

Air-Sealing

an Old House

Older homes often need work to become more energy efficient. Insulation can help—especially in older homes where existing insulation is lacking or is nonexistent. But insulation alone is not the solution. In fact, air-sealing is a key component of the whole building envelope and, when done properly, can actually help many types of insulation work more effectively.

Let's take a look at some numbers from the EPA:

- Recent estimates show that homeowners can save an average of 15% on heating and cooling costs by air-sealing as well as ensuring that insulation is present in attics, around rim joists, and in floors over crawlspaces.
- This can translate to an 11% savings on total energy costs.
- Sealing air leaks throughout a home can reduce total air infiltration by 25%.

Not only does air-sealing help reduce energy costs, but it also makes a home more comfortable. If you've ever reached for the thermostat because your living room feels too warm in the summer, or because the home office gets chilly in the winter, that's a sign that you need better air-sealing. Drafts and air leaks are often responsible for the areas in a home that seem warmer or cooler than they should be. Eliminate them to keep temperatures more even throughout.

So how do you go about air-sealing a home for your clients, efficiently and effectively? To learn more, we spoke with Mark Wojtiuk, General Manager of RHH Foam Systems, Inc. His company specializes in spray polyurethane foam used for insulation and air-sealing. With his help, we've produced a guide to walk you through the process.

Understanding the stack effect

“Energy is saved when holes between conditioned and unconditioned areas are sealed,” Mark says. “When there are holes within the building envelope, the home will experience a ‘stack effect’ where hot air rises and escapes from the top of the building envelope.” This in turn depressurizes the house, drawing in cooler air from below.

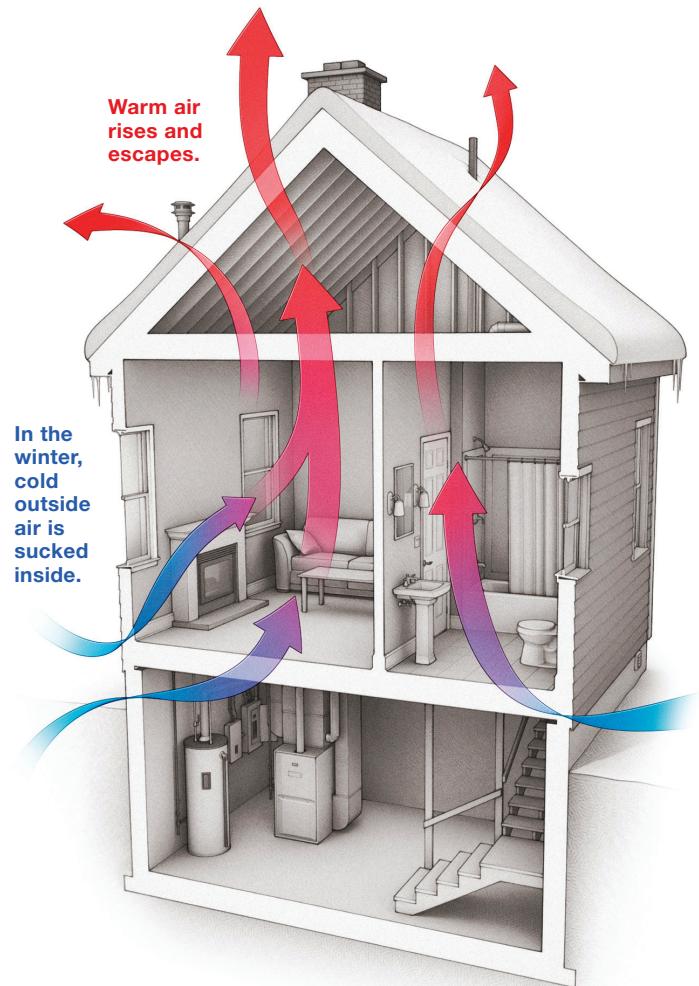
The stack effect is a complex beast—but before you start air-sealing work, it’s important to understand how it affects energy usage, especially during the winter.

