

# The Evolution of a Crawlspace – Lessons Learned From a Big Energy Retrofit



Presented by:

Mike Barcik, Southface & Skye Dunning, BPS

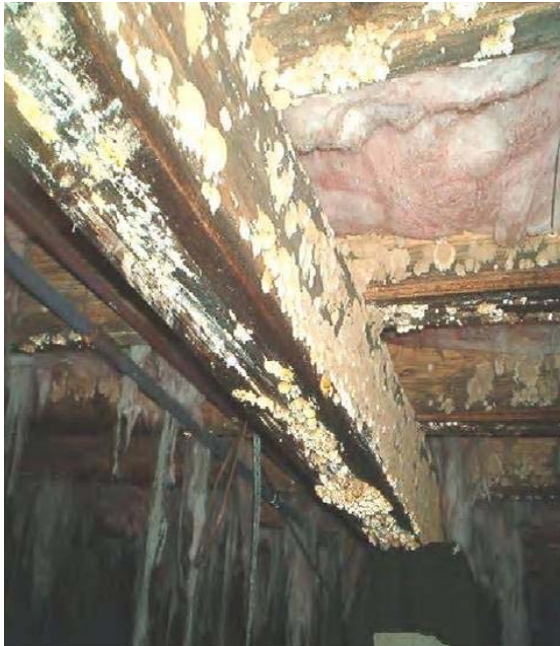
*RESNET 2014 Conference*



About  
Southface



# Crawlspaces and the old way of thinking...



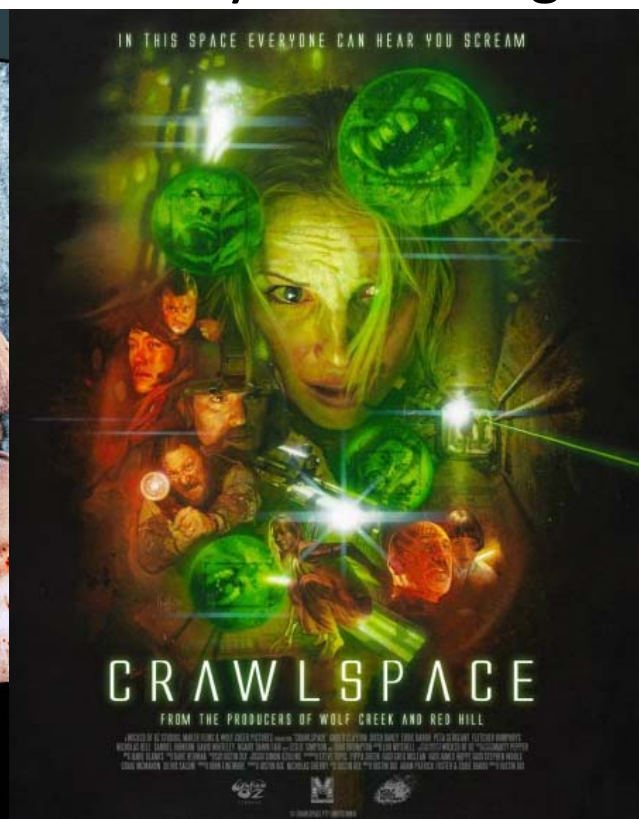
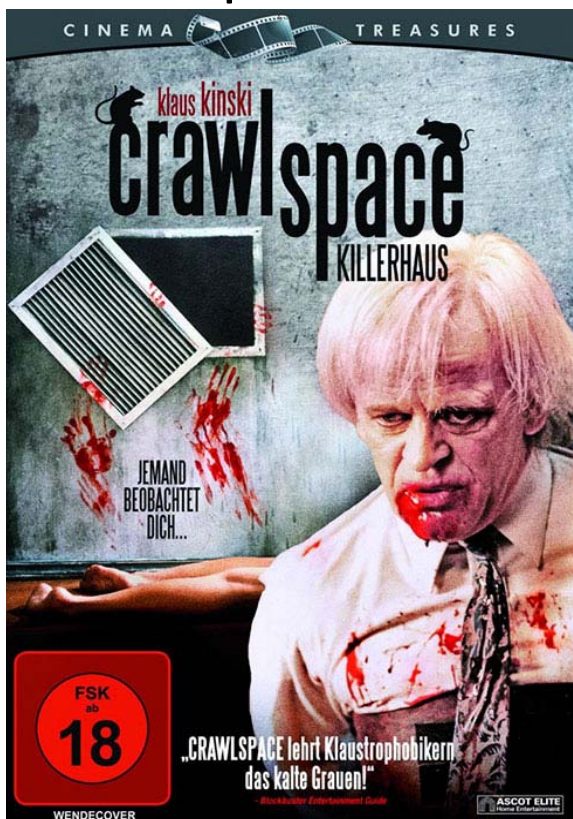
- Moisture problems could be solved by venting
- Hide stuff down there
- Use vented crawlspace air for combustion
- More vents are better, right? 1:150 rule of thumb
- Hang batt insulation in cavities



 Southface

3

# Crawlspaces and the old way of thinking...



## Advantages of a Properly Retrofitted Closed Crawlspace

- Forces you to address bulk moisture issues
- Ensures you will have a Class I vapor retarder
- Maintains interior crawlspace RH levels
- Crawlspace is “nice” – greatly reduced mold risk
- Floor above is more comfortable
- Energy savings are generally the result
- Requires you to fix or upgrade combustion equipment
- Structure and hardwood flooring more stable
- Reduces risk of pest damage (termites, bugs, vermin, etc.)
- Ductwork is now inside conditioned envelope
- Pipes inside conditioned crawlspace won't freeze
- Conditioned storage area in crawlspace



## Disadvantages of a closed crawlspace

- Costs \$ to
  - upgrade combustion equipment
  - address all moisture issues
  - set up conditioning and maybe to operate
  - to remove old insulation and install new
  - add crawlspace monitoring/alert system
- Radon levels could increase inside home
- “Non-believers” (e.g., some pest control people) don't get it and can thwart the system
- Cannot store chemicals, gas lawn equipment
- Not necessarily appropriate to some crawlspaces (low clearance, flood plain, etc.)
- Background of contractor influences outcome:





# Code says to vent, but offers an exception...

## SECTION R408 UNDER-FLOOR SPACE

**R408.1 Ventilation.** The under-floor space between the bottom of the floor joists and the earth under any building (except space occupied by a *basement*) shall have ventilation openings through foundation walls or exterior walls. The minimum net area of ventilation openings shall not be less than 1 square foot (0.0929 m<sup>2</sup>) for each 150 square feet (14 m<sup>2</sup>) of under-floor space area, unless the ground surface is covered by a Class 1 vapor retarder material. When a Class 1 vapor retarder material is used, the minimum net area of ventilation openings shall not be less than 1 square foot (0.0929 m<sup>2</sup>) for each 1,500 square feet (140 m<sup>2</sup>) of under-floor space area. One such ventilating opening shall be within 3 feet (914 mm) of each corner of the building.

