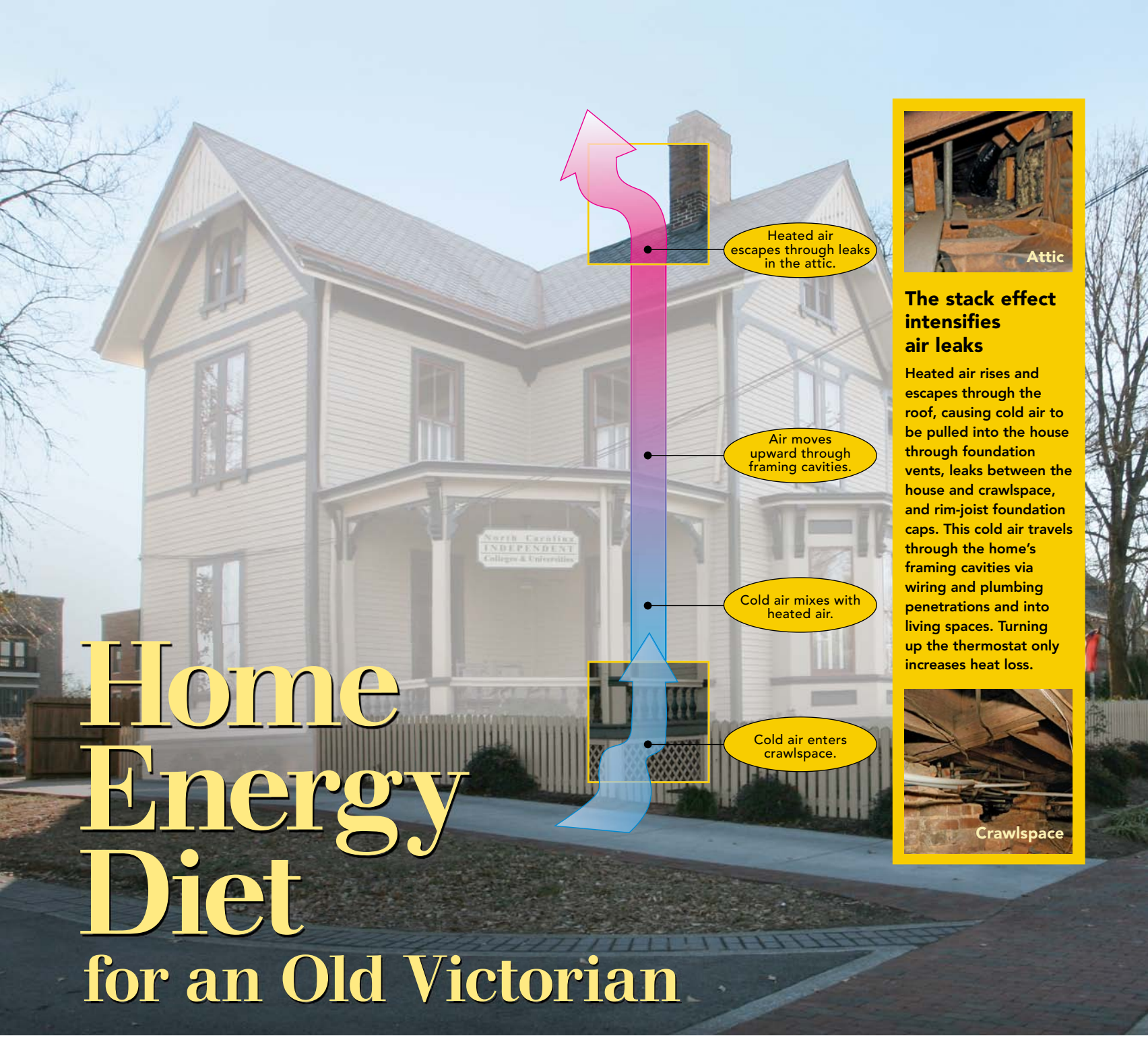


Home Energy Diet for an Old Victorian

Sealing the crawlspace and plugging holes cut a big home's heating bill in half

BY JEFF TOOLEY

The stack effect intensifies air leaks

Heated air rises and escapes through the roof, causing cold air to be pulled into the house through foundation vents, leaks between the house and crawlspace, and rim-joist foundation caps. This cold air travels through the home's framing cavities via wiring and plumbing penetrations and into living spaces. Turning up the thermostat only increases heat loss.

