATTIC AIR CONNECTEDNESS to home tested & proven to be <5% Zonal Pressure Proportion

Often, you may not be aware your home even has these side attic 'mystery rooms', but if they're there, they're having an effect on your home's performance. The insulation may have been installed at the roofline, or at the wall and floor plane (or both), but the **airseal layer** will tell you whether these side attics should be INSIDE or OUTSIDE spaces. The wall between an attic and living space is called a **'knee wall'** because it's generally not a full-height wall. There are a surprising number of ways heat bleed can happen in a side attic: under the adjoining wall through the floor cavity, through outlets or insulation gaps in the knee wall, or even through wide open holes as you can see below.



MISSING AIR BLOCK IN FLOOR CAVITY

BAD



BLOCKED, TO BE SEALED & INSULATED

GOOD



PLUMBING EXPOSED TO AIR & HEAT BLEED



KNEEWALL INSULATED, PLUMBING PROTECTED

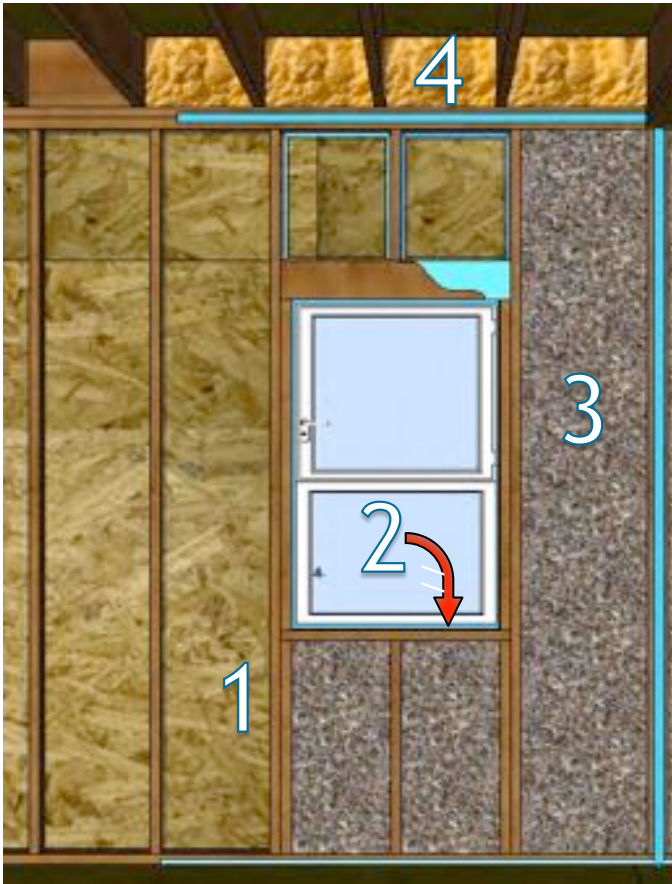


ICE DAMS CAUSED BY ATTIC AIR LEAKAGE



ROOF OVER WELL-AIRSEALED SIDE ATTICS

WALLS



INSIDE SURFACE:

1. The less framing, the better (more wood means less insulation)
2. Spray-applied sealant around windows, and at all joints
3. Perfectly installed insulation between studs (air is the main insulating ingredient)
4. Insulated band joist cavities (where the floor joists above meet the exterior wall)

EXTERIOR SURFACE:

5. Cladding (siding, brick, stone... whatever covers the structure)
6. Ventilation space (vertical strips that create a 1" space for water to dry)
7. Drainage plane (waterproof barrier, in this case sealed building paper)
8. Exterior insulation (taped at all seams for airtightness)
9. Sheathing layer (plywood or similar, for stability)



Walls, like ceilings, provide structural support and **control layers**. The control layers are for controlling (you guessed it) **heat bleed, air leakage, moisture, and air quality**. Structurally, there are wood or metal studs, and in between these we put insulation. This is **not** the best way to control heat bleed- you should aim to add a **continuous layer** of insulation outside the structure (especially for metal studs, which bleed heat 400 times faster than wood). **Less studs and more insulation** is always the goal. No matter which type of insulation you use (they're all good, when used correctly), the main ingredient is **air**; any insulation that's crammed or squeezed has less air, and won't work correctly.