**R408.2 Openings for under-floor ventilation.** The minimum net area of ventilation openings shall not be less than 1 square foot (0.0929 m<sup>2</sup>) for each 150 square feet (14 m<sup>2</sup>) of under-floor area. One ventilation opening shall be within 3 feet (915 mm) of each corner of the building. Ventilation openings shall be covered for their height and width with any of the following materials provided that the least dimension of the covering shall not exceed 1/4 inch (6.4 mm):

1. Perforated sheet metal plates not less than 0.070 inch (1.8 mm) thick.
2. Expanded sheet metal plates not less than 0.047 inch (1.2 mm) thick.
3. Cast-iron grill or grating.
4. Extruded load-bearing brick vents.
5. Hardware cloth of 0.035 inch (0.89 mm) wire or heavier.
6. Corrosion-resistant wire mesh, with the least dimension being 1/8 inch (3.2 mm) thick.

- 1:150 s.f. just vents
- 1:1500 s.f. with Class I vapor retarder installed (e.g., 6 mil poly)



# Unvented option, part 1

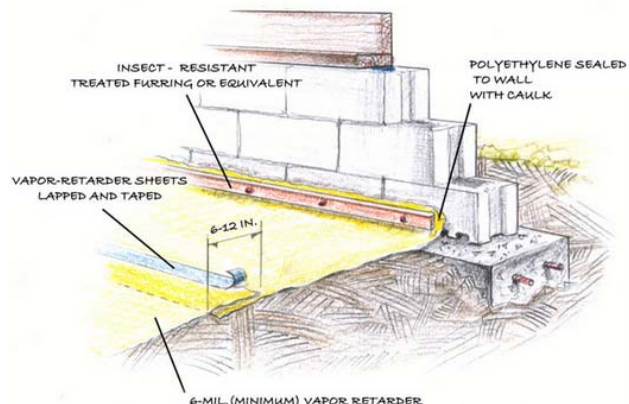
**R408.3 Unvented crawl space.** Ventilation openings in under-floor spaces specified in Sections R408.1 and R408.2 shall not be required where:

1. Exposed earth is covered with a continuous Class I vapor retarder. Joints of the vapor retarder shall overlap by 6 inches (152 mm) and shall be sealed or taped. The edges of the vapor retarder shall extend at least 6 inches (152 mm) up the stem wall and shall be attached and sealed to the stem wall or insulation; and



Photo thanks to Donnie Holmes

EPA Indoor airPLUS | MOISTURE CONTROL 1.2  
www.epa.gov/indoorairplus



CRAWL SPACE - VAPOR RETARDER OVER SOIL

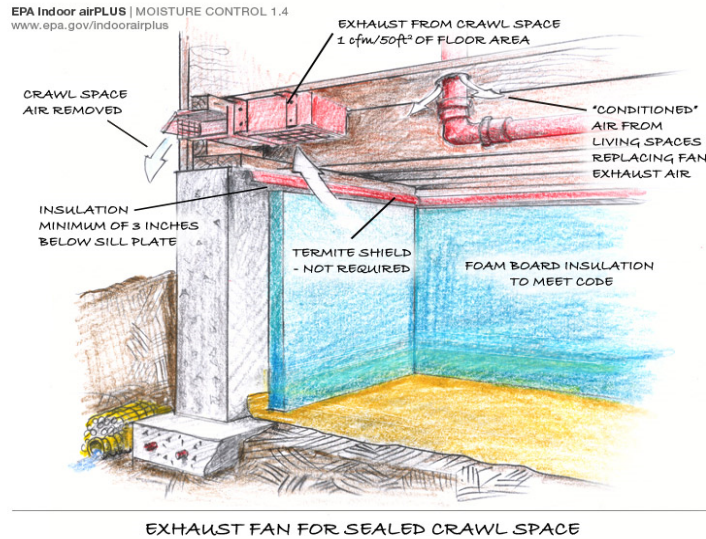
# Unvented exception, part 2.1



2. One of the following is provided for the under-floor space:

2.1. Continuously operated mechanical exhaust ventilation at a rate equal to 1 cubic foot per minute (0.47 L/s) for each 50 square feet (4.7m<sup>2</sup>) of crawlspace floor area, including an air pathway to the common area (such as a duct or transfer grille), and perimeter walls insulated in accordance with Section N1103.2.1 of this code;

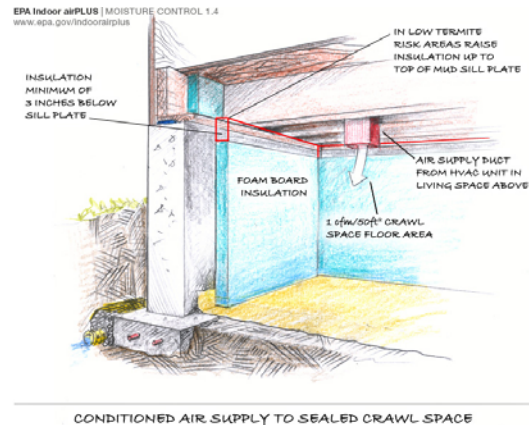
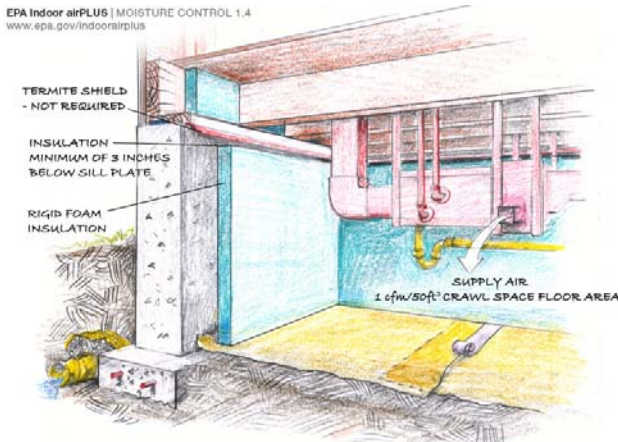
- Arguably, an active radon remediation system could be deemed continuously operated mechanical exhaust ventilation



# Unvented exception, part 2.2



2.2. Conditioned air supply sized to deliver at a rate equal to 1 cubic foot per minute (0.47 L/s) for each 50 square feet (4.7 m<sup>2</sup>) of under-floor area, including a return air pathway to the common area (such as a duct or transfer grille), and perimeter walls insulated in accordance with Section N1102.2 of this code;



CONDITIONED AIR SUPPLY TO SEALED CRAWL SPACE

CONDITIONED AIR SUPPLY TO SEALED CRAWL SPACE



## Unvented exception, part 2.2 (with a bit of an interpretation)

2.2. *Conditioned air supply sized to deliver at a rate equal to 1 cubic foot per minute (0.47 L/s) for each 50 square feet (4.7 m<sup>2</sup>) of under-floor area, including a return air pathway to the common area (such as a duct or transfer grille), and perimeter walls insulated in accordance with Section N1102.2 of this code;*



- Arguably, a crawlspace can be “conditioned” by installing a dehumidifier that is delivering the required cfm
- Especially in mixed or warmer climates,
  - drying the crawl air is more important
  - since the walls are insulated, the crawlspace temperature should remain reasonable (above 60 ° F)
  - duct leakage contributes to “conditioning”
- Our preferred approach since crawl gets what it needs (moisture control) based on sensor located in the crawlspace itself

## Unvented exception, part 2.3

2.3. Plenum in existing structures complying with Section M1601.5, if under-floor space is used as a plenum.



**DON'T  
DO  
IT**



**DON'T DO IT.**

# IECC Details...

## Insulating Crawlspace Walls



**R402.2.10 Crawl space walls.** As an alternative to insulating floors over crawl spaces, crawl space walls shall be permitted to be insulated when the crawl space is not vented to the outside. Crawl space wall insulation shall be permanently fastened to the wall and extend downward from the floor to the finished grade level and then vertically and/or horizontally for at least an additional 24 inches (610 mm). Exposed earth in unvented crawl space foundations shall be covered with a continuous Class I vapor retarder in accordance with the *International Building Code* or *International Residential Code*, as applicable. All joints of the vapor retarder shall overlap by 6 inches (153 mm) and be sealed or taped. The edges of the vapor retarder shall extend at least 6 inches (153 mm) up the stem wall and shall be attached to the stem wall.

