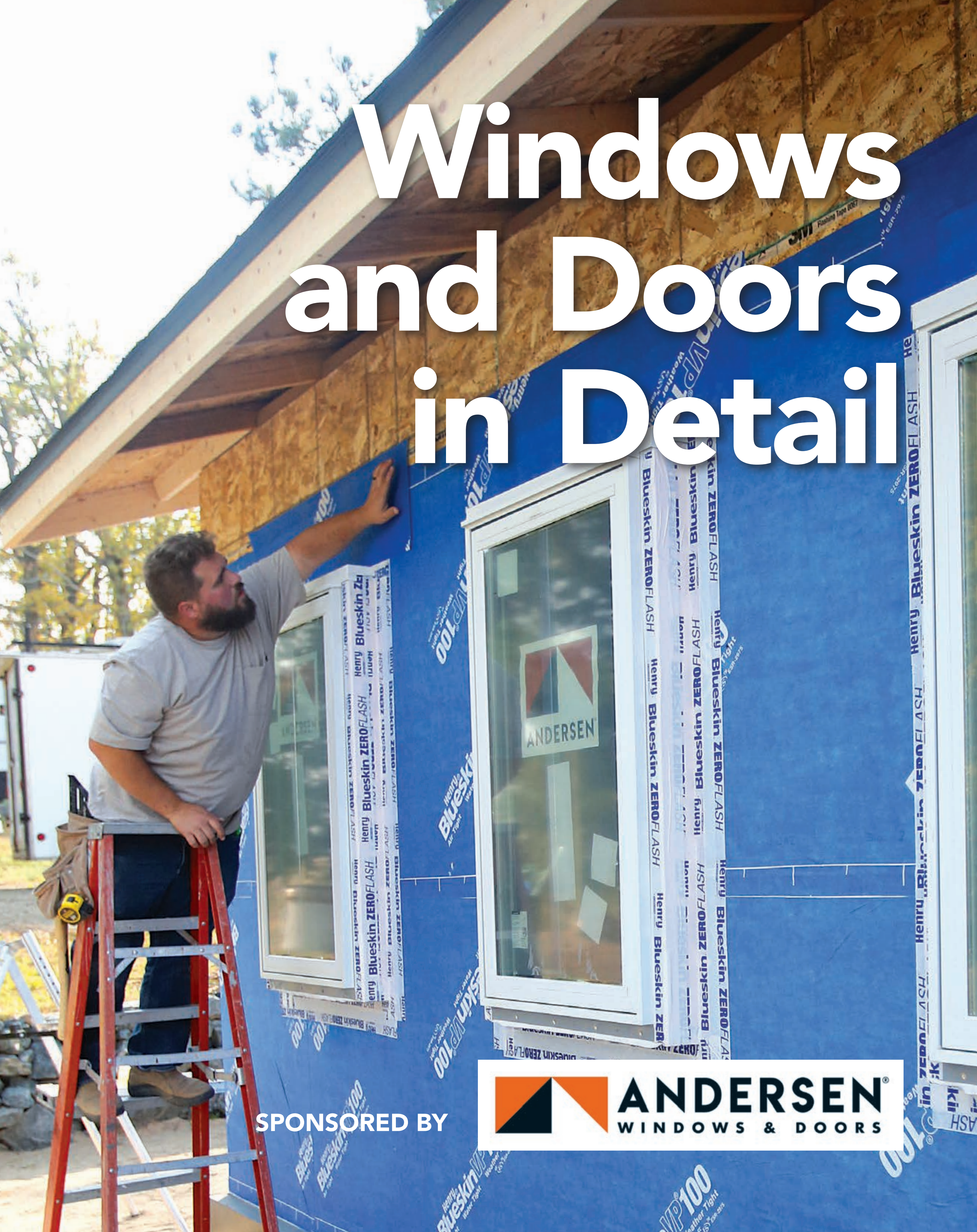
Windows and Doors in Detail



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A Practical Perfect Wall

Getting the details right for a wall assembly with the control layers to the exterior and lots of drying potential

BY RANDY WILLIAMS

Joe Lstiburek's "Perfect Wall" is now a well-known building science concept in which all four control layers—water, air, vapor, and thermal—are placed to the outside of the structure. It's a highly efficient and durable way to build a wall (or a roof), and it works pretty much everywhere. But while the concept of a Perfect Wall is simple, executing some of the details required for a true Perfect Wall assembly can become quite complex (and expensive), especially in cold climates where a very thick layer of exterior insulation is needed.

Thankfully, the Perfect Wall concept can be applied to modified assemblies that provide easier constructability and affordability while maintaining high levels of efficiency and durability. The most practical approach is to split the thermal layer between continuous exterior insulation and cavity insulation (keeping some of the thermal control inside the building), ensuring there is a sufficient ratio of insulation outboard of the sheathing to provide condensation control by keeping the sheathing warm.