NO AIRSEAL AT PORCH CONNECTION

BAD



PORCH-CONNECTION AIRSEALED

GOOD



SPRAY FOAM INSTALLED TERRIBLY- TWICE THE COST WITH ZERO BENEFIT



SPRAY FOAM FILLS CAVITIES PERFECTLY

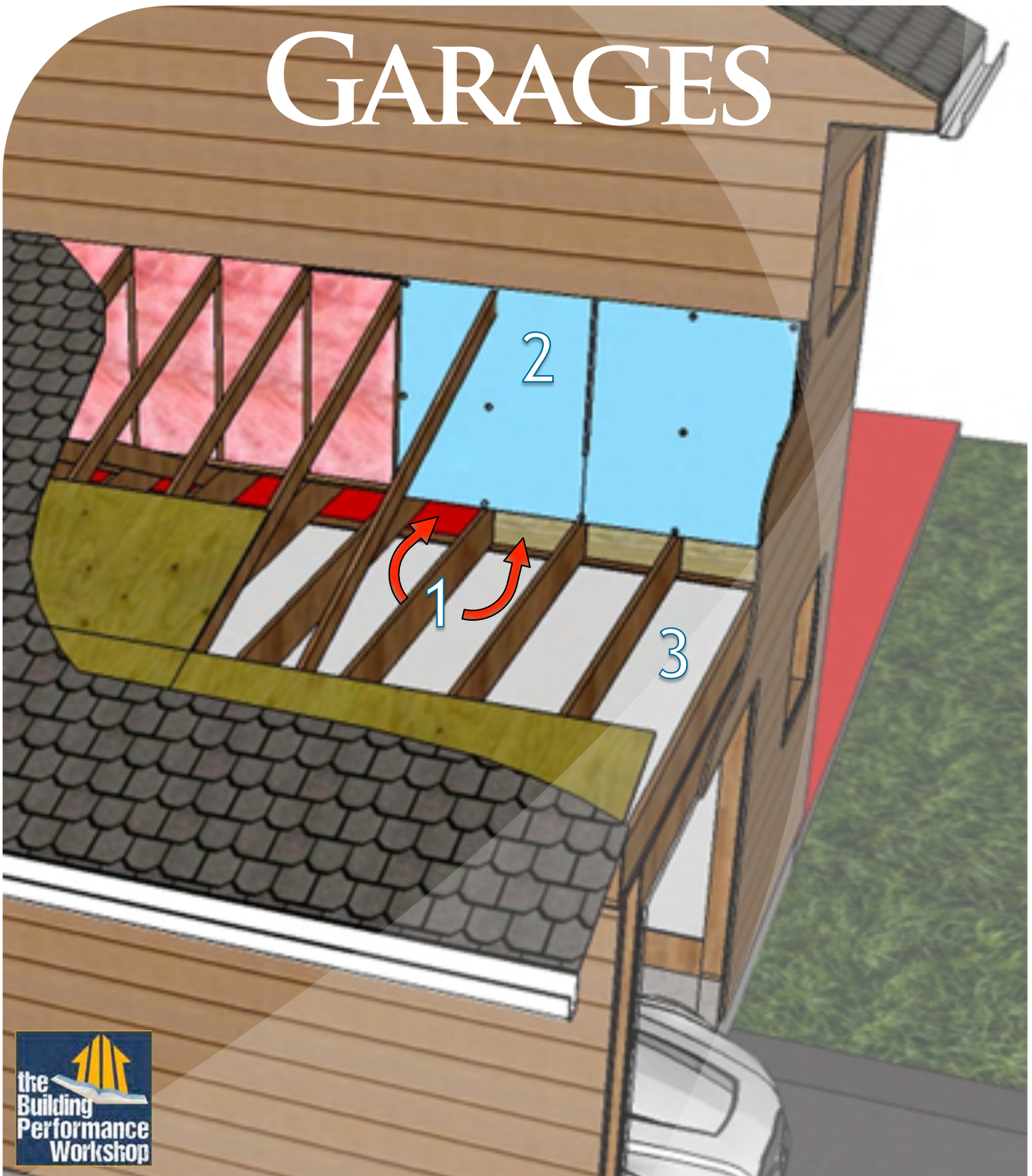


TOO MUCH WOOD, TOO LITTLE INSULATION CRAMMED IN



WOOD FRAMING PERFECT & ALIGNED, WITH UNIFORM FLUFFY INSULATION

GARAGES



1. CEILING JOIST CAVITY blocked airtight at border of living space
2. KNEE WALLS sealed airtight front and back, and insulated uniformly
3. WALLS TO LIVING SPACE sealed airtight front and back, and insulated uniformly
 - ENTRY DOOR to home weatherstripped airtight
 - DUCTWORK in garage ceiling/walls sealed airtight and insulated to at least R-8
 - GARAGE AIR CONNECTEDNESS to home proven to be <5% Zonal Pressure Proportion