For nearly 20 years, my company has been diagnosing and fixing buildings with comfort, moisture, and energy-consumption problems. We're best known for sealing vented crawlspaces, but we also seal and repair leaky buildings and teach others to do the same at clinics and trade shows around the country. Often, the toughest part of my job is helping people to understand what's going on with their building and why my fix will work when past fixes have not. This recent job is typical of what I do.

I was called to an old Victorian house in downtown Durham, N.C. The attractive, three-story structure, which is now used as commercial space, was uncomfortably cold during the winter. Despite having four gas furnaces (350,000 Btu) to heat the 2800-sq.-ft. build-

ing, the occupants couldn't get the indoor temperature above 65°F when it was below freezing outside.

The client first called an insulation contractor, who said he couldn't help because the spaces with the insulation problems, including attic kneewalls and attic spaces over room additions, were inaccessible.

When I toured the building, I agreed that the areas identified by the insulation contractor were likely culprits in the building's heat loss, but I didn't agree that the spaces were inaccessible. I've cut holes in walls and ceilings to get at "inaccessible" spaces more times than I can count. Also, I didn't think that these leaky, underinsulated spaces were the building's only problems.

Another major concern was the house's vented crawlspace, which was within a degree or two of the outside temperature all winter long. This space contains uninsulated ductwork and a large number of open wall cavities, chases, and many other penetrations into the house.

I submitted a proposal to the client promising that heating costs would be half their current level and that the occupants no longer would need to wear multiple layers of clothing inside the building just to keep warm. When I didn't hear anything for several weeks, I assumed that the client had decided to ride out the winter, but when a stretch of unusually cold weather resulted in an $800 gas bill for the month of December 2010—and the building's occupants were still uncomfortable—the client asked me to get started as soon as possible.

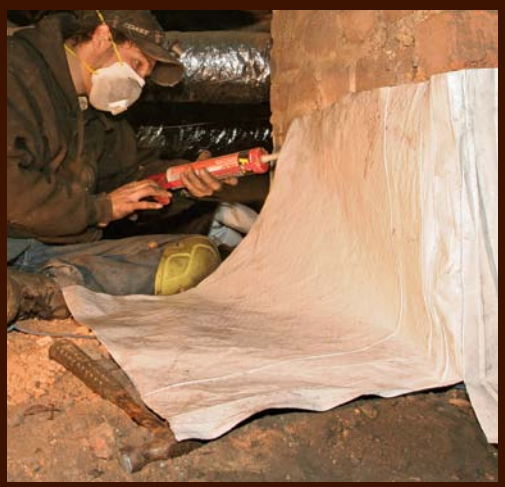
A clean crawlspace first

We began by cleaning all of the debris inside the crawlspace so that we wouldn't be hurt by various objects, such as sharp rocks, and so that these same objects

