CRAWL SPACE SCIENCE

Crawl Space Vents: Open or Closed?

Why seasonal vent management fails in the hot, humid coastal Southeast, what the field research and federal programs show, and how to close a crawl space so it stays dry.

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Wet, not dried. A vented crawl space in summer: water on the ductwork, puddles on the vapor barrier, and saturated insulation hanging from the floor framing.

Summary

For generations, homeowners have been told to open their crawl space vents in summer and close them in winter. In the hot, humid coastal Southeast, neither half of that advice keeps a crawl space dry. In summer, outdoor air often carries more moisture than the air already under the house, and it condenses on cooler ductwork, framing, and floors. In winter, the same vents bring in cold air, chilling the floor and raising heating demand.

This paper recommends permanently sealing foundation vents in this climate as part of a complete moisture-control system: correct any drainage problems, remove significant contamination, install a ground vapor barrier, seal the exterior openings, provide a reliable drying mechanism, and verify the result with wood moisture readings. It draws on HUD-funded field research by Advanced Energy and Duke University, a DOE-funded side-by-side study of closed and vented crawl spaces, DOE Building America guidance, the EPA's Indoor airPLUS requirements, the International Residential Code, and the author's observations from more than 600 crawl space inspections a year.

Key findings

- Of 45 vented North Carolina crawl spaces studied in 2005, **62%** had visible mold and **67%** had mold-supporting wood moisture. **100%** of June–July humidity readings were at or above 70% RH.
- Dew point measurements showed summer outdoor air was wetter than crawl space air. Venting had no potential to dry the crawl spaces in summer.
- In DOE-funded research at Princeville, North Carolina, properly closed crawl spaces were substantially drier than code-standard vented ones.
- DOE Building America, EPA Indoor airPLUS, and the IRC (since 2003) all support closed crawl spaces. Indoor airPLUS does not permit vented ones.
- Sealing the vents alone is not enough. A closed crawl space needs a drying mechanism and verification; controlled crawl spaces average **10–12%** wood moisture.

1. Why crawl space vents were required

The logic of the vented crawl space is straightforward. Moisture evaporates from the soil beneath a house. Foundation vents were expected to let outside air in, carry that moisture away, and keep the framing dry. Under the right conditions, in the right climate, that can work.

Vented crawl spaces became common long before central air conditioning was widespread. Houses operated differently, and construction practices were not the same as today's. Ventilation requirements were written into national codes in the mid-20th century, based on moisture studies from regions drier and colder than the coastal Southeast.

The advice to open vents in summer and close them in winter was passed down from one generation to the next. Before field studies and building science research were widely available, most people learned crawl space practice from those who came before them. A rule of thumb can become outdated when the conditions it was based on change, and in the humid Southeast, with air-conditioned houses sitting over vented crawl spaces, the conditions have changed.



Figure 1. The old rule was taught at the foundation wall (left). A typical wall-vented foundation in coastal Virginia (right).

2. The mechanism: dew point and condensation

Outdoor air does not dry a crawl space in summer because it is often carrying more moisture than the air already under the house.

Consider a July afternoon in coastal Virginia. It may be **95°F** outside with high humidity, and the air conditioning is running inside. The floor system above the crawl space is chilled from above by the conditioned house. Supply ductwork running through the crawl space carries air at roughly 55°F. The ground beneath the house is cooler than the summer air.

When the foundation vents are open, that hot, humid outdoor air enters and cools. As it cools, its relative humidity rises. When it contacts a surface below its dew point, the water vapor condenses into liquid water. It is the same reason a cold can of soda sweats on a humid day: the water is not leaking from the can, it is condensing out of the surrounding air.