CLIMATE ZONE	CRAWL SPACE <sup>1</sup> WALL R-VALUE
1	0
2	0
3	5/13
4 except Marine	10/13
5 and Marine 4	15/19
6	15/19
7 and 8	15/19

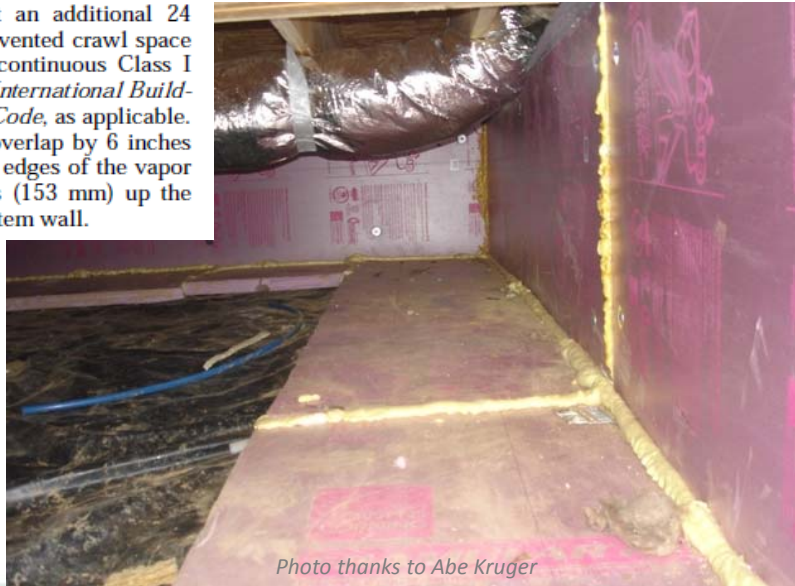


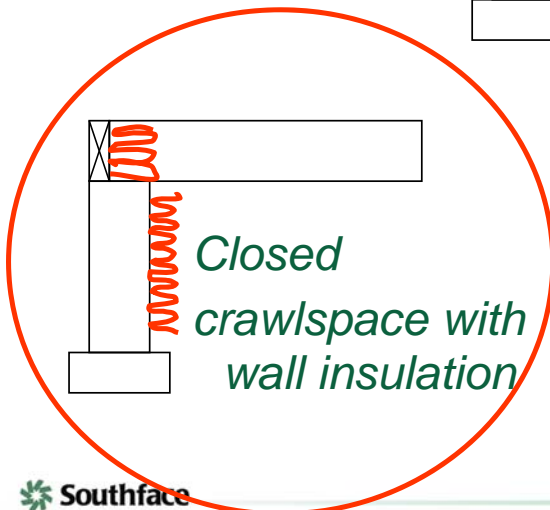
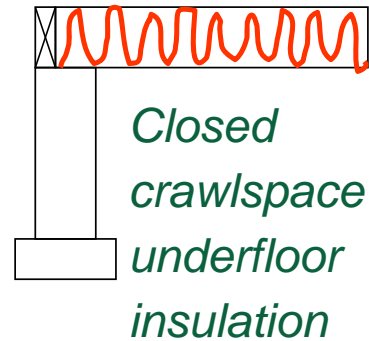
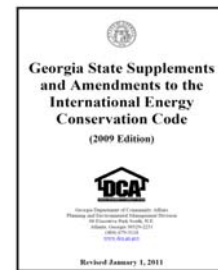
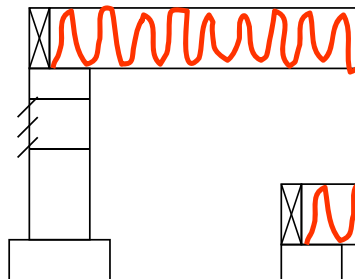
Photo thanks to Abe Kruger



## GA's Energy Code adventures...

### 402.2.9 Crawlspace Walls - 3 Options

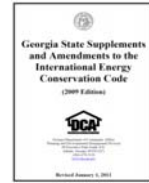
*Standard vented crawlspace - underfloor insulation*



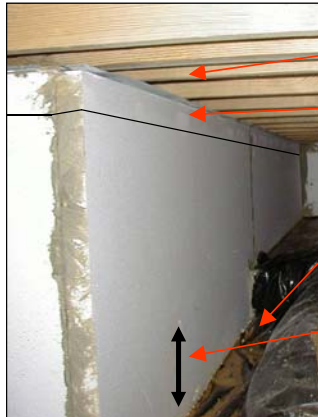
- Note:** all crawlspaces must meet vapor retarder requirements, as per IRC



## 402.2.9 – Crawlspace Walls (GA code)



**402.2.9 Crawl space walls.** As an alternative to insulating floors over crawl spaces, crawl space walls shall be permitted to be insulated when the crawl space is not vented to the outside. Crawl space wall insulation shall be permanently fastened to the wall and extend downward from the floor to within 9 inches (229 mm) of the finished interior grade adjacent to the foundation wall. A 3-inch (76 mm) inspection/view strip immediately below the floor joists shall be provided to permit inspections for termites. Exposed earth in unvented crawl space foundations shall be covered with a continuous Class 1 vapor retarder in accordance with the *International Building Code*. All joints of the vapor retarder shall overlap by 6 inches (152 mm) and be sealed or taped. The edges of the vapor retarder shall extend at least 6 inches (228 mm) up the stem wall and shall be attached and sealed to the stem wall.  
(Effective January 1, 2011)



- Insulate band joist area
- 3-inch view strip (removable is okay)
- Crawl space wall insulation to extend anywhere within 9 inches of finished interior grade
- Complete plastic sealed to walls at least 6 inches up the stem wall