In the winter, warm air rises to the upper levels of the home, where it will escape through cracks, gaps, and vents. Because warm air is less dense than cold air, the stack effect tends to be magnified when it’s cold outside. In fact, if you’ve ever noticed that you’ve had to push or pull harder to open an exterior door in the winter, this is why. The stack effect creates a kind of suction—and the taller the home, the greater the effect.

In a two- or three-story home, you can have a situation in which the indoor air pressure is higher than outdoor pressure on the upper floors, but lower than outdoor air pressure on the lower floors.

A home naturally wants to balance that pressure with outdoor air—so warm air escapes from the upper levels and cold air gets sucked into the lower levels to equalize the pressure on the floors.

This is what raises your heating bill: letting your conditioned, heated air escape, and needing more heat to warm



the cool air that’s being pulled in. The stack effect also pulls in outdoor-air contaminants, too.

In the summer, the stack effect kicks into reverse. It’s often warmer outside than inside, so on top floors, indoor air pressure is lower than outdoor air pressure, and hot air is pulled in from outside. On the lower floors, indoor pressure is higher, which pushes the cooled indoor air outside.

As you can see, the key to driving down energy bills—and making a home more comfortable—is to minimize the stack effect as much as possible. Air-sealing, then insulating, are the primary ways to do that.

Holes in the ceiling for duct penetrations are usually oversized and can leak significant amounts of air. Seal around them with spray polyurethane foam.



The basics of air-sealing

All properly sealed homes need both an air control layer and a thermal (heat) control layer (as well as water control layers). Insulation provides the thermal control and air-sealing the air control. Without proper air-sealing, the insulation won't perform as expected.

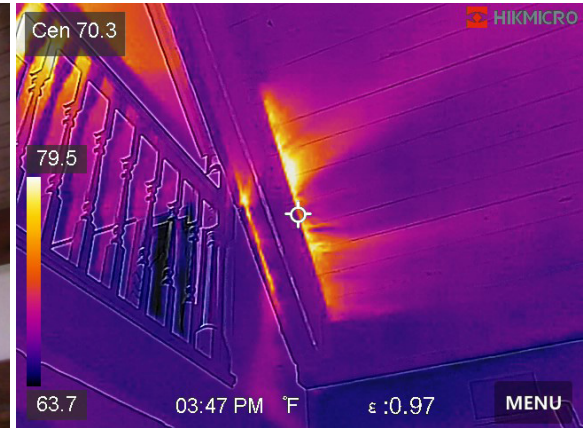
Air-sealing is about making a home as airtight as possible, to limit the amount of outside air that can be drawn in. This includes areas around windows and doors, around light fixtures and outlets, and around any penetrations in exterior walls—such as exhaust fans, indoor-to-outdoor plumbing, or places where wiring runs from indoors to outdoors. The rim joist, which connects a home's lower floor

to the basement, is another common spot for air leaks.

You'll find the most air leaks in the attic, which makes it the best starting point. According to Mark, "Some typical areas where one might find air leakage along the floor of the attic include top plates, attic hatches, electrical wiring penetrations, HVAC penetrations, plumbing penetrations, exhaust fans, electrical junction boxes, and recessed can lights."

As you can see, there are lots of opportunities for air leaks—and air-sealing aims to stop those leaks. When you can reduce airflow between conditioned and unconditioned areas, you can minimize the stack effect.

Thermal cameras will highlight big differences in temperature, which lets you zero in on spots where the leaks are happening. In this case, we can see leakage occurring on the rafters.



Finding leaks

Before you start sealing, you'll first need to find leaks—and there are lots of ways you can do that. "As air escapes into the attic from the conditioned space below," Mark says, "it will filter through fibrous insulations. The dirt particles will be left within the insulation, similar to an air filter within a furnace."