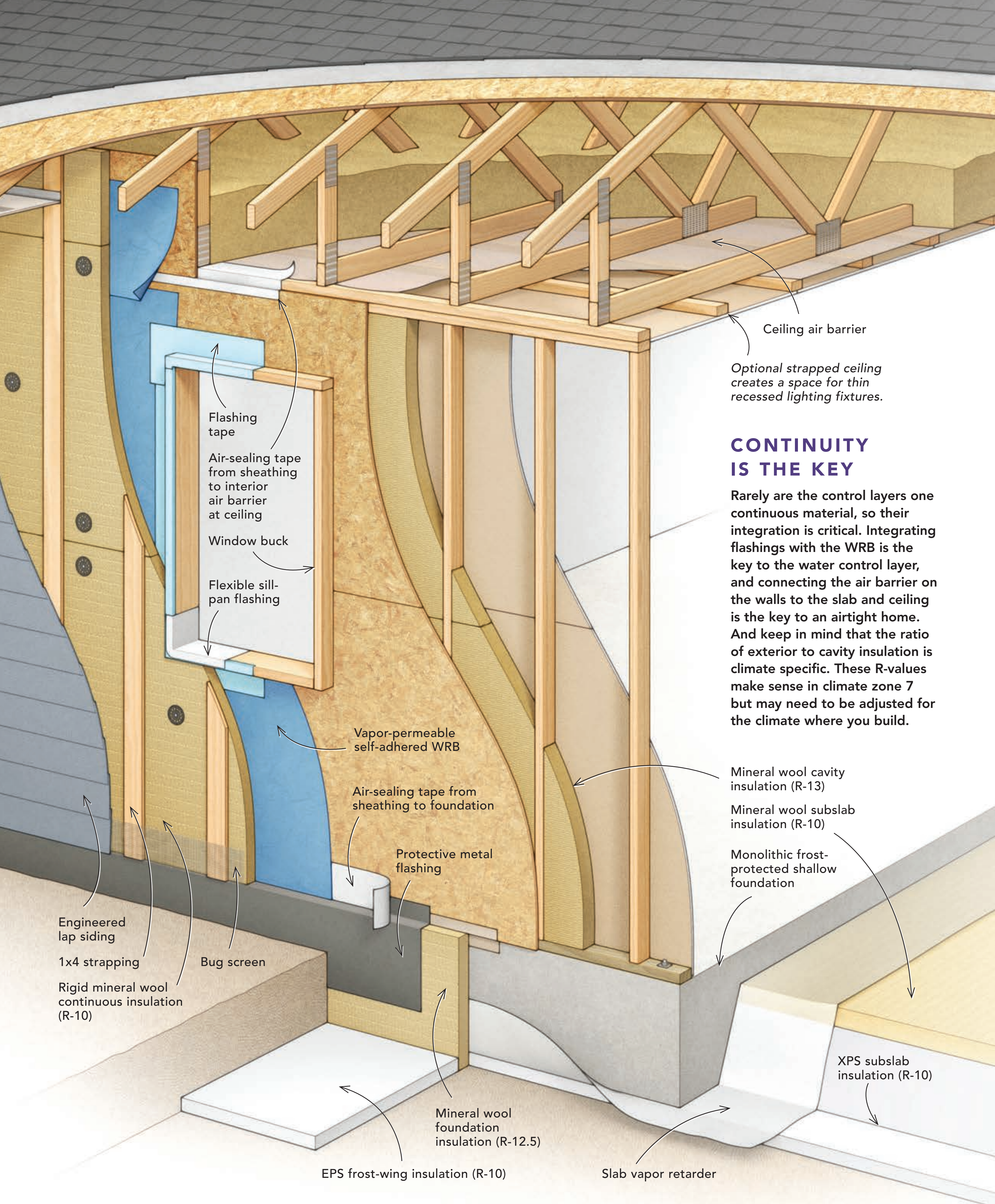
Lots of designers and builders are now taking this approach, and it has even made its way into the building codes. The project shown in this article demonstrates just how practical—and even affordable—it can be. Contrary to some opinions floating around in the industry, building to a higher performance standard doesn't have to be expensive or complex. It doesn't require seven-figure budgets, or exotic materials, or windows sourced from suppliers in different parts of the world. Rather, building a high-performance home relies on only two things: an understanding of the control layers, and the diligence to execute the details that make those layers work.

For the assembly on this project, I carefully selected and integrated the control layers with the aim of building a home that exceeded the requirements in the 2021 IRC while maintaining a modest budget, constructable details, and familiar materials. The result is a durable, high-performing assembly that is practical to build and (with minimal modifications) works in pretty much all climates—a practical Perfect Wall.

It's all about the control layers

This project is in northern Minnesota (climate zone 7). The design heating temperature is –20°F. (It's OK if you don't know what a design heating temperature is; the point is, it gets cold here.) The building has a simple 30-ft. by 36-ft. shape and is built on a frost-protected shallow foundation that has R-10 underslab insulation and R-12.5 slab-edge insulation. The roof is a 4:12 pitch built with 18-in. raised-heel trusses. The attic is vented, and the house has a flat ceiling inside. The goal was to build a structure to the prescriptive 2021 IRC with R-10 continuous insulation over R-13 cavity insulation, and with above-code airtightness of 1 ACH50 or better. We

Drawing: Christopher Mills



CONTINUITY IS THE KEY

Rarely are the control layers one continuous material, so their integration is critical. Integrating flashings with the WRB is the key to the water control layer, and connecting the air barrier on the walls to the slab and ceiling is the key to an airtight home. And keep in mind that the ratio of exterior to cavity insulation is climate specific. These R-values make sense in climate zone 7 but may need to be adjusted for the climate where you build.

used off-the-shelf Andersen 100 Series casement windows and builder-grade insulated steel exterior doors. There are no dormers, no foundation bump-outs, and, generally, no frills. But even a bare-bones build requires close attention to the control layers.

The water control layer is the most important. If a house's moisture-sensitive building components become wet every time it rains and can't dry before the next wetting event, the rest of the control layers won't matter. The water control is always located on the exterior of the home. A common mistake is to rely on cladding for bulk water control. Siding eventually leaks, so I consider the water control layer to be the water-resistive barrier (WRB) and all the important flashing details around windows, doors, and other penetrations.

We have many options for WRBs today, which are typically separated into four categories: mechanically attached (for example, DuPont's Tyvek or Magnera's Typar), integrated panels (Huber's Zip System sheathing; LP's WeatherLogic), self-adhered (Henry's Blueskin; Benjamin Obdyke's HydroGap SA), and fluid-applied (Prosoco's Cat 5).

Air control is the next most important control layer. Air control can be on the exterior or the interior of the wall, and some builders choose both. Membranes such as Pro Clima's Intello and Siga's Majrex are sometimes used along the inside face of the studs to accomplish both air and vapor control. However, sticking with the Perfect Wall ideal, I prefer to locate the air control layer outside of the structure, and integrated with the water control layer. Most WRBs are air-impermeable, but I don't recommend using a mechanically attached product as an air barrier. They are too difficult to detail for this purpose. Most high-performance homes I see being built today use an integrated or self-adhered WRB, especially when the WRB is also serving as the air control layer.

On this project, I used a self-adhered membrane, Henry Blueskin VP100, as my WRB and air control layer on the walls. Installed outside the sheathing and behind the exterior insulation, it's protected from the homeowners and the elements. And choosing a vapor-permeable product means I don't restrict the assembly's drying potential. Remember, the air barrier must be continuous; the drawing on p. 4 shows how I connected the air barrier on the walls to the foundation and ceiling.