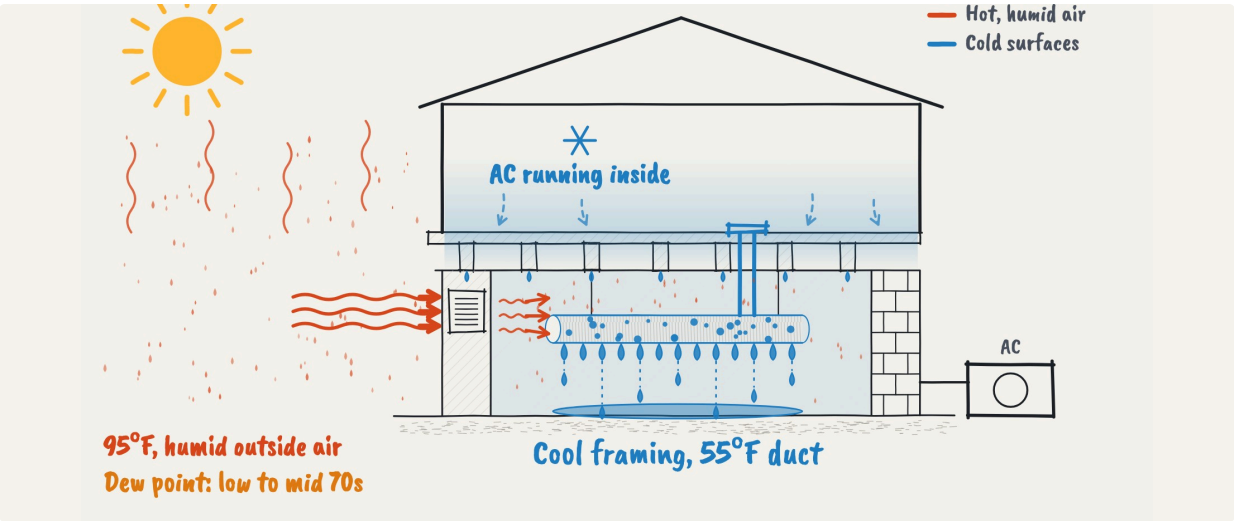


Figure 2. A vented crawl space on a July afternoon. Hot, humid outside air (red) enters through the foundation vent and condenses on the cold supply duct and cool floor framing (blue).

The result is visible in the field: ductwork dripping with condensation, puddles on top of vapor barriers, mold and fungus on floor joists and subflooring, wet fiberglass insulation hanging from the framing, and moldy ductwork and deteriorating wood. None of this requires a plumbing leak or groundwater. In many cases, the moisture comes from the same outdoor air the vents were supposed to use to dry the crawl space.



Figure 3. Left: wet, sagging insulation and staining on the floor framing. Right: mold on floor joists and subflooring. Photos: Patriot Crawl Space Repairs.

3. Field evidence: 45 vented crawl spaces

In 2005, Advanced Energy studied 45 wall-vented crawl spaces in Durham, New Hanover, Wayne, and Wilson counties, North Carolina, as part of a larger Duke University study funded by the U.S. Department of Housing and Urban Development (HUD) [1, 2]. The findings describe the normal condition of a vented crawl space in this climate.

Measure	Result
Crawl spaces with visible mold	**62%**
Crawl spaces with wood moisture readings at mold-supporting levels (19% or greater)	**67%**
June and July crawl space humidity readings at or above 70% RH	**100%**
August crawl space humidity readings at or above 70% RH	**99%**

More important than the humidity readings, the researchers calculated dew point, which measures the absolute amount of water in the air. Relative humidity alone can mislead: outdoor air often has a lower relative humidity than crawl space air, which makes it look drier. Dew point showed the opposite.

> *"Results showed that venting crawl spaces with outside air does not dry the crawl space nor does it have the potential to dry the crawl space during the summer months. Summer outdoor air was confirmed to be wetter than crawl space air and outdoor dew point temperatures frequently exceeded crawl space temperatures, potentially resulting in condensation."*
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> Advanced Energy, Long-Term Temperature and Relative Humidity report, Executive Summary, 2005 [2]

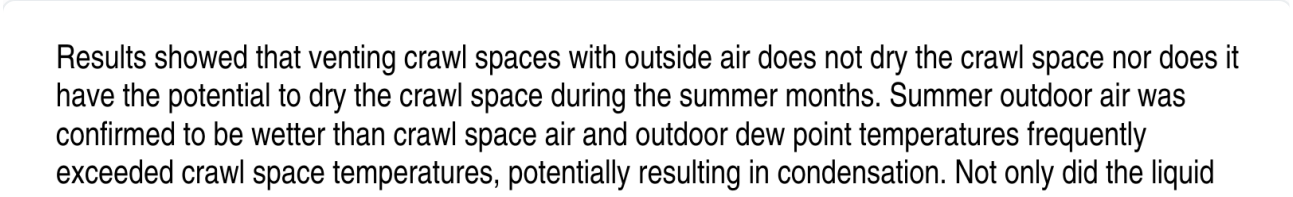

Results showed that venting crawl spaces with outside air does not dry the crawl space nor does it have the potential to dry the crawl space during the summer months. Summer outdoor air was confirmed to be wetter than crawl space air and outdoor dew point temperatures frequently exceeded crawl space temperatures, potentially resulting in condensation. Not only did the liquid