Garages must never be connected to your living space, since the stuff you keep in the garage (gasoline, paint thinner, cars exhausting carbon monoxide) are not healthy for your family to breathe. The main air connection between the garage and the house may not be the connecting door either, as there are tons of air pathways inside the **building cavities**, as you may already suspect. This is especially troublesome if you have a **'bonus room'**- a living space extending over the garage. Insanely, some building officials in that scenario will actually require holes to be cut in the ducts in the garage ceiling, which is a **huge hazard**. You can always discover these connections with testing.

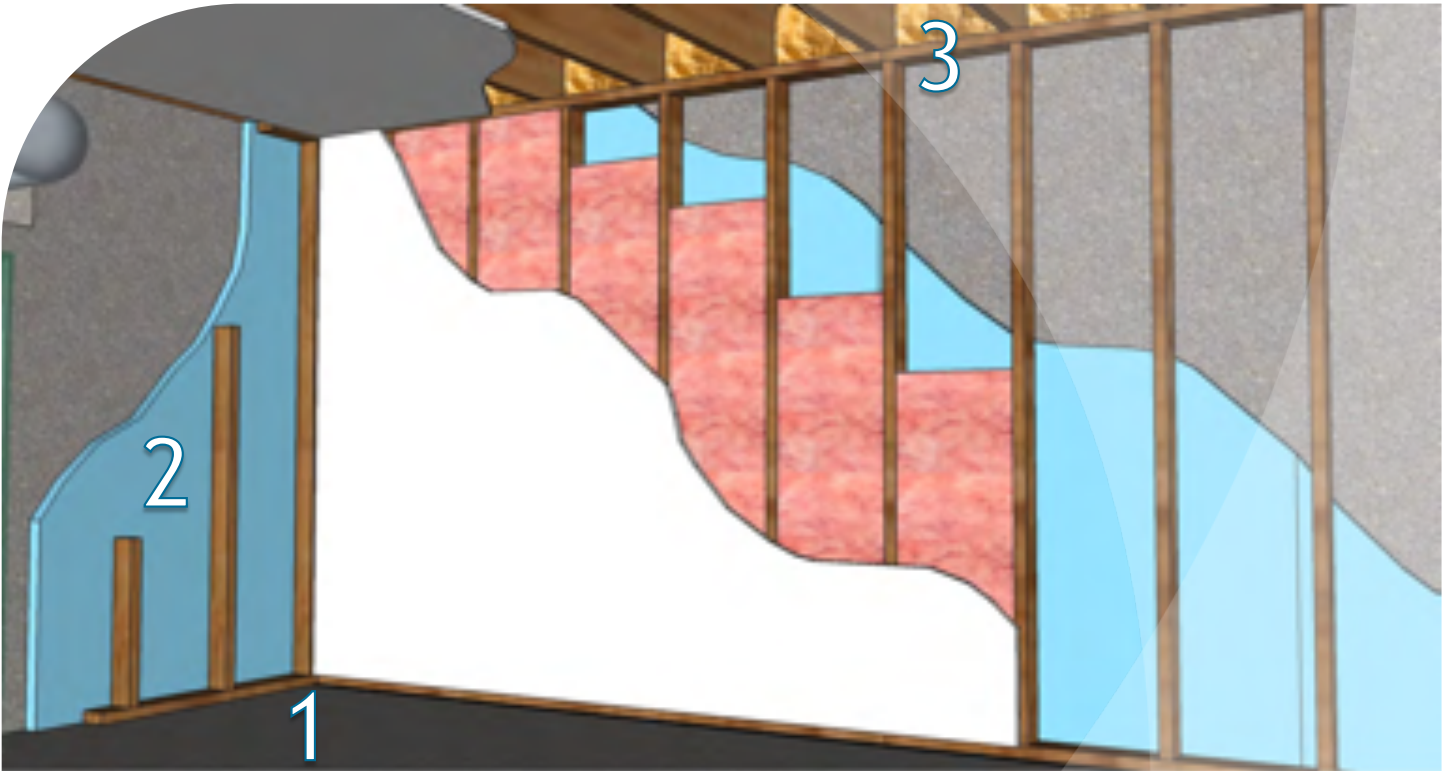


BAD



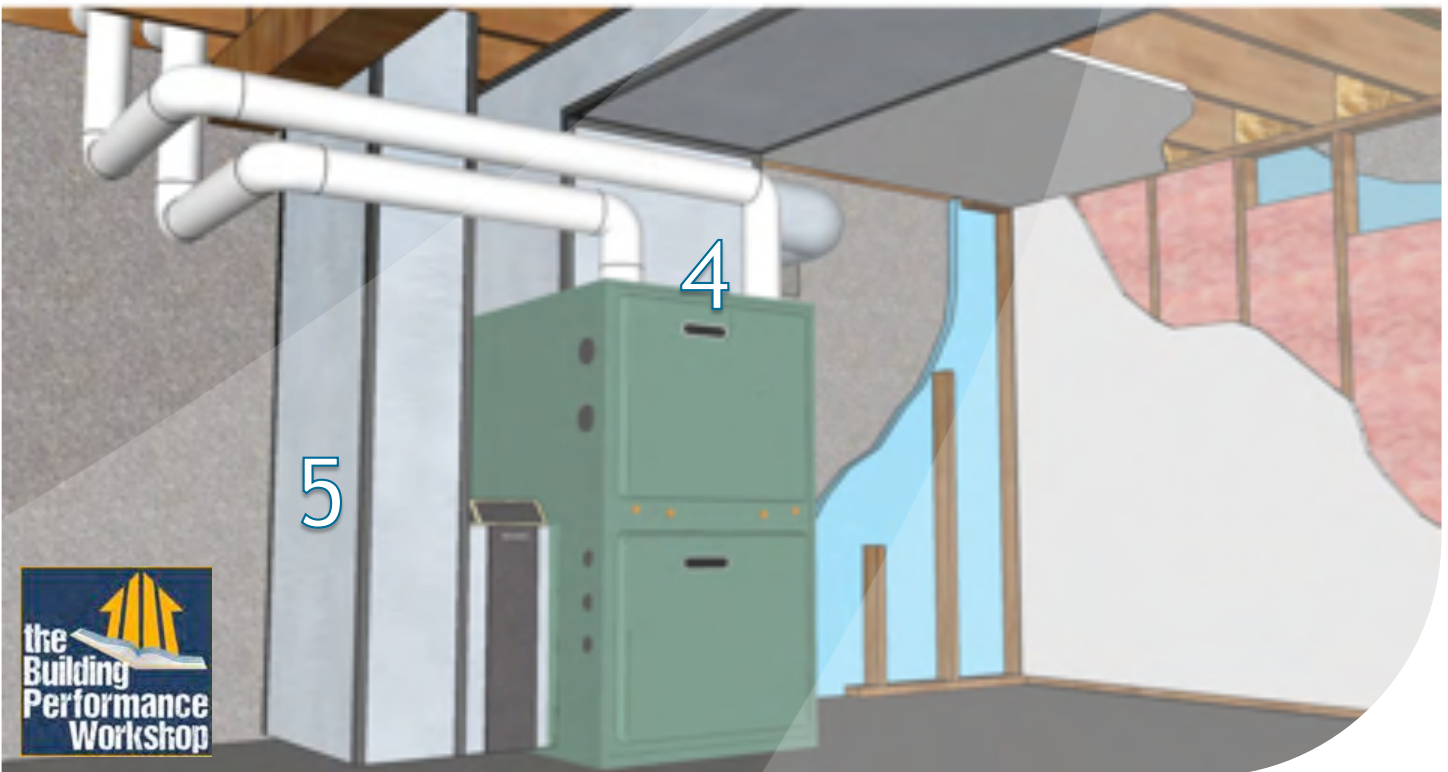
GOOD





BASEMENTS

1. DRAINAGE managed with drain tile inside, outside, or both (w/ optional exhaust system)
 2. WALLS insulated continuously (NOT interrupted by wood framing) where possible
 3. RIM JOIST airsealed in all corners and insulated to the same level as the walls
 4. COMBUSTION EQUIPMENT sealed combustion with dual PVC piping
 5. DUCTWORK sealed airtight and insulated, FILTER SLOT fitted with airtight cover
- SUMP/EJECTOR PUMP sealed with airtight cover



