Home Remedies for Energy Nosebleeds

With a little detective work, you can correct construction mistakes and cut energy bills by a third or more

BY BRUCE HARLEY

My friend Terry Brennan told me that on his first job as a mason's tender, he learned two things: "Whatever I did was wrong," and "If the work wasn't going to show, don't strike the joints" because it didn't have to be pretty. This is the same reason trim carpenters cut their teeth running baseboard in closets. As an energy consultant, I plug the same nosebleeds in new and old homes alike. Hidden mortar joints and closet baseboard notwithstanding, many things that go wrong in home building go wrong where sloppy work is done because "it's not going to show, so it doesn't matter."

We're good at cutting construction costs but bad at building houses that serve their owners well, minimize operating costs, and also reduce pollution.

Gaps in the construction sequence cause many problems

People think windows and doors are the biggest leaks in a house because windows and doors are the most visible holes. But even old windows and doors are relatively small holes. In reality, the majority of energy leaks happen in places you can't see, where one trade's work ends and another's begins: behind the drywall, up in the attic, or down in the crawlspace. Even when each trade does its job well, problems can occur because nobody sees the big picture. The way the work fits together is as significant as the work itself.

The gaps between trades usually translate into gaps in a house's thermal boundary. These gaps are addressed in current building codes, but building inspectors can't always offer protection. Sometimes they don't understand; sometimes they just don't enforce energy codes. The architect, general contractor, or homeowner must take the responsibility for understanding and closing these gaps.

Amazingly, the two trades most concerned with energy efficiency (HVAC and insulation) rarely follow the widely published minimum industry standards for their work. The reasons differ, but they share one common element: Their work is hidden behind drywall. The only feedback we get when these systems fail is comfort problems (which are often misdiagnosed) and high energy bills. Pressure to keep up-front costs low and underestimating the magnitude of the problems are also common to both trades. This standard of care isn't reasonable. Just because it has always been done this way doesn't make it right.

Some holes are so big that nobody notices them

It's not only insulation and HVAC contractors who are inadvertently sabotaging our houses. Framers often construct large holes that extend from the basement to the attic in the form of chimney, plumbing, and duct chases. These chases are hidden behind drywall or are covered by fiberglass-batt insulation. But insulation

Drawing this page: Jackie Rogers

alone won't prevent conditioned interior air from escaping. Big holes should be sealed with plywood, rigid foam, or drywall and caulk or spray foam.

Kneewalls and rim joists are two more often-missed examples. Think of them as long holes in a house. Kneewalls are found in finished attics and bonus rooms above the garage. Insulation is usually put in the kneewall and under the floorboards, but this insulation doesn't keep a room warm unless you block each joist cavity or, better yet, insulate under the roof deck (see p. 84). Rim joists also have myriad holes cut in them for dryer vents and outdoor water faucets. To seal rim joists, start when you build the house. Seal the top and bottom edges with construction adhesive during framing, and use spray foam afterward (see "The Best Way to Insulate a Rim Joist," *FHB* #189 or www.finehomebuilding.com).

Architectural massing can often mean massive leaking

Architects use features such as cantilevers and wraparound porches to break up the massing of a mundane facade. I have nothing against great-looking houses, but these architecturally interesting details can create giant energy nosebleeds.

Insulation and air-barrier details are often missed in cantilevered areas. The underside of a cantilever should be covered with solid sheathing (caulked in place) before finish materials are installed. Roof and wall sheathing is frequently left off below intersecting porch and garage roofs. The spaces below these roofs often connect to vented attics; they are just big air vents to the outdoors. Fancy details like tray ceilings and curved walls also can create big holes that open to attics.