Vapor and thermal control are the two remaining control layers. Depending on who you talk to, there may be some discussion on their order of importance, especially in different climate zones. In practice, as long as you consider the requirements and location of each in your design, and account for how they affect each other, order doesn't particularly matter. For instance, in a cold climate, if you locate the thermal control layer—or at least enough of the thermal layer—on the exterior, it will keep the sheathing warm in the winter and minimize condensation risk. This largely eliminates the need for high levels of interior vapor control, which is a benefit of the Perfect Wall. Conversely, with a well-detailed vapor control layer at the interior face of the studs in a cold climate, the importance of positioning of the thermal control layer to prevent the sheathing from becoming a condensing surface is reduced.

When designing the thermal layer for walls, the prescriptive codes allow for many insulation options. In my area, the 2021 IRC offers four different possibilities. I could

SLICK PEEL-AND-STICK

Two sets of hands, a deliberate process, and a little patience make installing a peel-and-stick water-resistive barrier (WRB) easy. Before starting the WRB installation, it's a good idea to inspect the sheathing for anything that could penetrate the membrane.

START AT THE BASE After wiping the flashing and tape of construction dirt, apply a layer of flashing tape along the base of the wall, sealing the kickout flashing to the sheathing.

CHALK A REFERENCE Snap a line at 48 in. from the base of the wall to provide a reference to keep the WRB membrane straight.

TACK IT UP After carefully aligning the membrane to the reference line, place a few hammer staples along the top edge of the membrane to hold it in place.

PEEL THE BOTTOM Slowly pull the lower release liner and smooth the membrane onto the sheathing, being careful not to let the product fold on itself.

PEEL THE TOP With the bottom of the membrane in place, peel and stick the upper portion of the membrane.

ROLL IT OUT Be sure you are satisfied with the positioning of the membrane before rolling the surface with a J-roller.

REPEAT THE PROCESS The second course of peel-and-stick membrane installs just like the first. Make sure to maintain at least 2 in. of shingle-style overlap.

PREP FOR BUCKS Cut back the membrane 2 in. around all the door and window openings. Remove the membrane directly above the openings (which is important later).

choose to use a cavity-only strategy, but I must achieve R-30 in the cavity. That would require me to use closed-cell spray foam in a 2x6 wall or build the walls with 2x8s or 2x10s if using fibrous insulation; neither was a practical solution for this project. I could choose one of two hybrid continuous insulation (CI) options, such as R-5 CI over R-20 cavity insulation, or R-10 CI over R-13 cavity insulation. Or I could forgo the cavity insulation entirely and move to R-20 CI installed on the exterior, leaving the open wall framing as a service cavity. This option would yield an actual Perfect Wall assembly, but it's not the most practical.

For this project, I went with R-10 CI over a 2x4 wall with R-13 in the cavities. This option allows for the proper ratio of continuous exterior insulation to cavity insulation for my climate so that the interior vapor retarder can move from a class I or class II to a class III vapor retarder, which painted drywall provides. In addition to creating a more durable wall, eliminating the interior vapor retarder allowed for some product and labor cost savings that helped offset the more expensive WRB and the CI. It's important to note that the prescriptive codes for insulation levels and for vapor retarders are interconnected but are found in two different parts of the IRC. Consult both for your projects to reduce the risk of making a mistake.

For the CI, I selected 2½-in. Rockwool ComfortBoard 80, a vapor-open, rigid mineral-wool insulation that will allow any moisture that should contact the WRB to readily dry outward. This product is easy to install, though it can be a bit finicky when you're trying to create a flat plane for cladding (more on this later). All CI options complicate window and door installation along with the other mechanical, electrical, or plumbing penetrations. Any competent builder can handle these challenges, though they do require some planning and sequencing adjustments.

Adjusting for different climates

As I mentioned earlier, one of the most interesting aspects of Lstiburek's Perfect Wall is that it works in pretty much every climate. This practical Perfect Wall assembly can also work in any climate. In either case, you'll likely adjust the R-value of the insulation and maybe the permeability of the WRB, depending on the climate zone and a few other building details.

In a cold climate like mine, the potential for condensation is in the colder months, when warmer (more humid) interior air pushes toward the colder (less humid) outside air. If the sheathing is at or below the dew point, vapor can condense and wet the sheathing. This assembly keeps the sheathing warm and eliminates the condensing surface and risk of condensation. To create a lot of drying potential should the wall get wet, all the materials I chose have higher permeability rates. But this concern is sometimes different in other climates.

In hot, humid climates, for example, the vapor concern happens in the warmest months, when the hotter (more humid) outside air pushes into the assembly toward the colder (less humid), conditioned interior air. In this scenario, rather than the sheathing, it may be a surface near the interior of the wall, such as the drywall, that could become a condensing surface. Instead of using insulation to keep the interior surfaces above the dew point, sometimes it's advantageous to slow inward vapor drive with a lower-permeance material on the exterior. This could be the WRB or the insulation.

Whether it's a wall, foundation, or roof you are planning, it's always important to understand your climate zone and to make sure the assembly details and materials make sense for your local conditions.

The trick with peel-and-stick

Everything I've discussed so far needs to be considered at the drawing board so that when the time comes to do the work, you can focus on the details. On-site, the work started with the WRB installation, which required a bit of prep work, including inspecting the wall for any errant fasteners that could puncture the membrane.

It's most common to install a peel-and-stick WRB horizontally, with shingle-style laps. It's possible to do this alone, but two people will accomplish it faster and better. The installation starts by snapping control lines to keep the material level or plumb. It's often helpful to tack the very top of the membrane to the wall with staples to hold it in place as you peel and position the bottom half of the material; just make sure to put the staple where it will be covered by an overlapping course. Blueskin can also be installed vertically, which makes it an easier one-person job, but understand that the overlap increases from 2 in. to 3 in. when switching from a horizontal to a vertical installation.

I am a fan of staying with a single manufacturer's system of products whenever possible.

THE BUCK STARTS HERE

Well-flashed, site-built window bucks provide the base for durable window installations in plane with the siding. Note that the rough openings are oversized to accommodate the window bucks.

BUCK THE OPENINGS After applying a bead of acoustical sealant, use a gauge block to set the projection before nailing off the bucks. In this case, the projection was 3¼ in. (to allow for 2½ in. of insulation and ¾ in. of strapping).

FLASH THE BUCK Use flashing tape to waterproof the bucks, starting at the bottom and working up to maintain proper shingle-style lapping.

SEAMLESS SILL Use a butyl flexible flashing tape to create a watertight, seamless sill-pan flashing.