That's one way to spot air leaks—simply inspect attic insulation to find the dirtiest spots. While it's a good place to start, you'll need to try a variety of techniques to find as many leaks as possible.

Start with a visual inspection—and make sure you have pen and paper handy to take notes. Walk the perimeter of the home to check electrical, gas, plumbing, and vent entrances. When it's cold outside, you can also often find drafts simply by feeling for them. When you're indoors, hold your hand near electrical outlets, windows, doors, baseboards, fireplace dampers, vents, and attic hatches to see if you can feel a faint but chilly draft.

The above techniques will help you find the bigger leaks—but most older homes will have lots of smaller leaks that will be harder to find through sight or touch. You

may need specialized equipment to find most of them. This includes:

- Safety gear
- A flashlight
- A thermal camera
- Smoke sticks
- An inspection camera

For safety, gloves and glasses are the minimum to prevent splinters or debris in your eyes—but a respirator is helpful if you'll be kicking up dust or working with insulation.

You can use a flashlight and a partner to shine light in areas where you suspect leaks. If your partner on the other side of the wall can see the light, you've got a leak. Smoke puffers and smoke pens are another useful tool. Hold them up where you suspect a draft, and if the smoke blows away, you've pinpointed a leak.

Rent or buy a thermal camera or an inspection camera for the tougher parts of this job. Thermal cameras will highlight big differences in temperature, which lets you zero in on spots where the leaks are happening. Inspection cameras give you a visual of the spots you can't see or reach—like behind the furnace or in a soffit.

Sealing leaks

To air-seal an older home properly, you'll need several different products. Some are suited to specific purposes, and some are general-purpose products—like spray polyurethane foam that you can use in a variety of areas. We'll cover the basics so that you know what to pick up at the home-improvement center.

Spray polyurethane foam

Spray polyurethane foam (SPF) will be your go-to sealant for many areas throughout the home. It also has serious longevity. Life-cycle studies on SPF show that when applied correctly, it will last the life of the building. Look for a product like RHH Foam System's Versi-Tite, which is a one-component low-pressure polyurethane foam.

"Versi-Tite is ideal for sealing gaps that are 1 in. wide or smaller as well as for around window and door framing," Mark says. "It has minimal expansion, which won't bow out window and door framing."

Two-component SPF's are easy to use in hard-to-reach areas because you can spray from up to 2 ft. away. One-component SPF's need to be applied at close range, as with a caulk gun.

There is little prep work required for spraying. "The surface one wants to spray should not be damp," Mark says. Use a fan or heater to dry out moisture prior to installation, and vacuum up cobwebs, loose dirt, or debris—then spray away.

How much will you need to buy? Manufacturers of single-component SPF provide an estimated yield based on bead size. In the case of Versi-Tite, one 24-oz. gun foam kit will cover around 4000 lin. ft. if you're filling 1/4-in. beads, or around 1000 linear feet to fill 1-in. beads.

And where should you avoid using SPF? It's not rated for use around chimneys or other high-temperature zones—you'll need a different solution for that. SPF should also not be used outdoors since UV exposure can degrade it rather quickly. You can, however, use it to seal around plumbing, electrical, or other penetrations that run indoors to outside. Just make sure that on the exterior, you cover the foam with an exterior-grade caulk to prevent UV exposure.

Larger holes

When you need to seal larger holes—greater than 1 in.—two-component SPF is a good choice. Use it for larger gaps around a home's rim joists. This is also often the product of choice to seal attic hatches.

You can use rigid foam insulation in conjunction with spray polyurethane foam, too. Hang the rigid foam first, then use the spray foam to seal around the edges of the rigid foam for a completely airtight fit. Cutting and cobbling together rigid foam and sealing with spray is effective but can be time-intensive. Using a two-part foam kit and spray-foaming the entire area will be faster and require less labor.

Sealing around electrical fixtures

Electrical outlets, light switches, phone jacks, junction boxes, and can lights are all common places for air leaks, and all can be sealed with tailor-made solutions.