Figure 4. Executive summary of the long-term temperature and relative humidity report, Duke University / HUD crawl space study [2].

4. Closed versus vented: the Princeville study

In a separate DOE-funded field study, Advanced Energy built and monitored matched houses on a single cul-de-sac in Princeville, North Carolina, comparing code-standard wall-vented crawl spaces with closed crawl spaces [3]. These were measurements in occupied houses over multiple years, not computer models.

> *"Findings indicated that in the humid conditions of the southeastern United States, a properly closed crawl space is a robust construction measure that produces a substantially drier crawl space and significantly reduces occupied space conditioning energy use on an annual basis."*
>
> Advanced Energy, Ventilated Versus Sealed Crawl Spaces in the South, U.S. DOE, 2005 [3]

The report's conclusion on the vented control houses is direct: the crawl spaces built to the default code requirements for ventilation "became wetter rather than drier from the exchange of air for the duration of the summer seasons" [3].

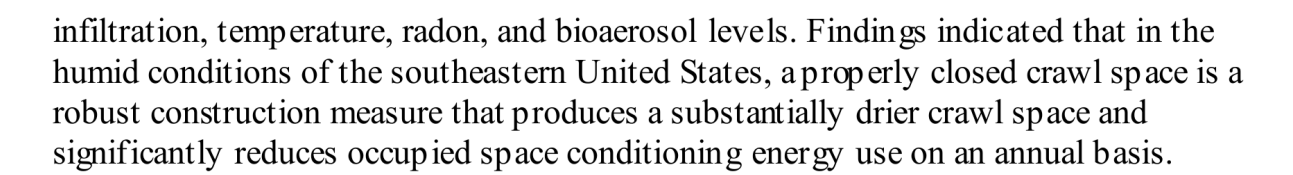

infiltration, temperature, radon, and bioaerosol levels. Findings indicated that in the humid conditions of the southeastern United States, a properly closed crawl space is a robust construction measure that produces a substantially drier crawl space and significantly reduces occupied space conditioning energy use on an annual basis.

Figure 5. Princeville field study abstract [3].

5. Federal guidance

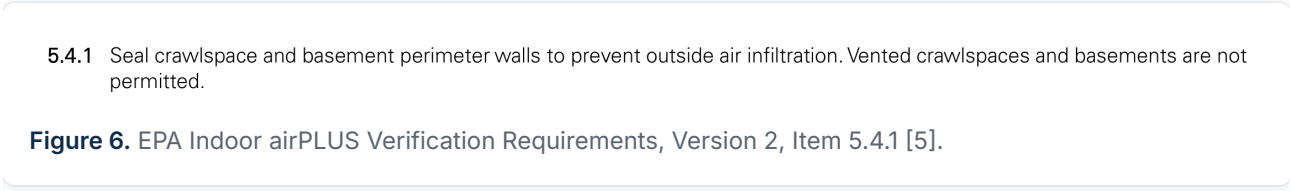
DOE Building America

The Department of Energy's Building America program has published guidance on closing and conditioning ventilated crawlspaces. It states the problem plainly:

> *"Research has shown that vented crawlspaces located in mixed or hot-humid climates tend to increase the moisture level within the space instead of keeping it drier. This increased moisture then condenses on the colder wood surfaces of the floor framing, promoting fungal growth and wood damage."*
>
> IBACOS for U.S. DOE Building America, Guide to Closing and Conditioning Ventilated Crawlspaces, 2013 [4]

EPA Indoor airPLUS

The EPA's Indoor airPLUS program does not permit vented crawl spaces in qualifying homes. Item 5.4.1 requires crawl space perimeter walls to be sealed against outside air infiltration. Item 4.2.3 requires that, in moist and marine climate zones, a crawl space not served by a cooling system with humidity controls be provided with active dehumidification that maintains relative humidity at or below **60%** [5].