Southface

## Details of GA code for unvented crawlspaces



Gap for pest inspection



SF suggestion: taped, hinged "plug" of rigid insulation board in gap

Southface



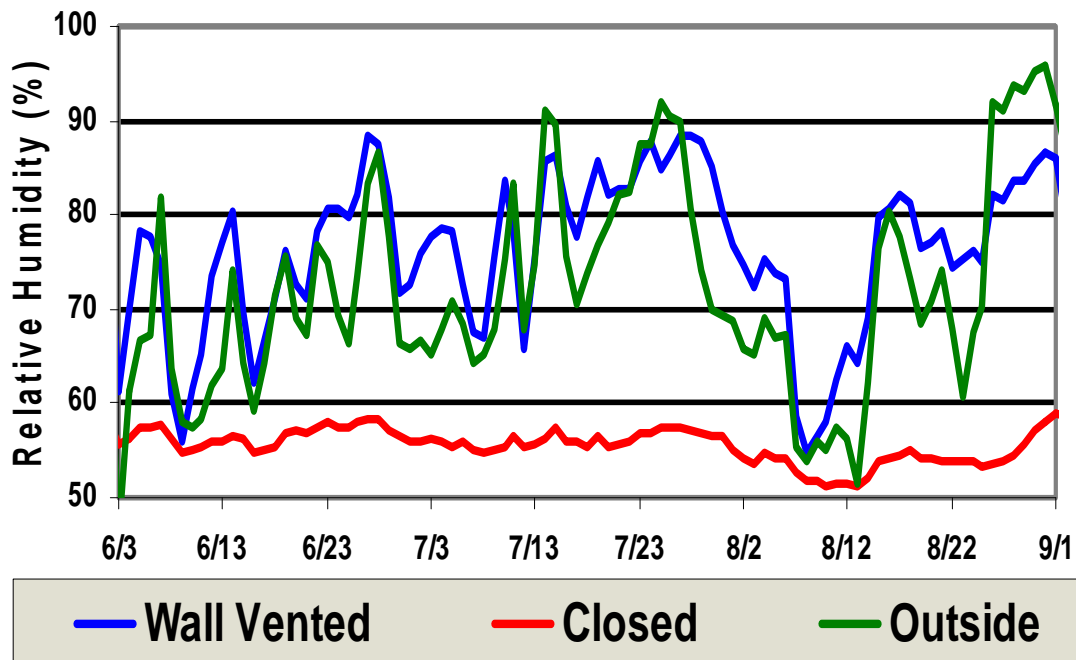
# Closed Crawl Space Study

[www.crawlspaces.org](http://www.crawlspaces.org)

[www.crawlspacesproducts.com](http://www.crawlspacesproducts.com)



## Crawl Space Moisture Levels Summer 2002



# Reality of Most Underfloor Insulation



 Southface

## Closed Crawlspaces

- Seal ground with plastic (6" up walls, 6" overlaps)
- Insulate interior of walls to satisfy code (R-10 in CZ4, R-5 in CZ3, R-0 in CZ2)
- Eliminate all vents and leaks (access doors)
- Satisfy IRC exception to vent requirement (2006 IRC section R408.3)

### Venting Exceptions:

- Continuous exhaust (radon)
- Direct condition crawlspace (supply)
- Direct condition (dehumidifier)



### Critical Details:

- No drainage problems
- Use a sealed combustion / direct vent furnace or install a Heat Pump
- Pest Control and Code Official awareness

 Southface



## Insulation techniques – Rigid Foam



EPS foam  
with borate



XPS foam



Poly-iso foam

- A desirable insulation installation is one that will stay in place, be resilient in case of moisture issues, and low cost

## Insulation techniques - Sprayed



Open cell



Closed cell



High-  
borate  
cellulose

- A desirable insulation installation is one that will stay in place, be resilient in case of moisture issues, and low cost

## Insulation techniques – Band area



Closed cell foam



Fiberglass batt



- Air seal + insulate rim/band area

### Blown bag

The band-joint area can be a challenge to insulate correctly, with some contractors opting for fiberglass batt rather than the complications of spray foam. For installers working with blown fiberglass or cellulose, National Fiber offers another option. Its Insul-Cube is a fire-rated bag can be filled with blown insulation on-site, then friction-fit between the joists. The amount of insulation used will vary according to the size of the space, and the cubes can be filled-in-place behind pipes or wires. National Fiber | 23

## Good Crawlspace Combustion



- Condensing Appliances

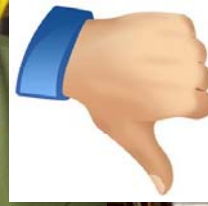




# Not Good Crawlspace Combustion!



- Atmospheric Appliances



# Combustion Water Heaters



# Electric Water Heating



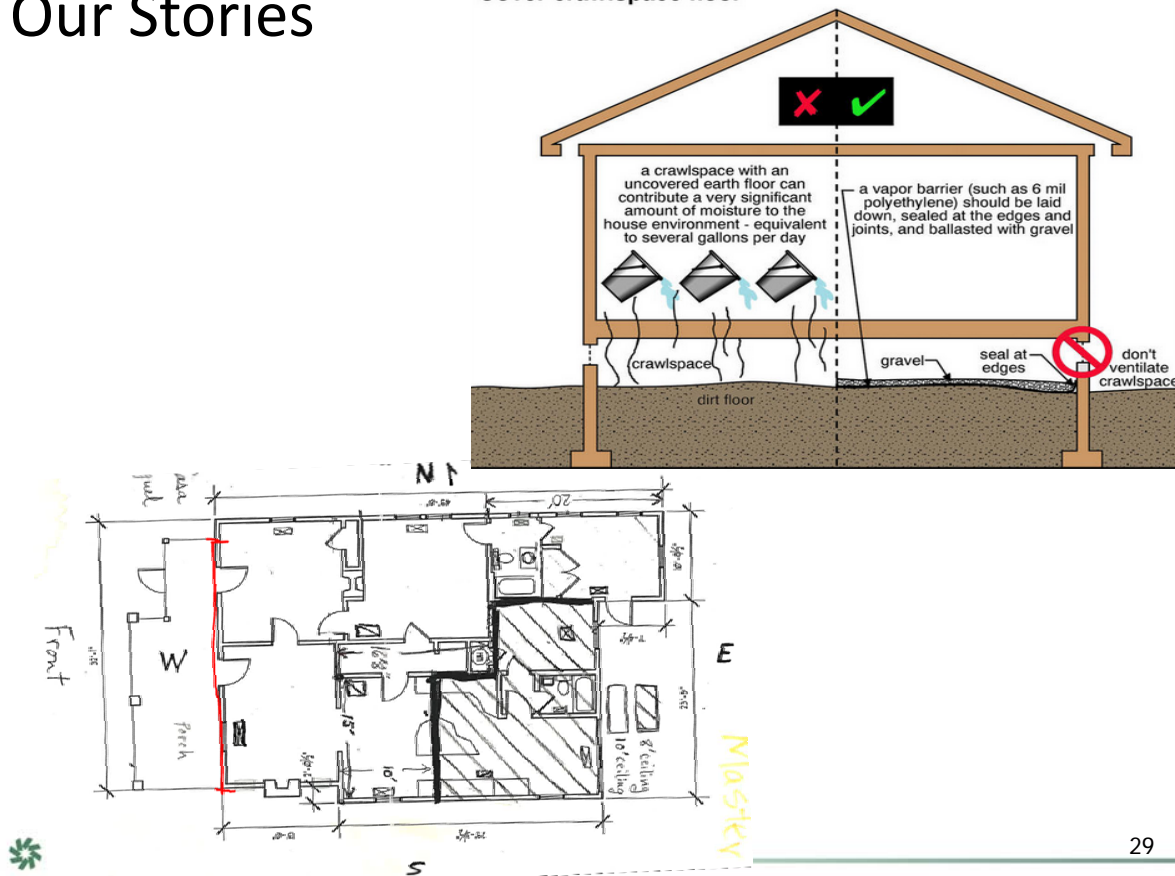
# In Need of Immediate Attention...