SHIM TO LEVEL Use horseshoe shims to make minor adjustments to the sill to create a perfectly level place for the window to sit. If you need help holding them in place, use a piece of flashing tape, but don't penetrate the sill-pan flashing with fasteners.

BELT-AND-SUSPENDERS SEALANT Apply a bead of all-purpose sealant to the face of the buck at the jambs and head, leaving the sill open for drainage.

SET THE WINDOW Lift the window into the opening and adjust for plumb and level, then fasten through the nailing flanges with roofing nails.

FLASH THE FINS Apply flashing tape over the window flanges at the jambs and the head. Leave the bottom flange untaped to allow for sill-pan drainage.

DUAL-PURPOSE CAP Install an aluminum head flashing that provides a kickout for both the buck and the window.

FINISH THE FLASHING Install a piece of peel-and-stick WRB above the window where previously omitted, creating a shingle lap over the head flashing.

On this project, I did use both a 3M and a Siga product for air-sealing before installing the WRB, but I used only Henry products for the WRB assembly so that there were no concerns about their compatibility. As an added benefit, sticking to Henry products increases the factory warranty from 10 years to 15.

If you are going to use products from a variety of manufacturers, make sure they are compatible. For flashing on this project, I also tried one of Henry's new tapes, Blueskin ZeroFlash. This synthetic butyl product is formulated to have good bond even in weather down to 0°F.

Penetrations are important

Windows and doors are the largest and usually the most numerous penetrations in the building enclosure. However, we also have smaller penetrations—such as those for outlets, water spigots, heat-pump line sets, and ventilation ducts—that need to be sealed so they don't leak either water or air. In the past, I used tapes to seal these holes, but I recently moved to gasket systems. Tapes can fail if the cable, pipe, or duct is moved after the tape is placed and the seal is broken. A gasket system allows for this movement while maintaining both the water seal and the air seal.

We used Pro-Flash gaskets on this project. These are simple, square pieces of flexible plastic sheeting with an integrated rubber gasket. There are four sizes designed for round penetrations ranging from 1/8 in. to 7 in. Part of the gasket can be cut away to allow for different-sized cables and ducts.

We had to deviate slightly from the manufacturer's installation instructions to better suit the self-adhered WRB; rather than integrating the gaskets with the WRB using a shingle lap as recommended by the manufacturer, we taped all four sides of the flashing to the WRB. As this method results in a reverse lap, Henry requires a bead of its 212 All Purpose Crystal Clear Sealant across the top of the top tape joint to back up the leading edge of the tape joint.

We also had a few recessed electrical boxes that the insulation needed to be cut around. We chose to use Arlington's Low Profile In Box. The box is shallow enough that we did not need to cut a hole into the wall sheathing, which would have complicated the air barrier; instead, we only needed to poke a cable through.

After the insulation and rainscreen strapping were installed, we fastened the electrical boxes, hose bibs, vent covers, and other accessories that penetrate the enclosure to mounting blocks made from pieces of the LP SmartSide that we used for siding, which created a finished look. The mounting blocks are attached to the rainscreen strapping.

Flat walls are the goal

When the time came to install the insulation, we temporarily fastened the Rockwool ComfortBoard to the wall with screws and washers. It is really the 1x4 rainscreen strapping, however, that will permanently hold the CI in place. We needed the ¾-in. strapping to be fastened through the insulation and sheathing and project a minimum of 1 in. into the framing of the building. Simple math gives us fastener length, but size and spacing are based on the weight of the siding. All these specifications can be found on the Rockwool website.

The density of ComfortBoard can make it difficult to keep the strapping flat on the wall. It is easy to overdrive the strapping fasteners and create waves in the strapping that could project through the siding. To make sure this wasn't a problem, we adjusted the screws securing the strapping in or out, using a long straightedge and a stringline to ensure a flat surface. While normal screws work well for drawing the strapping in, a screw with a reverse-threaded head (also known as a shim screw) is usually required to bring it out. The Rothoblass DRS spacer screw and the GRK Topstar are the two screws that work well for this task. It took two of us about an hour to complete the process on a 36-ft.-long by 9-ft.-tall exterior wall.

A rainscreen is an important detail with a lot of benefits, but a ¾-in. air space behind the cladding can be a problem if bugs and other critters are able to enter. At the bottom of the wall, we used rips of aluminum window screen to keep critters out. If we were building in a wildland-urban interface (WUI) area, this detail would have required a specific product to keep embers from flowing into the cavity in the event of a wildfire.

On this building, the air space extends all the way into the vented attic. We did this by installing the F-channel that would capture the soffit material over the rainscreen strapping. If we did not connect the rainscreen to the attic, we would need to create another pathway for the rising air to exit the space behind the wall cladding. This is typically accomplished by creating a gap where the cladding meets the soffit, requiring a second bug screen. But the building codes in some areas don't allow this alternate

A COZY CI SWEATER

A thick layer of continuous, high-density rigid mineral-wool insulation eliminates thermal bridging and controls the temperature of the sheathing.

PREP THE BOARDS Mark for cuts and notches with a permanent marker or by snapping lines on the mineral wool. Cut the boards with a mineral-wool insulation knife. Hole saws work well for cutting out circular penetrations.

STACK IT UP Install the boards horizontally, resting the bottom edge of the first board on the top of the flashing at the base of the wall. Working up the wall, use deck screws with large plastic insulation washers to hold the boards in place.

ADJUST THE FIT Once the boards are in place, trim them as needed to adjust for the perfect fit—just be sure not to cut the WRB behind the boards.

PLAN THE RAINSCREEN Mark the locations for the strapping with a long level before installation begins, being sure they align with the studs. Hold the strips back a few inches at the corners and around windows to maintain an adequate drainage space and provide secure nailing for trim.

SECURE THE STRAPPING Attach the 1x4 strapping through the insulation with screws that penetrate a minimum of 1 in. into the framing members. Be careful not to overdrive the fasteners.

FLATTEN IT OUT After the strapping is secured, ensure the corner straps are plumb and straight using a long level, adjusting the screws in and out as needed. Next, use a combination of a long level (or a straightedge) and a stringline (stretched from corner to corner) to ensure the straps are in plane as you move across the wall.

SIDING AND TRIM Proceed with the installation of trim and siding as usual.

approach (requiring that the rainscreen not be connected to the soffit), so check your local regulations.