5.4.1 Seal crawlspace and basement perimeter walls to prevent outside air infiltration. Vented crawlspaces and basements are not permitted.

Figure 6. EPA Indoor airPLUS Verification Requirements, Version 2, Item 5.4.1 [5].

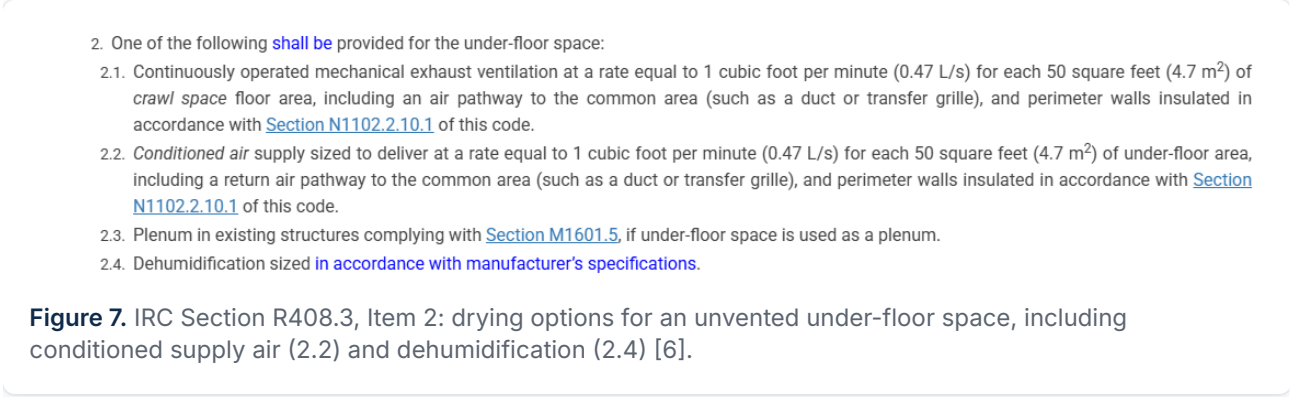
HUD

The HUD-funded research described in Section 3 documented moisture failures in traditional vented crawl spaces throughout the humid summer months [1, 2]. This evidence has been available for two decades. Vented crawl spaces are still permitted and built across the Southeast.

6. Why the code still allows vented crawl spaces

Model building codes are written for an entire country with very different climates. A crawl space in Colorado does not experience the same summer moisture conditions as one in coastal Virginia. States adopt thousands of pages of model code, and established construction methods can persist long after research becomes available.

The International Residential Code has allowed unvented, conditioned crawl spaces since 2003. Section R408.3 requires a continuous Class I vapor retarder over exposed earth, and one of several drying methods for the under-floor space, including conditioned supply air and dehumidification [6]. Sealing a crawl space has been code-approved for more than 20 years.



2. One of the following shall be 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 (4.7 m^2) of *crawl space* 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 N1102.2.10.1 of this code.
   - 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^2) 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 N1102.2.10.1 of this code.
   - 2.3. Plenum in existing structures complying with Section M1601.5, if under-floor space is used as a plenum.
   - 2.4. Dehumidification sized in accordance with manufacturer's specifications.

Figure 7. IRC Section R408.3, Item 2: drying options for an unvented under-floor space, including conditioned supply air (2.2) and dehumidification (2.4) [6].

In the author's opinion, builder resistance to added cost and reluctance to acknowledge past problems also play a role. But the fact that an assembly is allowed by code does not mean it is the best-performing design for a given climate.

7. Automatic vents, vent fans, and humidistats

Automatic foundation vents

In the author's inspections, automatic vents are frequently found with rusted mechanisms, stuck open or closed, or with hardware that no longer holds them securely. Even when they work as designed, most automatic vents open and close on temperature. They do not measure how much moisture is in the outdoor air, so they can open on a hot, humid summer day, exactly when that air should be kept out.

Powered ventilation fans

In a dry climate, crawl space ventilation fans may be useful. In the humid coastal Southeast, increasing outdoor airflow can make the problem worse. If the incoming air carries more moisture than the crawl space air, moving more of it through the foundation increases the moisture load.