For outlets, light switches, phone or cable jacks, or junction boxes, pick up some gaskets. These are usually made of a tough foam—and they come in a variety of sizes to suit standard outlets, switches, and so on.

Where can lights are concerned, you'll need to take some special steps. If you simply cover them with fiberglass insulation, you'll be creating a fire hazard since the fixtures emit quite a lot of heat. Instead, you can purchase boxes or covers that are made specially to cover the part of the light that resides in the ceiling cavity. Once the cover is installed, you can safely seal the edges with spray foam, then insulate over the top.

Weatherstripping

Weatherstripping is available in a variety of shapes and sizes, and it's what you'll need to seal around windows and doors—and that includes an attic hatch.

Before you get started, measure the length, width, and depth of the areas you need to seal. From there, you can choose weatherstripping in the right shape and size. Some will have adhesive backers so that you can apply it directly to window or door frames while others will need to be glued or fastened in place.

And don't forget to pick up a door sweep or two. For windows, you'll just need the weatherstripping, but for doors, you can use a door sweep to seal that bottom gap.

Exterior sealing

Wind, rain, UV rays, birds, rodents, bugs—there are lots of things outdoors that can damage air-sealing products (or use them to build a nest). When you're sealing an older home's exterior, you'll need materials that are impervious to these things.

For the most part, that will mean exterior-grade caulk, but you can supplement caulk with spray polyurethane foam and metal flashing sometimes. To seal a wall penetration where plumbing runs indoors to outdoors, for example, you can fill most of the cavity with spray foam, then cover the exterior portion of the gap with caulk to protect the foam.

When you have larger gaps or holes in exterior walls, remove cladding around the hole to get to the sheathing layer. Patch the sheathing first and seal the seams with caulk or exterior flashing tape (then re-install the exterior cladding). For small holes—less than 1 in.—it's still best practice to remove cladding back to the sheathing layer. You can use spray foam to fill the hole, apply flashing tape over it, and then reinstall your cladding. In cases where this is isn't possible, you can use a combination of spray foam or backer rod and an exterior sealant (color-matched to the cladding).

SPRAY FOAM FORMULATIONS

Spray polyurethane foam typically comes in a couple of different formulations: One component and two component. What's the difference?

One-component foams come in cans or bottles, and they're ready to spray—no mixing needed. Simply follow the kit instructions to connect included equipment to the can or bottle, and start sealing gaps.

Two-component foams feature two components that will need to be mixed on-site. They typically come in kits that will require you to connect a dispensing system that mixes the components as you spray the foam.

Which should you choose for air-sealing? According to Mark from RHH Foam Systems, Versi-Tite®, which is a one-component foam, is the best choice for sealing gaps that are 1 in. or smaller. "Versi-Foam® [two-component foam] is recommended for insulating or air-sealing larger areas such as wall units," Mark says.

One-component Versi-Tite is ideal for around windows because it has minimal expansion and will not bow the framing.



Common scenarios and best practices

In any older home, there will be a few areas that are prone to air leaks—around rim joists, windows and doors, attics, and so on. We'll show you how to handle some of the most common leaky spots.

Rim joists

Rim-joist sealing in an existing home often requires a little creativity. For the most part, the gaps between the rim joists and the foundation will be small—but because the home may have gone through several upgrades and renovations over the years, you could also have some big holes where large pipes or vents used to run. The rim joist is also part of your wall assembly, and should be insulated to at least the same R-value as the rest of the wall.

What to do? Start with spray polyurethane foam. Use it to fill gaps that are 1 in. or less in size.

For bigger gaps, there are a few options. You can hang up rigid foam insulation, then

seal around that with SPF, but it is quicker and easier to use a two-component spray foam kit. If the gap is truly large—like an opening for a hopper window that has been removed—you'll need to repair the opening before air-sealing.