Blower doors don't lie

After the windows and doors were installed, we performed a mid-build blower-door test. The goal of this test was to verify that we had hit our air-sealing goal, which was 1 ACH50 or less. The test result was 0.30 ACH50, which is 0.019 CFM per sq. ft. of surface area, or 60 CFM50. These were my personal best blower-door results. All the aforementioned details for this wall led to those numbers, but the continuity of the air barrier is a key piece.

I have been involved in several high-performance construction projects over the past few years. While all have resulted in a small increase in budget, each has also yielded operating cost reductions, added durability, and reduced maintenance costs. There is also the intangible added value of comfort—these homes are quiet, with consistent temperatures. With a practical approach to high performance, additional upfront costs are offset by long-term value. So take this project as an example that any builder who wants to move toward building better can accomplish the goal. In the words of Joe Lstiburek, it's building science, not rocket science. □

Randy Williams is editor at Green Building Advisor and a home energy auditor and contractor in Grand Rapids, Minn. Photos by Brian Pontolilo.

A Weatherproof Window

Layers of redundant flashing and sealant ensure that the most expensive part of your house is also the best protected

BY BRIAN KNIGHT

As the building industry tightens up on air-sealing and improves energy efficiency, we need to be more aware of the risks associated with air and water intrusion. Materials that get wet won't dry out as quickly or easily as they used to do in leaky, poorly insulated houses, and many of the materials being used to build houses aren't as resistant to moisture as their predecessors. There's no doubt that with windows accounting for such a large part of the building budget, and being one of the most direct connections to the elements, their installation deserves extra attention.

Windows are complicated, and so is their installation

Compared to solid areas of wall and roof, windows and their interface with the air barriers and water-resistive barriers (WRBs) of a house are complicated and vulnerable. Many builders and designers are confused about best practices, and inferior techniques are rampant. As windows, tapes, sealants, and WRBs evolve, so do the installation guidelines for these products. It's not uncommon for products that are typically used together to have conflicting installation instructions. When in doubt, I follow the window manufacturer's instructions as a bare minimum, and add improvements from there.

The best window installations include redundant layers of protection for keeping water out, incorporate measures for blocking the air movement that can draw that water in through weak spots, and provide an escape path for water that enters before it has a chance to cause damage.

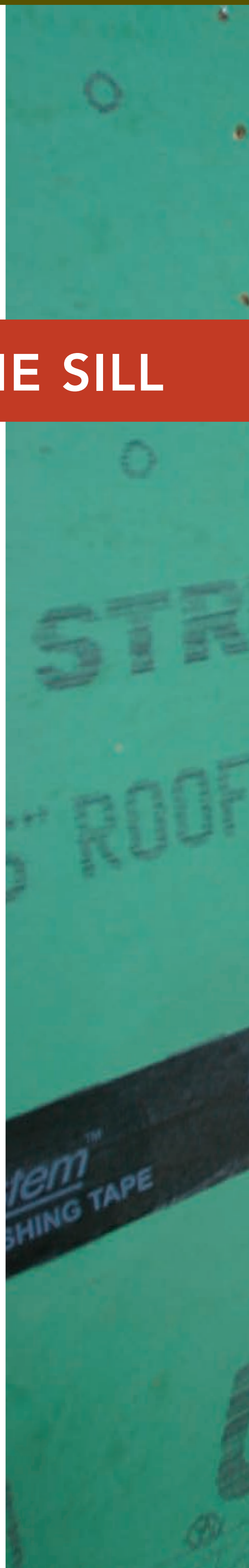
Not all windows are created equal, of course, and it's tough to predict long-term performance. But I don't discriminate or try to predict. Every window I install—regardless of brand, material, or price—gets the same belt-and-suspenders treatment to ensure that air and water leaks aren't going to be an issue.

Aim for waterproof, but plan for leaks

We should always assume that water will find its way into a window opening. Even if the installer does a per-

IT STARTS WITH THE SILL

Create your own sloped sill. *Remove stock from the rough sill to provide drainage in the case of leaks. Draw one line 3 in. from the outside face of the opening, and another about ¼ in. down from its outside edge. To create the slope, use an angle grinder equipped with a rough-grit flap disk.*



Installation

Width plus 12. *Cut a piece of flashing tape 12 in. longer than the width of the opening, which allows 6 in. of tape to extend up each side.*

Keep the transition tight. *Use a rafter square to press the tape tightly into the corners where the sill meets the sides of the rough opening, eliminating bubbles under the tape that are vulnerable to puncturing.*

Continuous outside corners. *You can buy flashing tapes made for curves, but they're expensive. Protecto Wrap tape is far more affordable and has enough flexibility to be stretched down onto the sheathing, where I tack it in place with button-cap nails.*

fect job with sealing and flashing, water can still leak through the window unit itself—especially as the materials, transitions, and sealants go through many cycles of expansion and contraction over time. Gravity, capillary action, blowing rain, and pressure differences can push and pull water into these weak points.

Water leaks from windows usually show up at the sill. Because this is the most vulnerable area of a window, it's also where the weatherproofing efforts begin.

As long as there is an air gap in place, a sloped and flashed rough sill is the best way to protect this vulnerable area. Creating a back dam along the rear edge of the sill flashing is one way to ensure that leaks under the window can't reach the interior of the opening, but I typically don't use back dams unless specifically required by the window manufacturer. I've found that they can complicate rough-opening dimensions, interfere with shimming the window off of the sill pan, and make it difficult to air-seal the bottom of the window.

A piece of bevel siding laid across the rough sill of the opening is the traditional choice for creating a slope, but it requires planning to make sure there is adequate height in the rough opening to fit the siding and layers of flashing tape. Manufactured sill pans are another option and are certainly better than nothing, but I don't like them. The ones I've tried don't have the amount of slope I prefer; can make shimming, air-sealing, and trim installation more difficult; and often are two halves that need to be pieced together and are then never visible for inspection. I prefer to avoid questionable joints or seams in this vulnerable area.

My favorite method is to add the slope right to the rough-sill framing. Sloping the sill after it has been framed eliminates any worry about reducing the height of the rough opening because you're actually enlarging it.

In addition to the sloped sill, the opening is protected with flashing tape, with the weakest interface being the spot where the sill meets the jack studs on each side. There are many ways of cutting flashing tape to fit this situation, but I prefer to stretch the sill flashing around the corner, eliminating the seam altogether.