# Our Stories

Cover crawlspace floor



# Skye's Experience

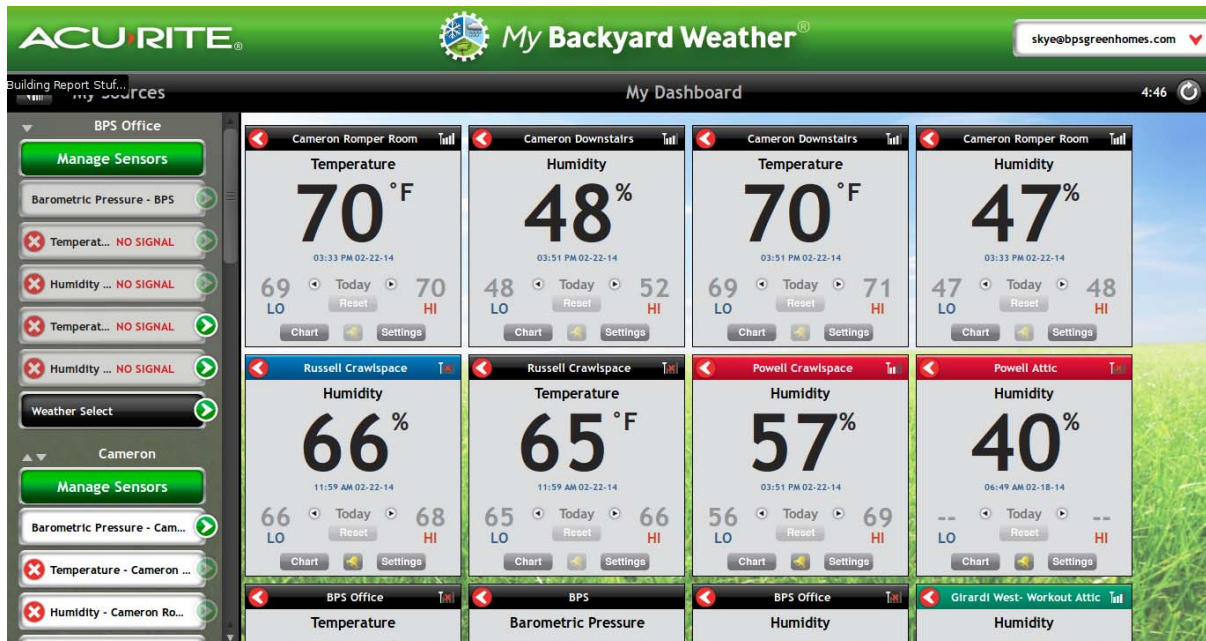


# Skye's Experience



 Southface

# Skye's Experience



 Southface



# Skye's Experience



 Southface

# Skye's Experience



 Southface

# Skye's Experience



 Southface

# Skye's Experience



 Southface



# Acme Small Group Exercise - Setup

- Break into groups of ~6 people
- Introduce yourselves and determine the facilitator and modeler
- Read the scenario and constraints for your team & determine a solution
- Choose a presenter; at the end they will share your scenario and results with the larger group



## Small Group Exercise - Directions

1. **Discuss** your Scenario and its constraints for creating a closed crawlspace
2. **Brainstorm** on solutions to best proceed (use flip chart or paper)
3. **Determine** how you will insulate it and how to satisfy code unvented crawlspace (how will you “condition” it?)
4. **Note** the important details of your solution
5. **Draw** a section or isometric sketch
  - Insulation method
  - Moisture details
  - Comment on the overall economics
6. **Present** your results to the larger group – consider a poster board



# Small Group Exercises

## Ready for Upgrade – Existing Vented Crawlspace Scenarios

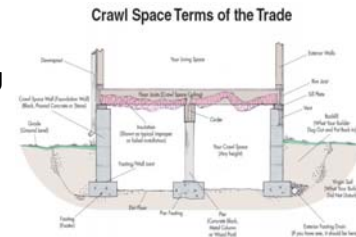
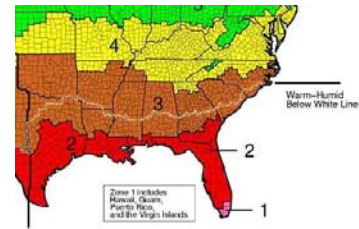
**Scenario A:** Boone, NC (CZ5, cold) –high-efficiency combustion furnace and standard gas water heater, water pooling at low point in crawlspace, decent budget

**Scenario B:** Nashville, TN (CZ4, mixed) – heat pump and low boy electric water heater in crawlspace, vented foundation wall includes porch area, small budget

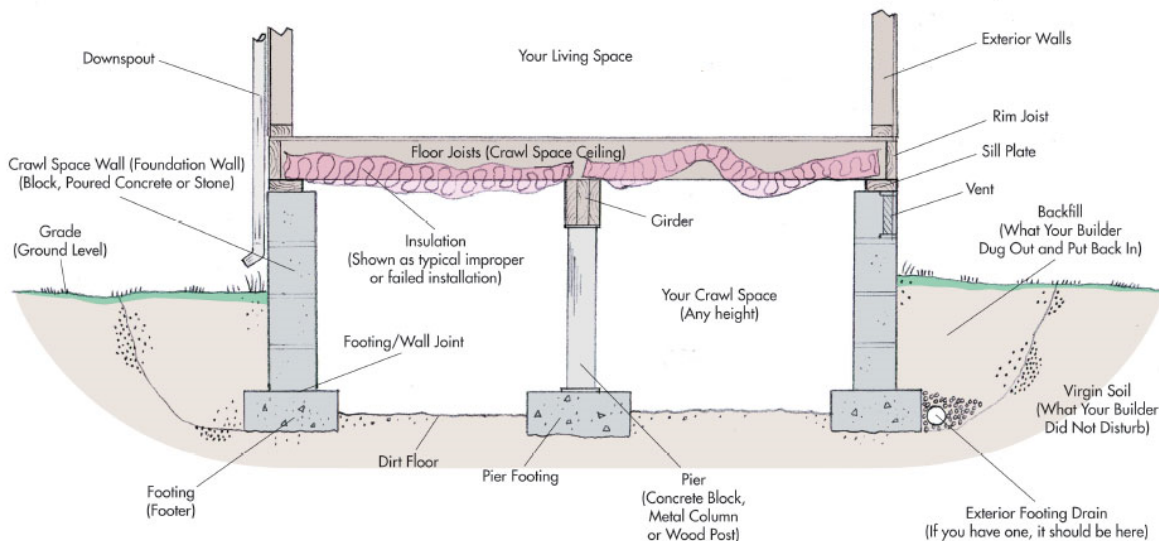
**Scenario C:** Florence, SC (CZ3, mixed, high termite risk) – older house-on-piers with brick curtain wall with no foundation wall, 80% gas furnace (no water heater in crawl), decent budget

**Scenario D:** Jackson, MS (CZ3, mixed, high termite risk) – CMU block crawlspace of home with no underfloor insulation. Electric heat pump, decent drainage, modest budget

**Scenario E:** Mobile, AL (CZ2, hot/humid) – packaged heat pump outside crawlspace (electric WH inside house), home near flood plain, some mold on floor joists, moderate budget



## Crawl Space Terms of the Trade





# Wrap up and Q&A - Thank You!

- Additional Questions?
- Closing Thoughts?
- Thank You!