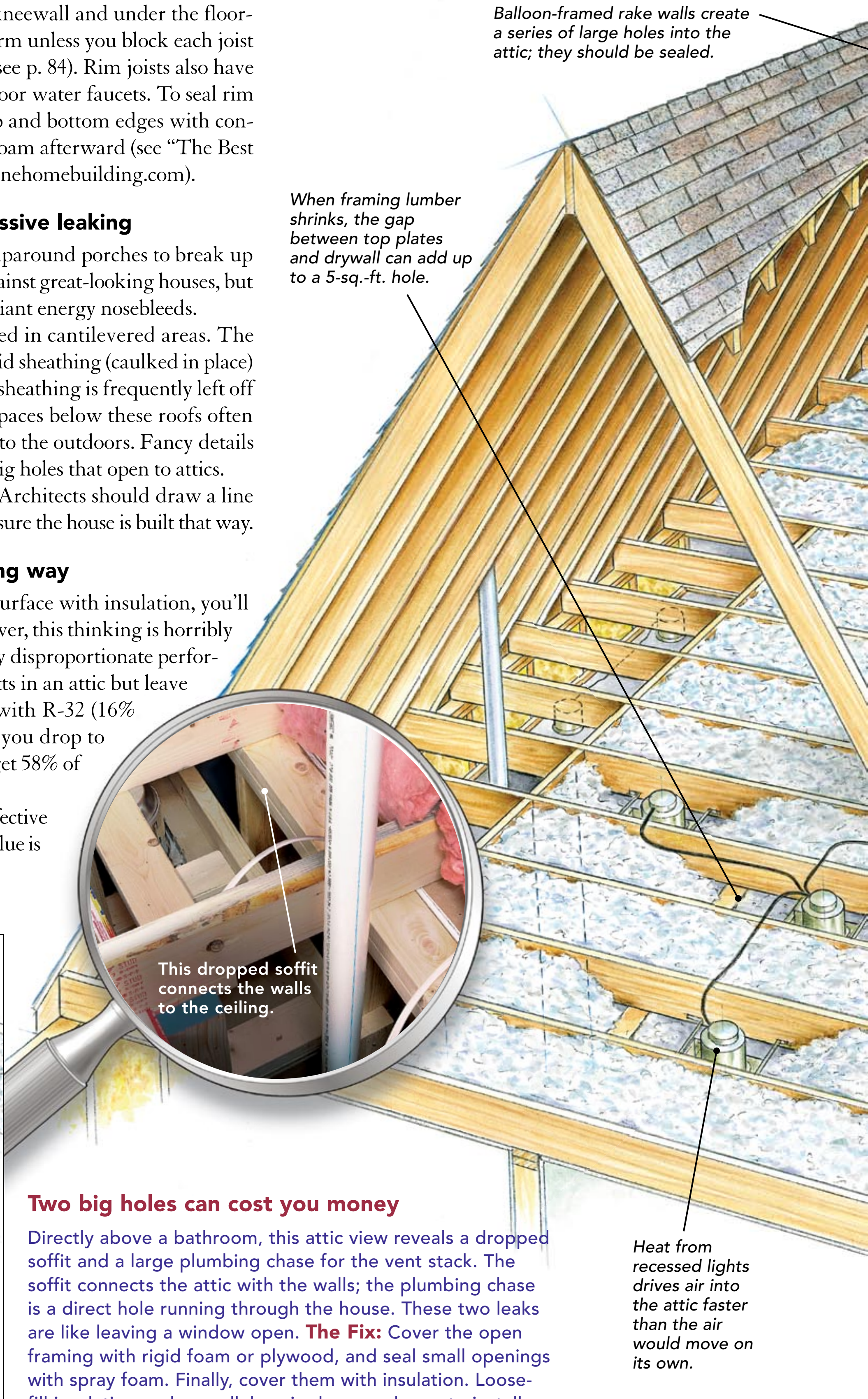
Great-looking houses should also perform well. Architects should draw a line between inside and out on the blueprints, and make sure the house is built that way.