If the window manufacturer allows it (some require continuous support at the sill), install the window atop spaced shims to increase the drainage and drying potential underneath the window unit and above the sloped, flashed sill.

The biggest obstacle in the drainage path is typically the window's bottom nailing fin. Do not caulk it, do not tape it, do not seal it in any way. Some window manufacturers call for a dashed bead of caulk, but I believe this is just asking for trouble. It's also much easier to tell my crew "No caulk at the bottom" and get consistent results rather than "X lengths of Y diameter caulk with Z amount of space

Easy air-sealing opportunity

Regardless of window brand, material, or type, I eliminate the possibility of hidden air leaks through joints and seams in the window frame with vapor-permeable Pro Clima Uni-Tape before the window is installed.

SEAL THE SIDES,

Sides are simple. *Cover each side of the opening with a piece of flashing tape that bridges the gap between sheathing and framing and that extends down to and over the top of a horizontal piece of the same tape, reinforcing the seam where the sill flashing adheres to the wall. I like Zip System Tape or 3M All Weather Flashing Tape 8067.*

Caulk three sides. *Lay a bead of high-quality caulk along the sides and top of the opening, keeping it close enough to the edge so that the nailing fin will compress it. Never caulk across the bottom. If the corners of the nailing fin are designed to receive a piece of manufacturer-supplied adhesive flashing, skip the caulk in the top corners, as shown here.*

BUT LET THE BOTTOM DRAIN

Bottom first. _Rest the window on the edge of the sill, tip it upright, and slide it straight in against the caulked sheathing._

Caps make a gap. _To promote drainage, slide caps from button-cap nails under the bottom nailing fin, pressure-fitting one next to each nail. These caps are thick enough to create a gap but not so thick that they will complicate trim installation._

Reinforce the fin. _Zip System Tape is 3¾ in. wide, which is wide enough for it to be adhered to the sheathing, across the nailing fin, and onto the side of the window frame._

between them" and then hope for no problems. I like to go even one step beyond by providing a gap behind the nailing fin to promote further drainage.

Deal with air from the inside

In an ideal world, the window unit and any manufacturer-installed jamb extensions have airtight joints, but a builder's best method for assessing airtightness is the blower door, and that means the window is already installed. I'm sure that some manufacturers seal this connection, but it's safer not to assume. I eliminate the possibility of a leaky unit by applying tenacious acrylic-adhesive flashing tape over any seams and joints in the window frame before it's installed. It pays to seal the joints in the rough opening as well to eliminate short circuits or air leakage from surrounding stud cavities. Control the window unit, control the rough opening, and then you can confidently address the space that's left between the two.

Canned spray foam is probably the most common way of sealing between the window unit and the framing. My biggest gripe with this method is that it's difficult to inspect for quality without a blower-door test. On a house I tested recently, I was surprised to find air coming through the spray foam around windows and doors, most likely in the area of a shim, which I've found to be the most vulnerable leakage point.

There are many variables to consider if you're relying on spray foam as an air barrier in this location—the size, shape, and consistency of the bead; whether the can was shaken adequately; if the humidity is suitable; and the texture and temperature of the substrate—so I prefer to think of this spray foam only for insulating purposes. Backer rod and caulk followed by a layer of vapor-permeable flashing tape is what I use as my air-control layers.

I buy several packets of backer rod in diameters of 3/8 in., 1/2 in., 5/8 in., and 3/4 in. to accommodate the different-size gaps I typically encounter, and I always use a rod that is slightly fatter than the gap being filled. For gaps smaller than 3/16 in., I skip the backer rod and simply caulk the gap. In all cases, I use a high-quality elastomeric or polyurethane sealant made for windows and doors, such as Sonneborne's NP1, Sika's Sikaflex, or Dap's 3.0. These sealants have better adhesion than typical silicone but still allow for plenty of expansion and contraction.

Flashing tape doesn't receive enough attention for use in this location. It's fast, durable, effective, and easy to inspect. Plus, it's the one air-sealing layer that's guaranteed to clear the shims installed around the window.

I prefer a tape that is vapor permeable—I use Pro Clima Uni-Tape—to eliminate it as a potential barrier should any moisture around the window need to dry toward the interior, but I would use something impermeable in a pinch. Tape is typically applied to the rough framing and the jamb-extension edge, but it's important to keep in mind the exposed reveals of the trim when placing the tape.

When followed by careful installation of the drywall, the exterior trim, and the head flashing (all of which are areas that should be handled with care to avoid damaging flashing tapes and air-sealing tapes), you've improved the performance of one of your building's weakest links. □

Brian Knight is owner of Springtime Homes in Asheville, N.C. Photos by Justin Fink.

AIR-SEAL FROM

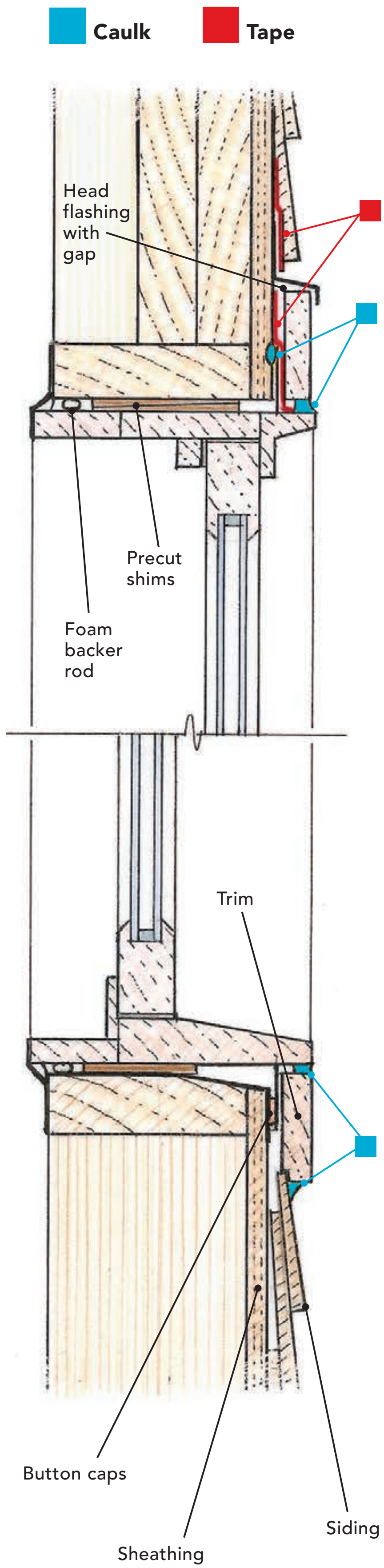
A conservative bead of foam. *A thin bead of low-expansion spray foam offers limited air-sealing and insulation, but avoid filling the entire cavity, especially toward the bottom, to allow for drainage in the case of water entry.*