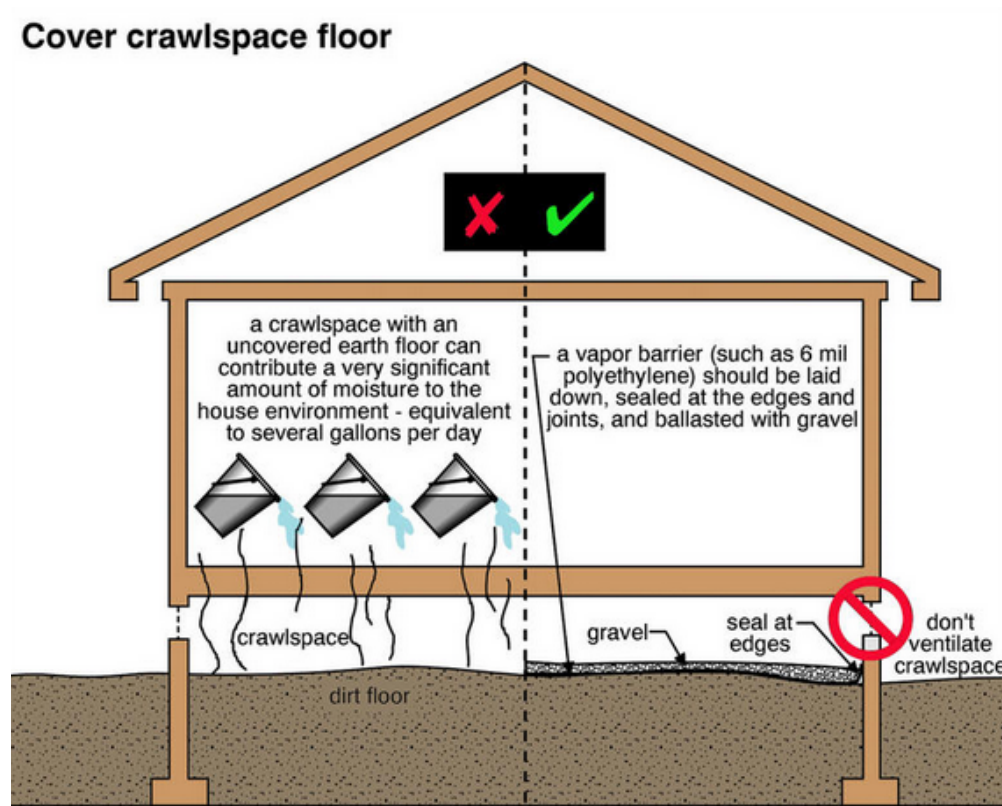
- [mikeb@southface.org](mailto:mikeb@southface.org)
- [skye@bpsgreenhomes.com](mailto:skye@bpsgreenhomes.com)



DRAFT --- The evolution of our crawlspace – tales of an IAQ & energy retrofit process by mike barcik

I've pretty much lived my entire life in older houses over vented crawlspaces – starting with my parents brick ranch built in late 50's, including college rental houses, the 1<sup>st</sup> house I bought, other rentals, and currently our 1,500 s.f. Craftsman bungalow in Decatur, built circa 1920. Without exception, all have had the air handler and ductwork located in the crawlspace, which is generally good from an air conditioning standpoint since they are not located inside the hot attic, but generally bad from an indoor air quality standpoint, since vented crawlspaces are moldy and that's a big allergy issue for me.

### Cover crawlspace floor



In the early days of 2000, just after we moved into our home, the basic state of our crawlspace was fixed vents, no real plastic ground cover, and R11 unfaced batts falling down in many places. Our foundation was constructed as a pier and beam structure with the exterior perimeter bricked in (probably at a later date) – typical vents had been added. The existing HVAC equipment was two 10 SEER, 2-ton air conditioners each with 80% AFUE furnaces. At some point in its life, our home had been turned into a duplex and later back into a single family home.

My wife Tiffany and I put down 6-mil (mesh reinforced) poly on the ground and I invested some effort in air sealing the more obvious targets for holes – mainly under plumbing. These openings were largely due to various retrofits that had occurred over the years, and many of those were huge – the hole under one of the bathtubs was probably 18" square!





*My surprise "helper"*

Another project was rerouting our dryer vent down and out through the crawlspace which involved working around various framing, wiring, and ductwork obstacles as well as coring a hole through the brick wall for a termination device.

Initial duct leakage was ~15-20% leakage to outside. I sealed ducts from the inside of our house by removing the grills and reaching down inside with handfuls of mastic – one system's panned return had separated 1.5" leaving a gaping leak to the crawlspace. And, I sealed some of the more obvious duct leakage points while inside the crawlspace at the air handler – but not really all that much as navigating to and around the air handlers was, and is, a moderate challenge. I also added an additional small return for a back bedroom and rerouted a bathroom supply that had been located directly behind a toilet – likely an outcome of various remodels over the years.



Around 2003 we took advantage of a furnace failure to upgrade one of our two heaters with a 92% AFUE condensing furnace— we received a utility rebate and also added a better, pleated 4" filter. As mentioned, our small house had been subdivided into two dwelling units at one point in its life and so had two separate mechanical systems, each serving ~750 s.f. The interesting result of this is that now that it is a single family residence again, it allows us to have temperature zoning – the left (northern) side is mostly bedrooms and the right (southern) is kitchen, dining, living room, etc.

We also had a very basic French drain installed on the high side of the house, plus routed the gutter downspouts to better drain away from the foundation to lesson exterior moisture risk.

All these improvements were valuable but still our floorboards went through a semi-annual process of expansion and contraction, primarily due to the change in moisture conditions in the vented crawl below. In the winter, cold and very dry air was vented into the crawl and caused the floor boards above to shrink. The opposite was true in the warmer, more humid months.

In 2010 we took advantage of the 30% federal tax incentives plus a \$200 rebate from GEFA and replaced the right side (southern) 80% furnace with a new 95% AFUE furnace with a variable speed blower and 4" pleated filter. Since our two current furnaces were each installed with both intakes and exhaust PVC pipes, the crawlspace now officially no longer needed to be vented in order to provide combustion air.



Working in a reasonably tight crawlspace is fairly labor intensive. In the fall-winter of 2011-12 we outsourced much of the work to a contractor and finally completed the encapsulation of the crawl at a total price of ~\$5,000. I was eligible for and did receive a \$700 rebate from GA Power for performing this upgrade. Their improvement modeling software predicted a 13.9% improvement. Unfortunately, this was not enough to hit the 20, 25, and 30% reduction thresholds required for the "bigger" rebates which reach upwards of \$2,000.

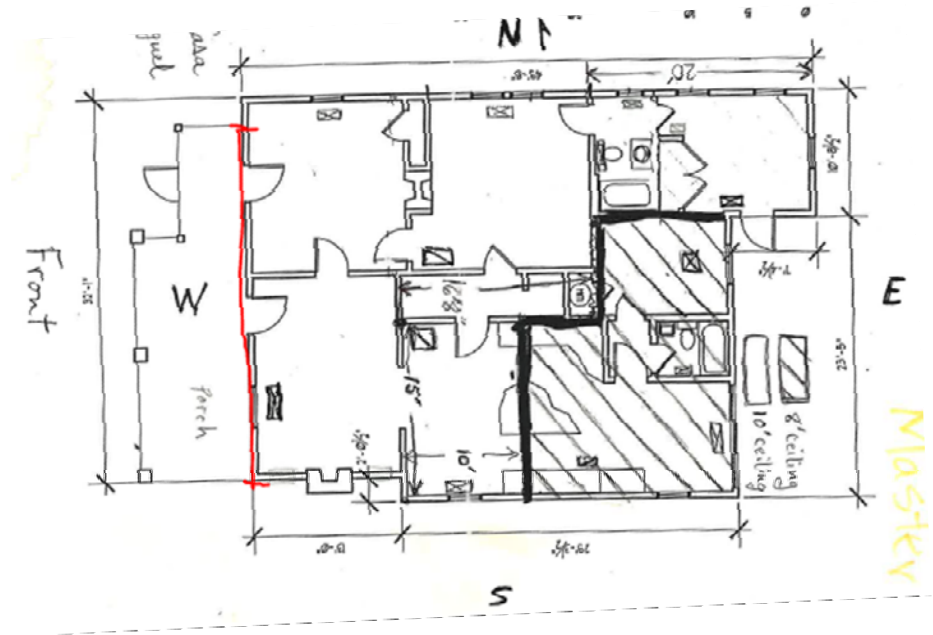
As part of the project, I elected to spend about \$1,000 on mold remediation plus \$450 on having both duct systems cleaned. These, plus removing the old, dirty under-floor batts did wonders for the air quality of the crawlspace and consequently for our living space too.