Basements can be complicated. They can get wet because of **groundwater** coming in or **condensation** of indoor humidity on cold surfaces. They get cold because they're in contact with the **underground** (55°F year round), and at ground level they bleed heat too (if there's snow, that gets pretty cold). Air leakage can come through the **rim joist** (the perimeter of the floor joists overhead) or through cracks and pits in the **slab floor** (radon can be an issue here too). In 99.9% of cases, the basement is absolutely an inside space- the **insulation should be on the walls**, not in the ceiling. And **insulation for pipes and ducts** will keep heat from bleeding down through the concrete floor.



RIM JOIST FRAMING
VERY DIFFICULT TO AIRSEAL

BAD



PROPERLY AIRSEALED RIM JOIST

GOOD



BASEMENT WALL TOTALLY UNINSULATED



BASEMENT WALL EXTERIOR INSULATION



HVAC EQUIPMENT CROWDED
BY AIR POLLUTANTS

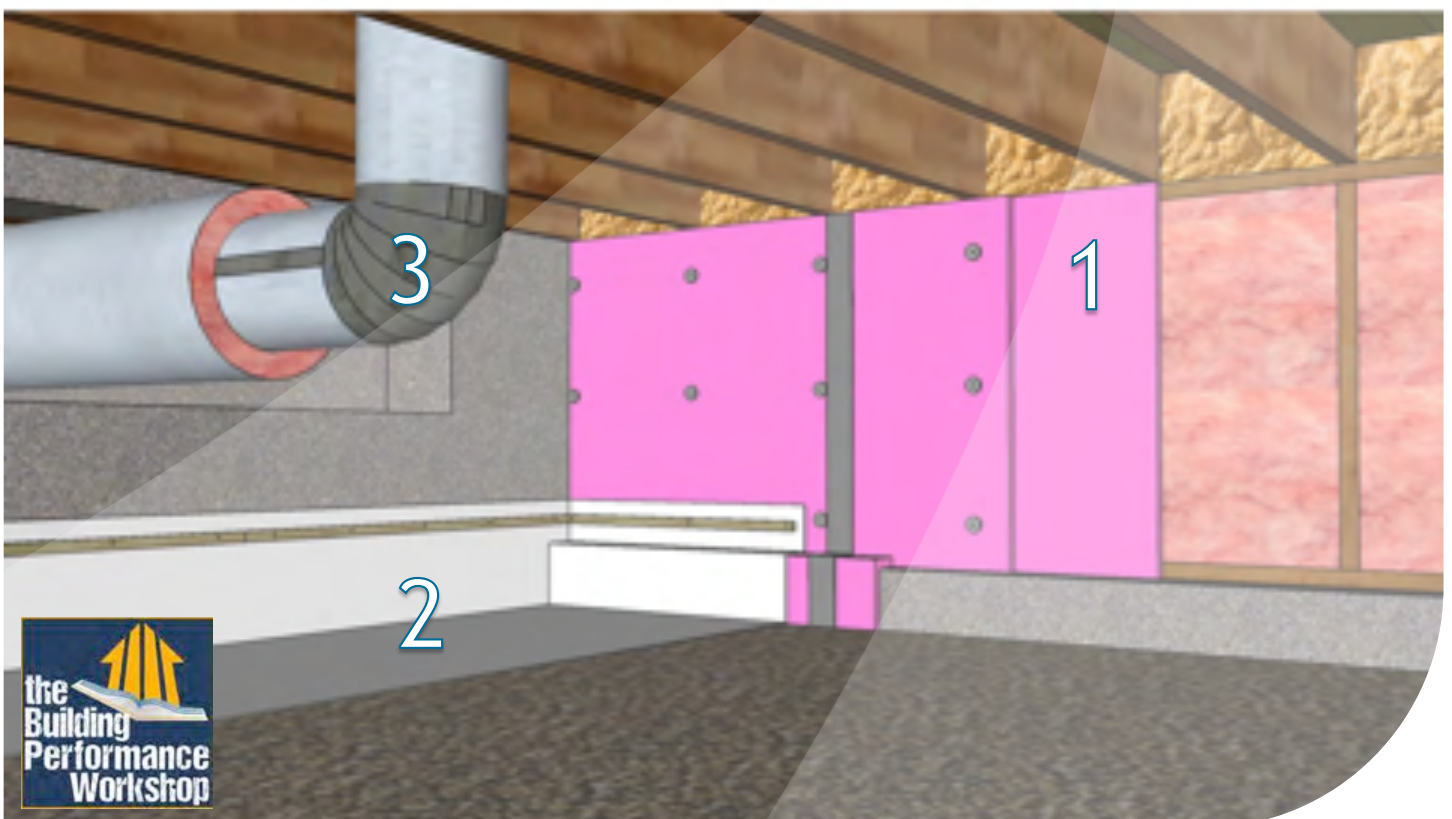


HVAC EQUIPMENT GIVEN AMPLE SPACE

CRAWLSPACES



1. EXTERIOR WALLS and RIM JOIST sealed airtight, insulated evenly and neatly
 2. GROUND COVERED with >6mil plastic vapor barrier, sealed airtight at seams
 3. DUCTWORK sealed airtight and insulated to at least R-8 (more is better)
- CRAWLSPACE AIR CONNECTEDNESS to home proven to be >95% Zonal Pressure Proportion



Crawlspaces used to be vented to outside and considered outside space; testing has proven that approach causes a **lot of problems**. Plus, if you test any vented crawl with zonal pressures, you'd probably find that it's more airway-connected to the home than the master bedroom suite. Bringing a crawlspace fully inside is called '**encapsulation**', and when complete, it should be the same temperature and humidity as the rest