A caulk joint that will last. *Foam backer rod cut and pressed in around the window jamb creates a flexible base for the bead of caulk that follows it. Use a wet finger to smooth the bead against the backer rod, creating the ideal hour-glass shape that allows the sealant to expand and contract without cracking or debonding.*

Drawing: Vince Babak

Tape is the innermost air-seal. *Applied so that it bridges the gap between rough frame and window jamb, flashing tape provides an easily inspectable air barrier that, like the backer rod and caulk, isn't affected by the shims along the four sides of the window.*

Finish strong on the exterior



The exterior weatherization—the tape, the head flashing, the caulk, and their integration with the trim and the siding—is the last step in a well-detailed window installation. It's fairly common for people to unknowingly seal the crucial water exit points while missing some of the important leak-prone areas. Here are some general guidelines.

- Wherever there is flashing or a shingle-style transition in which one piece laps over another, such as clapboard over the head flashing, don't caulk. Any transition other than a lap, such as a butt joint where siding meets trim, should be caulked.
- Whatever the material, seal the top and bottom pieces of trim to the nailing fin or window frame to prevent water running behind it, even if the wall includes a vented or ventilated rain-screen assembly.
- Don't let installers place siding directly on top of the head flashing, and never add caulk in this location. Space the siding off the flashing to achieve a gap of ⅛ in. to ¼ in.; otherwise, paint can seal this water-drainage pathway.

A Practical Approach to

This straightforward method focuses on water management, air infiltration, and smooth operation

BY MARK PETERSEN

When it comes to window installation, I've always been careful about following the manufacturer's instructions. And that approach has paid off because I've only had a few windows fail, all of which were covered by the manufacturer's warranty and repaired by the window company itself. However, many of the instruction manuals only include the bare minimum amount of information, and that has a lot to do with how windows are tested.

Windows achieve their performance ratings by being tested on very specific and somewhat generic wall assemblies, and manufacturer's installation instructions are designed to replicate those same conditions. But test conditions don't always address the real-world environment and all the challenges installers face on the job site.

On this new-construction project, I installed casement windows with 6⁹⁄₁₆-in. jamb extensions. These windows are fiberglass inside and out and have a nonintegral nailing flange. While you might be installing a different style of window on your next project, most of the tips in this article apply to a wide variety of window installation scenarios. □

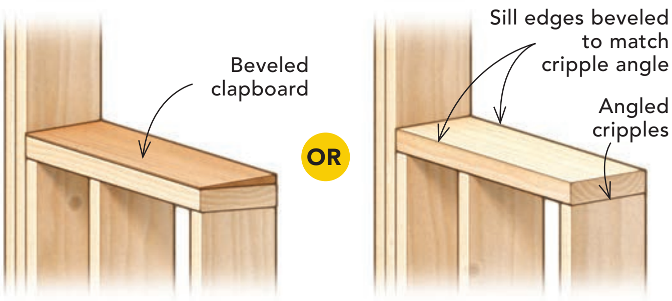
Mark Petersen is technical editor. Photos by the author.

Drawings: Christopher MIlls

Installing Windows

PREPARE THE ROUGH OPENING

Some manufacturers recommend that their windows have a ¼-in. gap between the window and the rough opening, the same gap size that was used when the window was tested. I find that ⅜ in. on each side makes it easier to square up a large window in a less-than-perfectly-framed opening. If an opening was framed out of square, plumb, or level to even a moderate degree, the window will need to be rotated within the space, which means that the gaps at the corners will be reduced or eliminated altogether. With a clearance of only ¼ in., there may not be enough room to fully correct the window. That small gap also makes it difficult to insert a spray-foam insulation tip/straw into the gap, especially on windows with jamb extensions.



Direct water out with a sloped sill

These sills were sloped by cutting the cripples underneath the sill at a 4° angle. To keep the rough sills in plane using this method, shave a bit off by ripping the edges on a tablesaw at the same angle of the slope, or install them in plane with the exterior and shave off the inside projection with a handheld power planer. If you use a presloped pan liner or piece of beveled siding, you'll have to frame the openings larger to accommodate the additional thickness.

Cut and wrap the WRB

It's best not to have seams in the plywood directly above rough openings, but this is not always reality. To prevent water that may find its way behind the water-resistive barrier (WRB) from funneling into a rough opening, caulk or tape intersecting plywood seams before installing the WRB. Once the WRB is fastened to the wall, cut across the top and bottom and down the middle of the opening. Fold the sides into the opening, trim them off flush with the inside of the jack studs, and fasten them in place near the inside edge.

Install pan flashing

Whichever type of pan-flashing system you use, make sure that it's compatible with the type of WRB you're working with. In this scenario, I used all DuPont products to ensure they would all play together nicely. I installed 9-in. Flex Wrap pan flashing so it would cover the entire sill and lap onto the WRB at least 3 in. onto the wall. I cut the flashing 1 ft. longer than the sill so it would run 6 in. up onto each jack stud, and rolled it out after installation to achieve proper adhesion.

Seal with tape

Use seam tape to seal the WRB to the jack studs. I also cover the edges of the pan flashing with seam tape, mainly to keep it in place until it gets covered with siding, which is especially important in cold-weather applications.

BEFORE YOU SET THE WINDOW

Fold back the top of the WRB
Cut up and away about 6 in. at a 45° angle from each top corner. Fold the top flap up from underneath, or tape it up out of the way.

Tack level shims in place
It's easier to install the shims perfectly level before setting the window. On mulled units, it's critical that you install shims directly below the mulls so the window won't distort over time.

Cut the shims just long enough that they fully support the entire window frame, but not so long that they become difficult to insulate around. And do yourself a huge favor and tack the shims in place with trim nails before you insert the window; there's no chance that the shims will stay put through the installation process without nails.