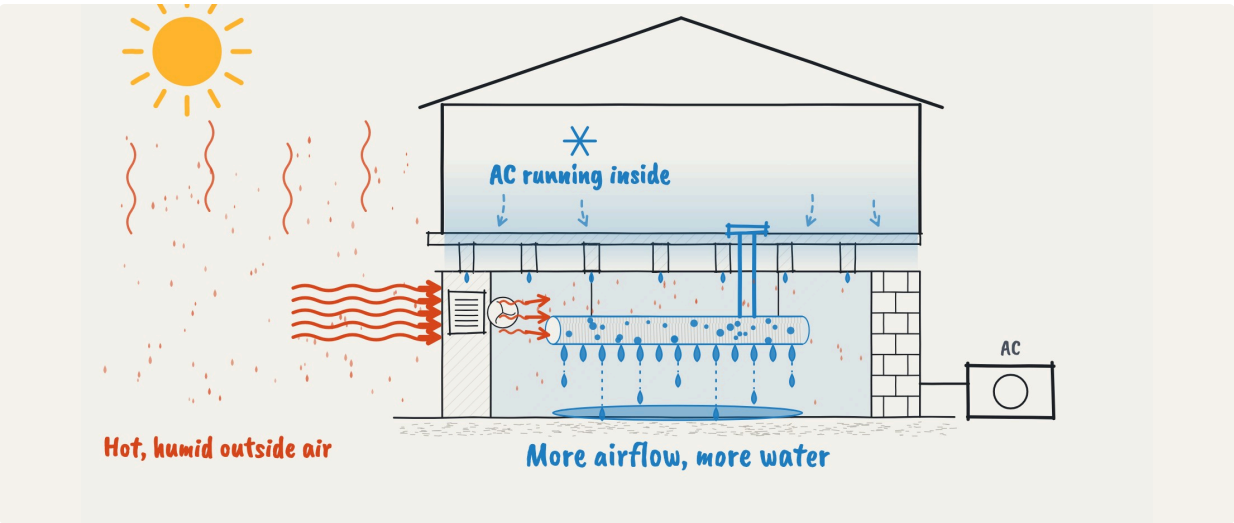


Figure 8. A powered vent fan pulls more humid outside air into the crawl space, increasing condensation on cool surfaces.

Humidistats

A humidistat-controlled fan does not necessarily solve this. Relative humidity alone does not indicate which air contains more water vapor; warmer air can have a lower relative humidity while holding more water. The correct comparison is dew point, as the HUD-funded research demonstrated [2].

8. Seasonal vent management

Closing vents in summer and reopening them in winter fails the other half of the year. In winter, ventilation brings cold air into the crawl space and makes the floors colder, especially where the floor insulation has already deteriorated, increasing heating demand.