of the living space. The floor of the crawl is the only place in any house where a **sheet of plastic is always a good thing**. If you're pouring concrete, the plastic needs to go underneath. Insulation should generally go on the walls, and not in the ceiling overhead.



FILTHY CONDITIONED CRAWLSPACE

BAD



CLEAN & DRY CONDITIONED CRAWLSPACE

GOOD



INSULATED AGAINST THE HOME (CEILING) AND AGAINST OUTDOORS (WALL) PICK ONLY *ONE* - INSIDE OR OUT!



INSULATED EFFECTIVELY AT WALL ONLY



UNSEALED DUCTWORK, UNPROTECTED BY INSULATION IN FLOOR CAVITY ABOVE



SEALED DUCTWORK, TO BE INSULATED

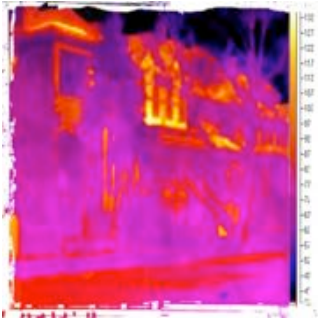
THERE IS NO REASON WHY YOU CAN'T EXPECT GUARANTEED CONTROL OVER A MEASURABLY COMFORTABLE, HEALTHY, DURABLE AND ENERGY EFFICIENT HOME. STOP WASTING MONEY, TIME AND SWEAT ON WHAT DOESN'T PROVABLY WORK. STOP GUESSING.

*PROOF IS POSSIBLE.
ASK FOR IT.*



AIR TIGHTNESS TESTING

BUILD A PLAN FOR EXACTLY WHERE AND HOW MUCH TO AIR SEAL THE ENCLOSURE AND DUCTWORK



INFRARED THERMAL PHOTOGRAPHY

SEE THE BARRIERS TO HEAT BLEED WITH YOUR OWN EYES



HVAC TESTING

ENSURE THAT TEMPERATURES AND AIR FLOWS ARE CONSISTENT & COMFORTABLE



SAFETY TESTING FOR SIDE EFFECTS

PROVE THAT YOUR HOME IS TUNED AS A SYSTEM, AND THAT THERE AREN'T UNINTENDED CONSEQUENCES

Hi, we're Grace and Corbett Lunsford. We weren't always experts in the Science of Homes- we started out as a musician and an actress who knew nothing about building. So in 2008, we learned a few things very quickly: construction is unbelievably messy, most pros are over-rushed and under-paid, and homeowners end up suffering in small ways, for their entire lives in a house. None of this has to be so- you can opt out of the whole thing with performance testing.