The remaining money went towards the plastic skirting that was carefully sealed to the walls and piers and connected to the ground vapor retarder as well as the wall insulation (rigid Thermax, ~R5 to R7). The Georgia energy code requires a 3" uninsulated gap just below the bottom of the floor joists to provide a means for visual inspection of termites. Because I did not want to compromise the completeness of the wall insulation coverage, I had a 3" strip of insulation installed that was hinged with a piece of tape. The foam board can easily be opened out for inspection and then folded back for continuous insulation coverage.





Rim joists were sealed and insulated with batts and foam board. I also found more holes in the floor that were now easily observed (they had formerly been covered by batts). These were fairly simple to seal using a foam gun. Because my house features a 30' front porch, it was necessary to frame, sheath, and insulate a separation wall to isolate the vented porch crawlspace from the unvented main portion under the house.



Above: Red line shows location of wall separating house foundation from porch foundation

We definitely encountered some mold in the older duct wrap that was severely compromised at several locations. I have repaired a few pieces but still have others to get to. While it is a much more pleasant place to be, working in the crawlspace still requires a physical effort that is hard to always find the motivation for.

We discovered a disconnected duct that was broken at an elbow gore – the one that I had recently rerouted from behind the toilet to a new location. It had been fairly thickly coated with mastic so it was almost certainly broken by a subcontractor trying to maneuver around it. I considered “arthroscopic” repair by using mastic to glue straps to the inside and securing and sealing it entirely from the inside but in the end I just reconnected and insulated it from the crawlspace side.

We discovered two internal sources of bulk moisture – one from a partially buried former water pipe that was easily fixed by adding a threaded plug at a fitting. The other was a sink water supply leak that was dripping from a poor solder joint. I re-soldered it and so far so good.

Because my crawlspace features three exterior access doors plus another access door to connect with the vented crawlspace under the porch, I made four custom sealed and insulated access doors – each took approximately four to five hours to fully fabricate and install. But, when they are closed and sealed, they are tight and are actually better insulated than the main crawl walls.



I have come to believe that conditioning the crawlspace with a dedicated dehumidifier is the absolute best approach since it is moisture and not temperature that we are trying to control. Particularly with the walls insulated and the ducts running through it, the temperature in the crawlspace will be somewhere between the ground and the floor above – pretty close to room temperature. On a below-freezing day, the air temperature in the crawlspace was <math>< 10^{\circ}</math> F different from the indoor temperature.

I invested \$175 for a 45 pint dehumidifier by Soleus that pulls 570 Watts on high speed (I am running it on low). It was easy to plumb it to drain to the AC condensate pump (which occasionally has had its float switch stick in the on position – odd). I decided to run the dehumidifier on low fan speed for about

a month solid to thoroughly dry out the crawl and to gauge the operating cost which turned out to be about \$1/day. The moisture levels were great after that month and I decided to install a time clock to limit run time to ~6 hours per day in an attempt reduce operating cost.



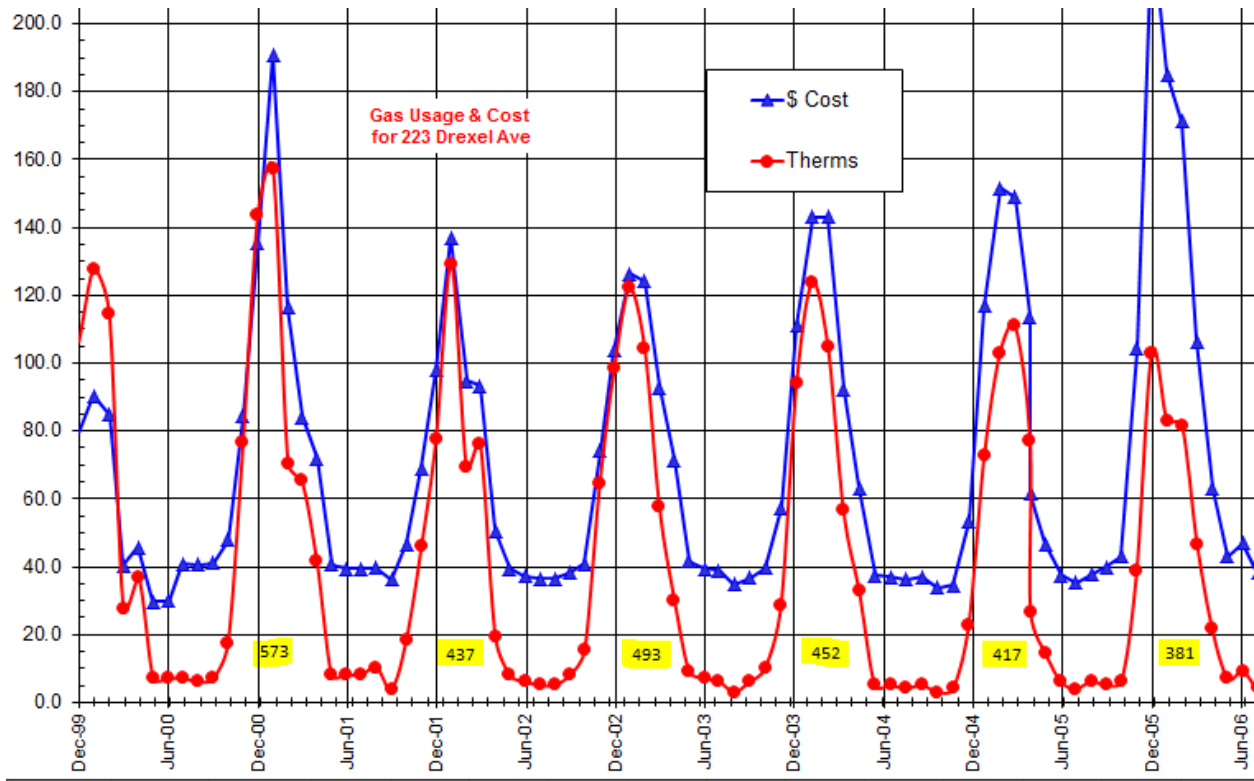
I also have a separate Relative Humidity (RH) sensor with an alarm that will alert me if the moisture levels get too high. So far, only seven hours in the first 200 days have exceeded the 65% RH alarm threshold that I programmed and I believe will prevent mold growth from occurring. Typically the crawlspace RH is ~55% which is where I have set the humidistat on the dehumidifier.