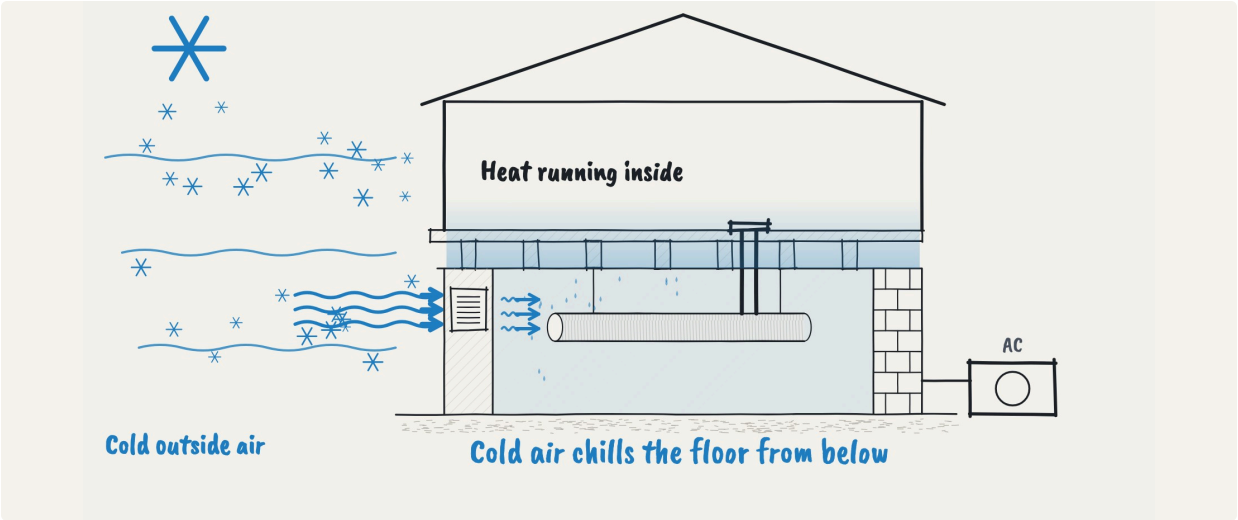


Figure 9. Winter: cold outside air (blue) enters through open vents and chills the floor system from below while the heat runs inside.

The vents should be kept closed year-round. A homeowner who is not ready for a complete system can close the vents, place a sensor in the crawl space to watch temperature, humidity, and dew point, and check wood moisture. That is a stopgap, not a system.

9. Recommended assembly for the coastal Southeast

For a typical low crawl space in the coastal Southeast, the author recommends a simple system:

1. **Correct groundwater and drainage problems first.** Bulk water must be handled before the space is closed.
2. **Remove significant contamination.** Remove significant mold growth, damaged insulation, and other deteriorated materials.
3. **Install a durable ground vapor barrier** to control evaporation from the soil.
4. **Seal the foundation vents**, access door, utility penetrations, and other unwanted exterior openings, with particular attention to rodent entry points.
5. **Provide a reliable drying mechanism.** Where suitable HVAC ductwork is available, the author generally prefers a small amount of conditioned supply air, because the system is simple and requires very little maintenance. Otherwise, a dedicated crawl space dehumidifier is a good option.

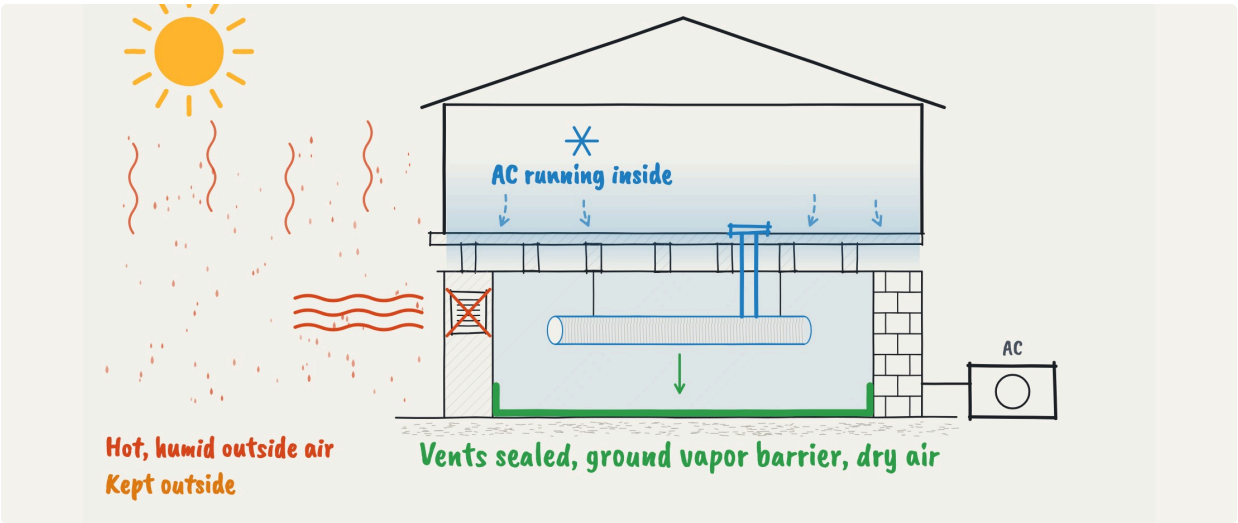


Figure 10. The closed crawl space: vents sealed so humid outside air stays outside, a continuous ground vapor barrier, and dry air supplied to the space (green).



Figure 11. Drying mechanisms. Left: a conditioned supply-air tap from the duct trunk. Right: a dedicated dehumidifier in a closed crawl space.