SEALING A DRAFTY CRAWLSPACE

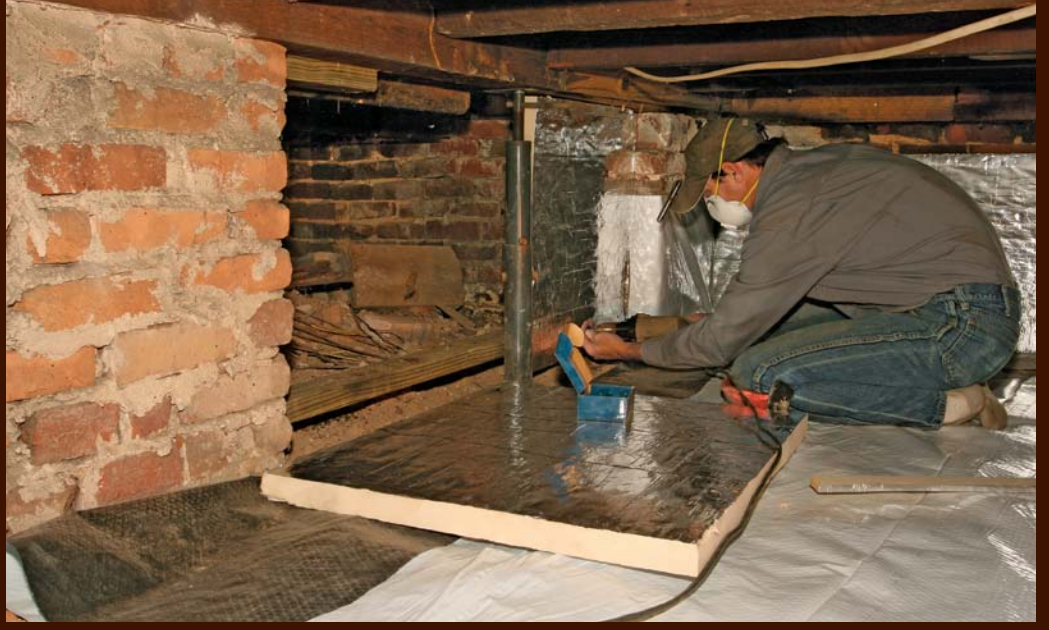
This basement crawlspace was within a few degrees of the outside temperature throughout the winter. The cold air reduced the air temperature in the uninsulated ductwork and, aided by the stack effect, circulated throughout the house through numerous holes (some very large) in the crawlspace ceiling.

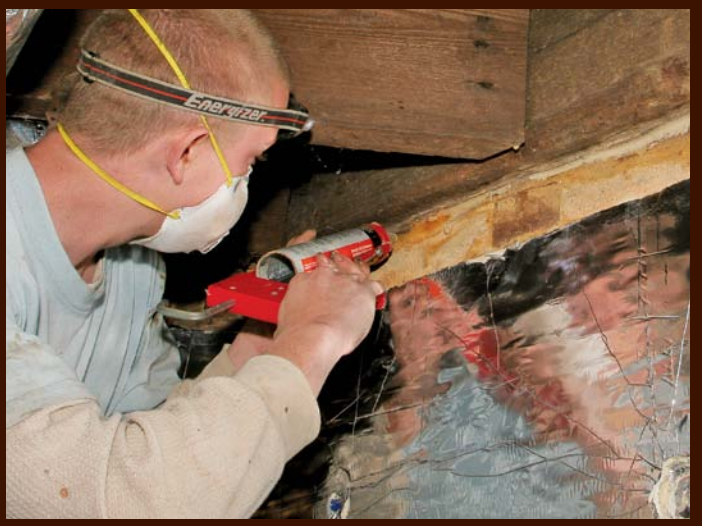
1 ***Start with cleanup.*** *The first step in sealing a crawlspace is to remove all debris, manmade and otherwise (see inset photo), so that it doesn't damage the plastic liner that eventually will cover the floor. A good dust mask is a must as mold spores are likely.*



2 ***Cover the walls.*** *The foundation walls are covered with 12-mil reinforced poly sheeting to stop the flow of air and moisture into the crawlspace. The poly is held in place with a thick bead of solvent-based construction adhesive.*