Attics

Attics often have lots of air leaks—and you'll find them around the attic hatch, around can lights or light fixtures in the attic floor, around furnace flues and vent pipes, via dropped soffits, and elsewhere.

- For a dropped soffit, you can use rigid foam insulation to fill the biggest part of the opening into the attic—then use spray foam to seal around the edges.
- Kneewalls in a finished attic can be sealed using spray foam.
- Vent pipes and furnace flues can be sealed with mineral wool or aluminum flashing plus caulk rated for high-temperature use.

- Junction boxes can be sealed with gaskets.
- For can lights, get covers in the right size, place them over the fixtures, and then insulate and seal around the cover.

Last, you'll need to seal the attic hatch, if you have one that opens into a conditioned space. Start with a piece of rigid foam insulation cut to fit the back of the hatch. This will keep it insulated—but you'll still have air leaks around the edges of the hatch where it rests on the frame. Use weatherstripping here so that when you close the hatch, it rests on the weatherstripping.

Wall penetrations

The process of sealing exterior wall penetrations—places where vents, plumbing, electrical, or gas lines run through exterior walls—is similar to sealing around rim joists. Inside, you can use SPF to seal the gaps. But because SPF degrades when exposed to UV, you'll need to use exterior caulk on the outside.

Windows and doors

Windows and doors have two main areas where air is likely to leak: around the window sashes or door, and around the frame.

Sealing around window sashes means using the right weatherstripping. You'll need a type that can stand up to friction when you open and close the window—and it should also be able to handle exposure to moisture and temperature changes.

Similarly, you'll need weatherstripping to seal around a door, too. Make sure that the door is tight on its hinges and choose a weatherstrip that allows you to close the door tight (but not so tight that you have to really push to close it). Install a door sweep at the bottom of the door to prevent a draft.

And what about window and door frames? This is one of the best uses for one-component spray polyurethane foam. Simply remove the trim around windows and doors, which should expose any gaps around the frame. Fill these gaps with one-component SPF, and once the SPF has cured you can rehang the trim.

WHERE NOT TO SEAL, AND WHERE TO SEAL CAREFULLY

Ensuring proper ventilation

As you're hunting leaks, keep in mind that no home should be completely airtight. Some ventilation is necessary, but it needs to be done right. Proper ventilation includes exhaust fans in bathrooms, fans in the HVAC system, attic vents, dryer vents, and vents for any combustion appliances. Ventilation helps control moisture within the home so that you don't end up with mold. Where combustion appliances are concerned, it prevents leakage of combustion products—like carbon monoxide—into the home.

Where necessary, you may need to bring in a qualified, certified technician to ensure that gas or oil-fired furnaces and water heaters are properly vented. Remember that safety should always be the top priority, even over energy efficiency.

Chimneys, spark zones, and high-temperature areas

Don't rely on spray foam or regular insulation to seal around chimneys, flues, or anywhere that fire or sparks could present a hazard. The wrong materials in these areas can create a dangerous tinderbox should a spark ever happen to land on the sealant.

That doesn't mean you can't seal these areas, however. To seal these spaces, use high-temperature silicone caulk made especially for use around chimneys, flues, and other potentially dangerous spots. In some areas—especially around a chimney—you can also use aluminum flashing to seal a larger gap, then use the high-temperature caulk to seal around the flashing edges.

Wrapping up

Air-sealing isn't a difficult job to do, but it is a detailed task. As homes age, they develop more and more air leaks due to modifications, the breakdown of original materials, or simply due to the way the home shifts and settles over time.

Be prepared to use a variety of tools to find air leaks and do a comprehensive evaluation from top to bottom.

With that, it's smart to avoid a "one and done" mentality toward air-sealing. You may have sealed all the air leaks that you found this time around—but that doesn't mean you didn't miss a few or that new leaks won't develop in time. It's a job that should be done every few years to keep energy bills down and make a home as comfortable as possible.