With insulation, a little laziness goes a long way

People naturally think that if you cover 98% of a surface with insulation, you'll get 98% of the performance. With insulation, however, this thinking is horribly wrong. Gaps and missing insulation create a hugely disproportionate performance penalty. For example, if you install R-38 batts in an attic but leave 0.5% of the surface area uncovered, you end up with R-32 (16% reduction in R-value). Leave 2% uncovered, and you drop to R-22 (42% reduction). So with 98% coverage, you get 58% of the performance.

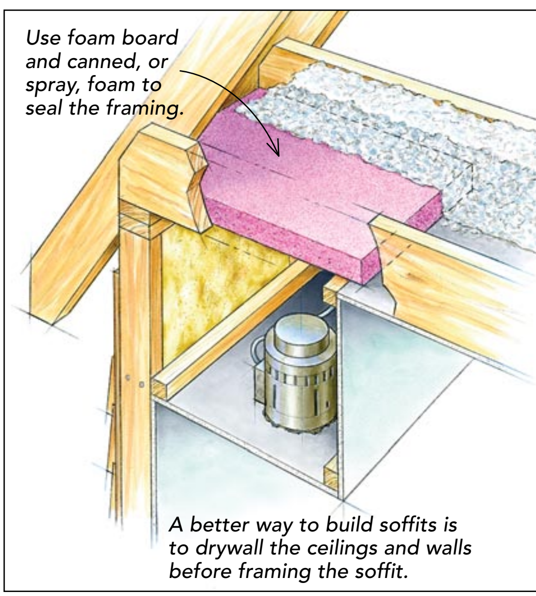
If you run across information saying it's not cost-effective to add insulation, it probably assumes the initial R-value is

Uncover the hidden holes in your house



Two big holes can cost you money

Directly above a bathroom, this attic view reveals a dropped soffit and a large plumbing chase for the vent stack. The soffit connects the attic with the walls; the plumbing chase is a direct hole running through the house. These two leaks are like leaving a window open. **The Fix:** Cover the open framing with rigid foam or plywood, and seal small openings with spray foam. Finally, cover them with insulation. Loose-fill insulation such as cellulose is cheap and easy to install.



Drawings: Don Mannes. Photo this page: Kevin Kennefick. Photos left, facing page: John Curtis. Product photos, facing page: Krysta S. Doerfler.

Some holes are hidden behind duct tape

Ducts that are poorly sealed lose up to 40% of the air they transport. If the ducts are in the attic, this can cause ice dams in winter. In the summer, it just wastes money. **The Fix:** Instead of relying on duct tape to seal joints in the duct system, cover the joints with latex duct mastic ($18 a gallon at www.efi.org). To apply, wear two pairs of gloves (cotton over vinyl). Bridge gaps larger than ¼ in. with fiberglass tape, followed by mastic.

what you say it is. In all likelihood, the R-value is less than half what you think, and the upgrade is worth much more—provided it's done right.

HVAC ducts can leak one-third of the air they transport

From 20% to 40% of the air that comes out of furnaces and air conditioners never gets to the rooms it's supposed to heat or cool. When you consider that most of the ducts are in attics, garages, and vented crawlspaces, the effect of that loss is huge: We're heating and cooling the outdoors. Sometimes whole rooms are disconnected, as when the ductwork isn't connected to the register and the duct spews conditioned air into the attic or crawlspace. Return ducts often leak more than supply ducts, but although they cause less energy loss, these leaks cause moisture problems and pressure imbalances that pose health and durability risks by contributing to mold, ice dams, and even carbon-monoxide poisoning.