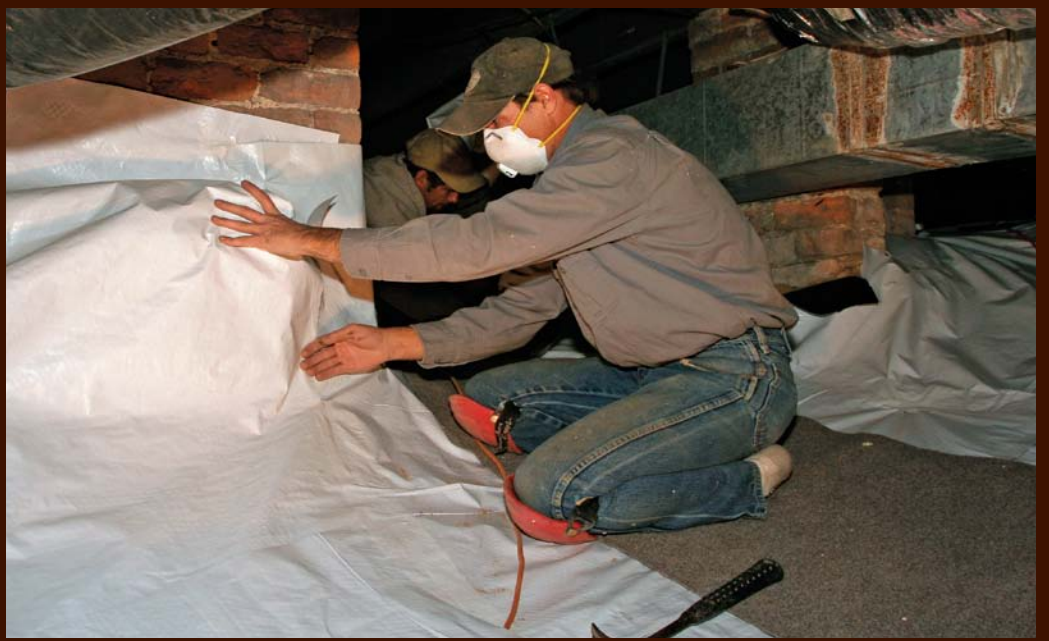
3 ***Insulation prevents heat loss.*** *A layer of 1½-in., foil-faced polyisocyanurate is put over the poly sheeting. The insulation is held in place with 2½-in. powder-actuated pins with 2-in. washers. Seams are covered with 2-in. foil tape.*





4 ***Separate inside from outside.*** *Built with rigid insulation, pressure-treated lumber, and canned spray foam, walls separate the cold outdoor spaces under a pair of porches from the conditioned crawlspace.*

5 ***Caulk the mudsill and insulate the band joist.*** *The mudsill is sealed with polyurethane construction adhesive, which sticks better than anything else the author has tried. The band joist then is insulated with foil-faced fiberglass insulation.*



6 ***Cover the soil.*** *A heavy-duty reinforced plastic liner is placed on the crawlspace's dirt floor. Seams are covered with special tape, and the plastic is lapped onto the brick piers that support the house. The laps are first glued to the piers with solvent-based construction adhesive and then secured with the seam tape. At one time, the author used troweled mastic for sealing seams, but the tape is neater, is faster, and performs just as well.*

wouldn't damage the plastic liner that would later cover the dirt floor.

Once the space was clean, we began covering the masonry with 12-mil reinforced polyethylene sheeting (www.crawlspacedepot.com.) as a way to stop groundwater infiltration. We installed the poly sheeting on the brick foundation wall with a solvent-based construction adhesive and also lapped it onto the dirt floor by about 12 in. We worked in 5-ft. to 10-ft. sections and then covered the plastic with fire-rated, foil-faced polyisocyanurate insulation secured with powder-actuated pins equipped with 2-in. washers. The foil tape we applied to all the insulation seams further reduces air infiltration. Both the insulation and the sheeting cover the existing foundation vents.

We typically keep both the poly sheeting and the polyiso insulation down about 3 in. from the top of the wall so that exterminators can look for termite tubes. Subterranean termites and most other destructive insects in our region need moisture and wet wood to survive. We often find that once we've dried and sealed a crawlspace, the bugs go away.