10. Verification

A closed crawl space should be verified, not assumed. The measure that matters most is wood moisture content in the framing.

Condition	Wood moisture content
Properly controlled crawl space, typical average (author's field readings)	**10–12%**
Properly controlled crawl space, occasional summer highs	**15–16%**
Mold-supporting level used in the HUD-funded study [1]	19% or greater



Figure 12. Left: a 10.5% wood moisture reading on framing in a controlled crawl space. Right: a temperature, humidity, and dew point monitor, useful for verification and as a stopgap.

Simply sealing the vents may work in some homes, but without a dedicated drying strategy the remaining moisture is left to incidental air leakage. DOE Building America guidance makes the same point: retrofitting a vented crawlspace "requires more than just sealing off the vent openings," and simply sealing the vents without addressing other details "could make the situation worse, increasing the levels of moisture" [4].

11. Exceptions and design considerations

Some houses require a different design. These are design conversations, not reasons to leave vents open.

Flood-prone foundations. Homes in designated 100-year flood zones may need insulated, weather-stripped flood vents to meet both flood requirements and closed crawl space requirements [5].

Combustion appliances. Naturally drafting combustion equipment located in a crawl space depends on that space for combustion air. DOE Building America warns that sealing the vents without addressing it can create "a deadly situation" [4]. Such equipment must be replaced with sealed-combustion or direct-vent equipment, or relocated, before the crawl space is closed.

Radon. Where radon is a risk or the local code requires soil-gas control, houses with closed crawl spaces must be tested and monitored, with mitigation installed if necessary [4].

Other climates. The recommendations in this paper are for the hot, humid coastal Southeast. Drier and colder climates have different moisture conditions and may call for different approaches.

12. Conclusion

In the hot, humid coastal Southeast, traditional crawl space ventilation is a failed moisture-control strategy. Opening vents in summer introduces the moisture the vents were meant to remove. Opening them in winter brings in cold air.

Foundation vents should be permanently sealed as part of a complete moisture-control approach: drainage corrected, contamination removed, a ground vapor barrier installed, exterior openings sealed, and a reliable drying mechanism provided. Conditions should then be monitored to verify that it works. That is what the field research supports, what federal programs require, what the residential code has permitted for more than two decades, and what the author has found works in the crawl spaces his company repairs.

References

[1] Advanced Energy. 2005. *Crawl Space Characterization.* Report submitted to Duke University and the U.S. Department of Housing and Urban Development. Raleigh, NC. September 30, 2005.

[2] Advanced Energy. 2005. *Long-Term Temperature and Relative Humidity.* Report submitted to Duke University and the U.S. Department of Housing and Urban Development. Raleigh, NC. September 30, 2005.

[3] Davis, B., Dastur, C., and Warren, W. 2005. *A Field Study Comparison of the Energy and Moisture Performance Characteristics of Ventilated Versus Sealed Crawl Spaces in the South.* Advanced Energy, for U.S. Department of Energy, National Energy Technology Laboratory. DE-FC26-00NT40995. osti.gov/biblio/850459

[4] Dickson, B. 2013. *Guide to Closing and Conditioning Ventilated Crawlspaces.* IBACOS, Inc., for U.S. Department of Energy Building America Program. nrel.gov/docs/fy13osti/54859.pdf

[5] U.S. Environmental Protection Agency. 2024. *Indoor airPLUS Verification Requirements, Version 2.* Items 4.2.3 and 5.4.1. epa.gov/indoorairplus

[6] International Code Council. *International Residential Code*, Section R408.3, Unvented crawl space. codes.iccsafe.org

About the author



Robbie McCarty is the owner of Patriot Crawl Space Repairs in Hampton Roads, Virginia. He personally inspects more than 600 crawl spaces a year and has been involved in building, renovating, inspecting, and selling hundreds of homes across roughly three decades in Virginia construction and real estate. He holds a Virginia Class A contractor's license, a master plumber license, a licensed pest control operator credential, and MICRO certification as a mold remediation contractor.

His company specializes in structural repair, mold remediation, and moisture control in the hot, humid coastal Southeast. His Crawl Space Science video series and technical papers document what works, and what does not, in this climate.

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