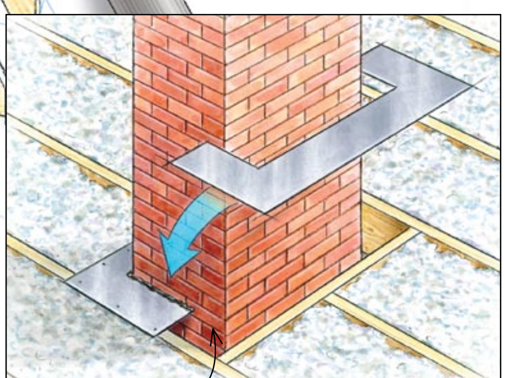
Required by code, duct-sealing is rarely completed and even more rarely tested. Houses more than 10 years old didn't have this code requirement. Every connection in every duct run should be sealed with mastic (not tape), and the system should be pressure-tested, just like your plumbing. Holes in the air handler can be sealed with aluminum-foil tape because mastic would render the cabinet unserviceable. After you seal the ducts and the cabinet, insulate them carefully.

Retrofits can be more difficult. If you can access the ducts, you can use mastic under the insulation (put the insulation back when you're done). If the ducts are inaccessible, you can seal them from the inside with a product like Aeroseal (www.aeroseal.com), or you can move the insulation and the air barrier to bring the ducts inside the thermal boundary.

Putting the air handler outside the house is not a good idea

Many air handlers and ducts are in attics. This location is a lot more costly than people realize. Putting an air handler and ductwork in the attic, garage, or crawl-

Wiring holes in top plates allow air to leak into the attic.



Cut sheet metal or cement board to bridge the gap between the framing and the chimney. Seal the gaps with a fire-rated sealant.

Some holes are code-required

Extending from basement to attic, code-required chimney-clearance space (photo left) can be a major escape route for conditioned air. If the clearance is supersize to accommodate ductwork, then the losses multiply. **The Fix:** The code also requires noncombustible firestops; close off the opening with sheet metal or cement board and fire-rated sealant (available at most hardware stores and home centers).

Kneewalls and vented roofs mean cold bonus rooms

When air-sealing is overlooked, insulation can't stop chilly air. Consider the size of this leak: Each joist bay is roughly a square foot times the number of joist bays, twice. For a 40-ft.-long Cape, this amounts to a 57-sq.-ft. hole in the thermal boundary that nobody notices. **The Fix:** Two options work. Use solid blocking (foam board or plywood) in each joist bay (seal the edges with canned foam), or insulate the roof with spray foam.

OVERSIZE HVAC IS OVERKILL

When it comes to air-conditioning units, oversize air handlers waste energy, burn out faster, and leave the house cold and clammy. Unfortunately, many HVAC contractors still rely on rules of thumb to determine system size. The best way to get the right-size HVAC unit is to model your home's energy features with one of the many software programs available (such as the one at www.hvaccomputer.com; $49 for homeowner version).

To calculate whether an existing AC unit is too big, measure the number of minutes per hour that the AC unit runs on the hottest afternoons in the summer. Then divide 60 by the number of minutes to determine the amount that the unit is oversize. For example, 60 ÷ 30 = 2x oversize; 60 ÷ 20 = 3x oversize.

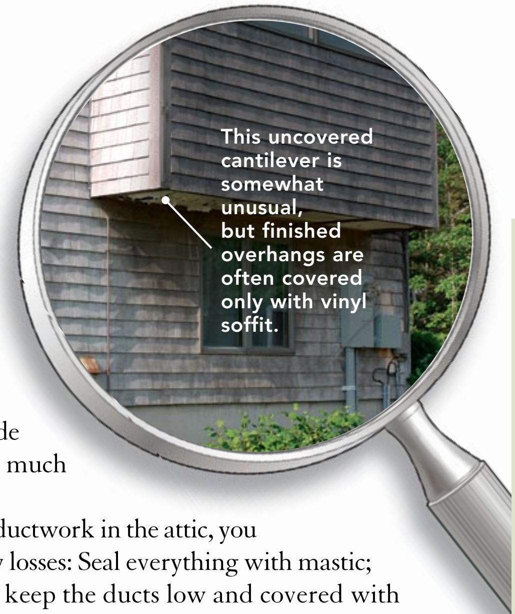
Putting an HVAC system in the attic is like putting it outside

In the winter, uninsulated attics are almost as cold as the outdoors; in the summer, they're much hotter. If R-30 insulation is required in the attic floor, does R-6 make sense for the air handler and ducts? No. **The Fix:** Move the HVAC out of the attic, or insulate the attic at the roof. Spray foam is a good choice. Calculating the correct size (see above) and optimizing duct layout make it easier to find room within the home's conditioned space.