Close porch connections

This house has two porches that share the same foundation as the rest of the house, so there was no separation between the porch crawlspaces and the house's crawlspace. To keep cold air that seeps under the porch from entering the crawlspace and spreading throughout the house, we needed to create some kind of separation between the porch crawlspace areas and the rest of the crawlspace. We decided to build a wall of pressure-treated 2x4s and polyiso sheathing. We capped this wall with a termite shield and sealed the perim-

3 WAYS TO STOP AIR IN ITS TRACKS

Unconditioned air moving from vented attics and crawlspaces through framing cavities is a notorious energy waster. The author uses three methods to seal these cavities. Many projects require a combination of methods; he used all three on this house.

Block with rigid foam

Plug joist cavities with rigid foam. *The filthy insulation shows that dirt-laden air has moved through this space for decades. The easiest way to solve the problem is to cut and fit rectangular pieces of rigid foam in each joist bay. Spray foam holds it in place and seals the perimeter.*

eter and gaps with some canned spray foam.

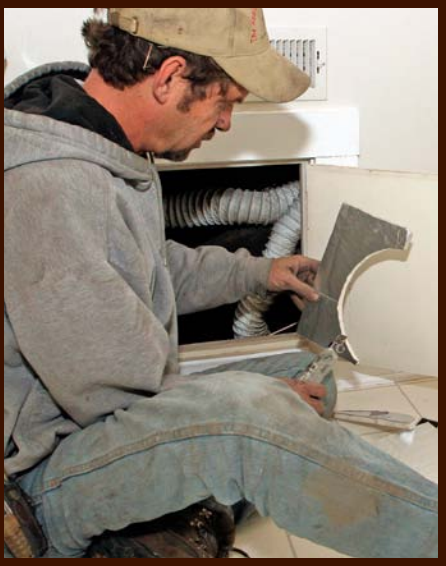
Thick plastic liner stops air and moisture

With work on the walls completed, we turned our attention to installing a heavy-duty 12-mil reinforced poly vapor retarder and air barrier on the dirt floor of the crawlspace. We rolled out the 12-ft.-wide pieces of poly and used a wide, extrasticky tape to cover the seams. We brought the liner up the sides of the masonry piers and lapped it over the polyiso that we previously had installed on the foundation walls. The seams on these areas also were taped. The last step in each section was to drive 5-in. galvanized spikes through the plastic into the ground. We used these spikes to prevent the plastic liner from billowing up from the air pressure created by the cracks and gaps in the masonry foundation and from the stack effect. Once we had gotten the plastic on the ground, our work in the crawlspace became a lot more pleasant. In fact, we begin working in our socks so that the surface would stay clean and damage free.

Seal holes above

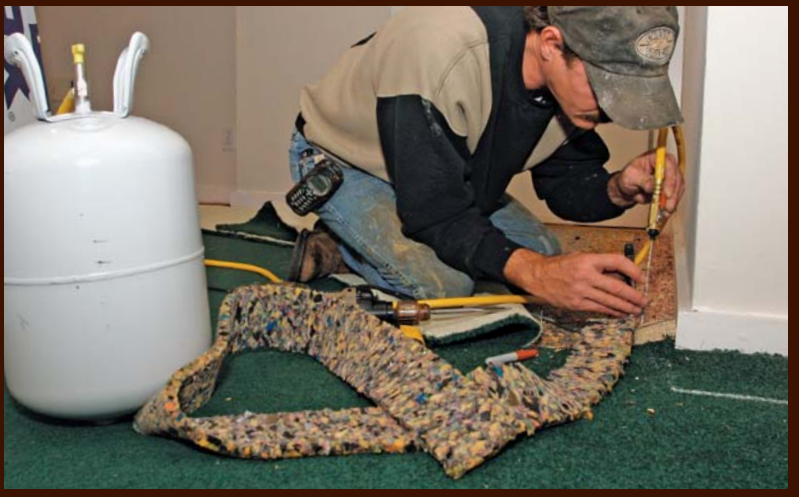
Next, we turned our attention to sealing the holes in the floor above the crawlspace. We used