*Sensor with alarm tracks if RH gets above 65%*

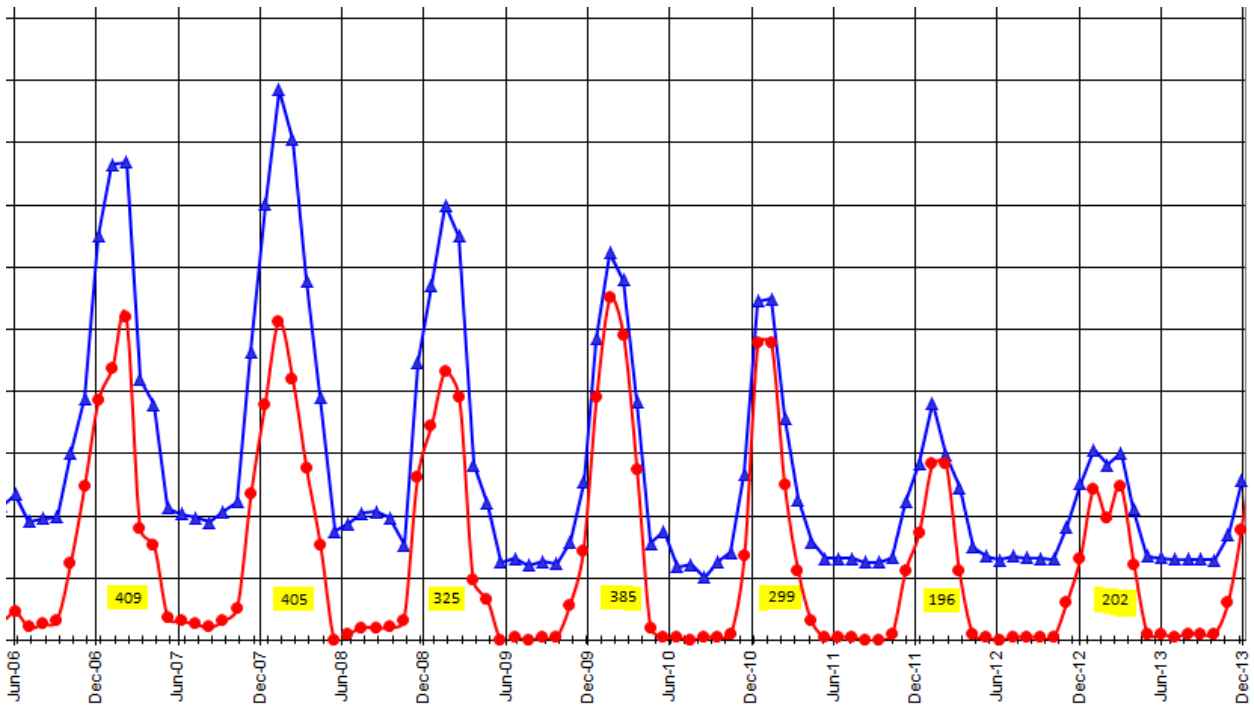
Although it was a pretty mild winter compared to the previous two, on the few cold days we had, I noticed our furnace operation seemed to be significantly less (and our gas heating therms dropped ~35% from 299 in winter 2010-11 to 196 in winter 2011-12 and 202 therms for winter 2012-13). I would expect that usage will go up some as winter 2013-14 appears to be significantly colder.





Above: Gas usage for first seven winters of occupancy (**highlight** values are seven coldest months)

Below: Gas usage for latest seven winters of occupancy (**highlight** values are seven coldest months)



The comfort of the floors and house is noticeably better and we now keep the indoor thermostat setpoint around 68° whereas before we required 70°. And the air quality of the crawlspace is also drastically improved – I can actually go in there without a filter mask!

I've run a HERS analysis using REM/Rate on our home and calculated the HERS Index\* before and after closing up our crawlspace. Before the encapsulation project, our Index was 94, afterwards it dropped to a 70 which represents a 24% improvement. For comparison, when we purchased our home in December of 1999, and before we made any of the numerous improvements, it had an Index of 150 (meaning it used 50% more energy than a 2006 code-based home).

*\* [The HERS Index compares an as-built home's modeled energy consumption for heating, cooling, water heating, lights and some appliances (H+C+W+LA) to a fictitious reference home that is built exactly to meet the energy code (2006 IECC). An Index of 100 means the home uses exactly the same energy as if it were built to code; an Index of 88 means the home uses 12% less energy than a code home while an Index of 112 means the home uses 12% more.]*

In the fall of 2012, I decided to add four small recirculation fans in two different locations that operate on the same six hour (timer controlled) cycle as the dehumidifier. They are similar to a computer fan, are very low power draw and quiet – they are placed in two different locations around the crawlspace to help stir the air within the crawlspace and only pull minimal watts per pair. Especially since there is no longer under-floor insulation acting as an acoustical buffer, the dehumidifier is a little noisy and can be heard operating while inside the home (along with the occasional run of the condensate pump). In this case, having the time clock operate the recirculation fans and dehumidifier during active daylight hours (~9 am to 3 pm) ensures that noise isn't an issue.



In Jan 2013, I retested for radon levels inside the living area of the home. The previous test done in January 2010 yielded fairly low levels (2.3 pico-curies/L) back when the crawl was still vented. Fortunately, the newest test results are still fairly low (2.8 pico-curies/L); if they were confirmed to be above action levels (4 pico-curies/L), we would likely add a perforated pipe under the plastic that is then vented up and to the outside above the roofline; we'd install a continuously operating inline radon fan if necessary.

I'm somewhat regretting that I didn't have the old duct wrap removed – there is mold in the fiberglass that sometimes comes loose and gets airborne. I have rewrapped certain portions but a few sections still are uninsulated and the majority of the existing duct wrap is pretty old. Fixing old metal ducts (mainly sealing and re-insulating) is certainly a lot of work but I'm definitely glad I've kept them due to the exceptional airflow they provide.

The spring and early summer of 2013 was extraordinarily wet – we actually had more rain by the end of June 2013 than we had all year in 2012. Many normally dry Atlanta homes featured wet basements and crawlspaces and there was a definite spike in mold & moisture problems. Our standard cooling strategy of not running the a/c and night flushing the house with the whole house fan probably went on too long as we had some surface mildew growing on leather shoes inside a closet – problems we never experienced in 13 previous years.

Because of the excessive rainfall, at some point I became concerned that up to six hours per day of crawlspace dehumidifier runtime might not be enough – I checked my RH data logger and sure enough, 65% RH had been exceeded for a few hours so we likely pushed the edge of mold growth (~70% RH) in the crawlspace. I switched the time switch to on which allowed the dehumidifier to run as much as it needed (its setpoint is 55% RH) and left it alone for about a month before changing back to the time clock mode – no other hours above 65%RH were logged and it has performed fine since the second half of 2013 was a more typical year.

A house like ours is an eternal project but we are thrilled that our energy footprint, indoor air quality, and wintertime comfort has improved so much.

Notes: I installed our gas dryer in April 2013 – since encapsulated, it was easier to work in crawlspace to run the gas line. The dryer vent later turned out to be restricted by lint buildup after over a decade of use – again fairly accessible to remove portions, clean out, then reassemble. Next big project – install ERV in spring 2014.