Product photos, facing page: Krysta S. Doerfler

Cantilevers can be like open windows

The same principle applies to cantilevers as to kneewalls: Cold air has a direct path to the living space through the insulation and floor framing.
The Fix: Cover the underside with solid sheathing, caulked in place.



This uncovered cantilever is somewhat unusual, but finished overhangs are often covered only with vinyl soffit.

space is like putting it outside the house. Attics are almost as cold as outside in the winter. In the summer, attics are much hotter than outside.

If you must place the air handler and ductwork in the attic, you can do a few things to minimize energy losses: Seal everything with mastic; insulate the air handler carefully; and keep the ducts low and covered with blown insulation. Even better, use spray foam on the whole roof and gable ends so that the attic space is within the house's thermal envelope.

The best idea, though, is to run the mechanical system inside the house. You can use smaller mechanical equipment with smaller ducts in shorter runs. With smaller ducts and shorter runs, it's easier to design space for them within the house. The payoff is a much more efficient HVAC system that increases comfort while decreasing operating costs. For more information, go to www.toolbase.org/techsets/forced-air-system.

Oversize AC units can hide many big problems

Oversize air-conditioning systems are the norm, not the exception. It's easier to pick a huge system based on erroneous rules of thumb than to spend time designing a more-suitable but smaller system (see "Central Air Conditioning: Bigger Isn't Better," *FHB* #164 or www.finehomebuilding.com). Oversize systems have the added problem of masking many of the problems I've discussed here. Poor insulation, duct leaks, and more can be covered up by blasting twice as much cold air through the ductwork as would be necessary if things were done correctly.

If you double the size of the AC unit, you can lose 50% of the performance and still provide enough comfort so that the homeowner won't call you back. But a behemoth AC unit short-cycles (turns on and off too quickly), which hurts its energy efficiency, degrades its ability to dehumidify the air, and shortens its life. A larger unit is also noisier and costs more to install (both system and ducts). The solution is simple: Pay for the load calculations, and size the unit correctly. In fact, according to the Air Conditioning Contractors of America (ACCA), it's often better to undersize an AC system a little bit.

Water heaters and windows are the next savings opportunities

Water heaters store hot water all day long. They keep it hot on the off chance that you'll need it. Tankless, or on-demand, water heaters, on the other hand, convert cold water into hot water when you turn on the tap. Conventional water heaters waste about 40% of all the energy you pay for; tankless water heaters waste little.

You'll notice that windows aren't on this list. Only after you correct all the things I've mentioned will your windows start to look bad. Upgrading the windows at the design stage to at least Energy Star (preferably beyond) is a lot less expensive than buying substandard windows now and replacing them later. Even so, windows are not usually the first place to start looking for big savings because the other nosebleeds are running hard. □

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3 WAYS TO CUT YOUR ELECTRIC BILL UP TO 20%

1. Phantom loads (energy used by devices even if they are not on) can amount to 10% of residential electric bills. Phantom loads come from perpetually plugged-in transformers that recharge cell-phone and laptop batteries. They also come from electronic appliances like TVs and microwaves with standby mode or built-in clocks. While these devices can be unplugged individually, it's more convenient to use a power strip that feeds multiple loads. Plug the power strip into a switched outlet, and shut it off with a wall switch.

2. Compact-fluorescent lightbulbs (CFLs) can take another 10% off your electric bill. Replace any incandescent light used for more than an hour a day with a CFL. For more on CFLs, see "What's the Difference?" on p. 106.

3. Buy Energy Star-labeled appliances. Energy Star appliances are more efficient than non-Energy Star-rated models.