Seal the kneewall floor



Seal the ceiling or floor. *When the joist bays are blocked with pipes or ductwork, seal the floor around them to stop air movement. Here, the author is cutting foam to fit around insulated flexible duct. For maximum benefit, the gaps between floorboards must also be filled with foam.*

Fill the joist cavity with spray foam



Fill with foam. *When access to cut and fit foam is impossible, foam can be injected into the joist cavity through holes drilled in the subfloor. The author drills three 1-in. holes about 4 in. apart: two holes for filling and one for observing the foam while it's being injected.*

rigid insulation and canned foam for large holes, and canned foam alone for small holes. We generally find small holes around every pipe and wire and bigger holes around waste stacks and under bathtubs. In this house, there was an 18-in. by 24-in. hole under the tub—equivalent to leaving a medium-size window open all year. We seal around chimneys with metal flashing and fire-rated foam, identified by its red color.

Stop air movement at the mudsill and band joist

With this work done, we caulked between the mudsill and the masonry foundation walls with polyurethane construction adhesive, which sticks better than anything else we've tried in spots like this.

Finally, we insulated the band joist with foil-faced fiberglass. In years past, we used the same foil-faced polyiso as on the walls. This works better at insulating and stopping air, but we found that it soon leads to moisture buildup in the band joist because it prevents the moisture from drying to the inside.

The final step is to install carpet runners over the poly sheeting on the main paths in the crawlspace and paths to mechanical equipment. This prevents other tradespeople from damaging the sheeting. It's also a visual reminder that the air-sealing and insulation improvements should be treated with care.

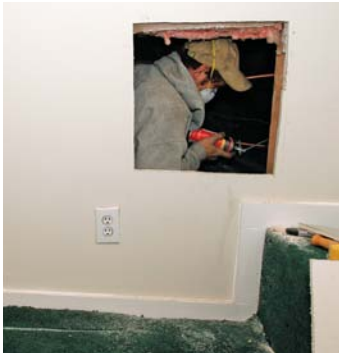
Separate the vented attic from the living space

Once the crawlspace was sealed, we turned our attention to sealing holes between the vented attic and other parts of the building. The biggest culprits were the third-floor kneewalls and an inaccessible attic space above a shed-roofed addition. The unconditioned attic space behind the kneewall connected to the rest of the third floor through the floor joists, which in turn connected to additional parts of the house through the balloon-framed stud cavities. To correct this, we stopped the airflow from the eaves by blocking the ends of joist cavities. We have three methods of doing this.

The easiest method is to fit rectangular pieces of rigid insulation in each joist bay and to seal around the perimeter with canned spray foam. We use this method whenever possible. Next best is covering the tops of the joists inside the kneewall space with rigid insulation. This method involves a lot more rigid foam and a lot more spray-foam sealing, and it's tough to get big pieces of foam through typical kneewall-access panels.

As a last resort (because it takes the most time), we fill a section of joist bay with spray foam that we inject through holes we drill in the subfloor. On this project, we used a 16-lb. canister of spray foam with a hose and a needle tip. Unfortunately, the small diameter tip dispensed foam very slowly. Next time, we'll use regular straw-dispensed foam.

To finish the job, we installed a thick layer of loose-fill cellulose on top of the existing attic insulation. We also had an HVAC contractor install a fresh-air supply to the mechanical room so that the existing gas furnaces would have enough combustion air and good draft. When less fresh air is coming into the crawlspace, it is important to have combustion appliances checked out by a qualified HVAC contractor as part of any air-sealing job.



Cut into inaccessible spaces. *An insulation contractor said he couldn't help the building's occupants because problem areas were inaccessible—a problem solved with a wallboard saw. This hole later was covered with an insulated access panel.*

This job was especially labor intensive, taking three workers and me six days to complete, not including the HVAC contractor's work. □

Jeff Tooley owns the Healthy Building Company in Siler City, N.C. Photos by Patrick McCombe.