Weep strips make a pathway for water
I recently discovered a drainage product called Wic-Dri, made by Weather-Bloc Systems. It's an adhesive-backed strip of interwoven microfibers engineered to minimize air infiltration while creating a path for water to escape from a rough opening. The manufacturer recommends installing a strip on the wall under the entire length of the bottom nailing flange, but I ran it to the inner edge of the opening and down the face of the wall so that water will be able to pass right through the layer of spray-foam insulation.

Caulk behind the flange
Use caulk that's compatible with the WRB to seal the area behind the nailing flange. Don't caulk the bottom of the opening—if unwanted water does find its way in, a caulked bottom flange will prevent it from escaping.

SET, SECURE, AND SQUARE

Tip the window into place

These windows have nonintegral nailing flanges, and the side flanges can sometimes slip out of alignment or slide out altogether. To prevent this, tape them in place with WRB seam tape before setting the window (photo right). If you know the opening is relatively square in relation to the sill, have a person inside center the window within the opening before tipping the window into place (photo left).

Secure the window bottom

Start by installing a screw at the very bottom of the nailing flange on each side of the window. I prefer screws to nails for several reasons. Screws have more holding power, they eliminate the risk of errant hammer blows, and they make it easier to back up a step to make adjustments. Use screws long enough to sink at least 1 in. past the sheathing and into the framing.

Check for square

Windows are not always perfectly square when you set them (especially large windows), and so they need to be corrected within the opening. By setting a window on level shims and securing the bottom, you can achieve plumb, level, and square by moving the top to one side or the other. Check that the window is square by measuring diagonally in both directions. Push the top one way or the other until both measurements are the same, and then use a level to confirm that the sides are plumb and the top is level. When everything is in place, add one screw at the top of each corner.

CHECK YOUR REVEALS

Line up jamb extensions with the drywall

If you've ever installed window casing, you can appreciate how much easier the job is if the window jamb extension is in alignment with the drywall. The framing around windows is not always even, so instead of just measuring out from the jack studs, I prefer to have the person inside use a ½-in. piece of plywood to represent the missing drywall. If the window you're installing does not have a jamb extension, simply measure in from the window to the block, and push in or pull out the window until everything lines up as you install the screws in the flange.

Check sash and frame alignment

To ensure smooth operation and to get the most energy efficiency from your windows, it's important that all the gaskets and weatherstripping on the frames and sashes line up properly. The best way to accomplish this is to make sure that the space between the sash and the frame are consistent. Start with the exterior reveals on the sides and the top of the window. Make adjustments simply by pushing the frame to one side or the other until the gap between the frame and sash is even. Add a screw in the side flange near the middle to hold things in place.

Before securing the rest of the flange, check the operation and reveals on the inside. Open the window all the way, and check that the gap between the hinge side of the sash and the frame is even. Close the window as far as it will go, but don't latch it. Check for consistent reveals between the nonhinged side of the sash and the frame.

If you are installing a window that requires shims and fasteners through the sides of the window jambs, now is the time to complete that process. Once everything is in alignment, finish fastening the nailing flange per your window manufacturer's recommendations. These windows require a screw in every other hole in the nailing flange.

SEAL IT UP

Seal the corners

Once the window is fully fastened, I fill all four corner gaps with caulking before covering them up with corner gaskets. Use the corner gaskets supplied by the manufacturer, or make your own out of window flashing tape if they're not provided.

Seal the sides

One potential drawback to a nonintegrated nailing flange is that the connection between the window and the flange is not always 100% watertight. This is easily mitigated when installing the window flashing tape over the flanges. Simply roll the tape ¼ in. up onto the window frame, completely covering the window/flange connection.

Run the flashing tape on the sides of the window just a bit longer than the top and bottom nailing flanges, and then run the top flashing tape 1 in. or so past the tape on the sides. You'll have to make a notch where the tape meets the corners. Leave the bottom flange untaped to maintain a path for unwanted water to escape. Use a roller to adhere the tape fully.

Seal the top

The last step on the outdoor portion of the install is to fold down the WRB flap at the top and use seam tape to secure it to the flashing tape. On windows that are protected by large eaves directly above, I run a continuous horizontal length of tape. For windows with a large area of exposed wall above them, I use the skip-tape method. That is, I tape about 8-in. to 1-ft. sections and leave a gap between them. The thought here is that any water that finds its way behind the WRB has a route back to the exterior.

Even though this window has a built-in drip cap, I have the siders add another Z-flashing/drip cap that will get taped to the WRB. The end detail (whether it gets bent up or down) of this final head flashing depends on the type of siding being installed, what the siding manufacturer recommends, and what the siding installation company prefers to do depending on their experience, preference, and warranty stipulations.

Seal up the inside

Because I'm relying on weep strips to usher uninvited water back outdoors, I simply fill the cavity between the window frame and the rough opening with spray foam. It's not easy to see exactly what's going on in that small space, but wearing a head lamp helps quite a bit. Only fill the space around the window frame; don't fill the entire space behind the jamb extensions. Filling that whole gap with foam would conceal the weep strips, which would sort of defeat their purpose. Also, if the jamb extensions are warped or bowed, adding foam behind them would permanently lock in the distortion or could even make it worse.

Create a back dam

The last step in this installation process is to create a back dam by caulking the gap between the inside edge of the jamb extension and the rough opening on the bottom and up each side 6 in. or so. This will prevent infiltrating water from running down into the wall cavity below. If it seems that the bottom window jamb extension is not perfectly straight, which is often the case on large windows, you may want to wait to create a back dam until just before the casing is installed. Otherwise, the caulking will secure the jamb extension in place, and it won't be able to be straightened out when it's time for trim.

If the jamb extension is going to be painted, or if you don't mind putty-filled fastener holes, you could use shims and tack the bottom jamb extensions in place. If you do wait to create your back dam until just before installing the casing, you'll likely have to trim off some drywall, which is easy enough to do with a multitool.

Installing Prehung

This straightforward method focuses on water management, air infiltration, and smooth operation

BY MARK PETERSEN

PREPARE THE ROUGH OPENING

It requires more space to install a door into a cockeyed opening. So, when you measure the size of the rough opening to make sure it's big enough, check that it's relatively level, plumb, and square. If it's not, you may need to shave off parts of the framing with a reciprocating saw. A rigid sill pan shrinks the opening ⅛ in. on both sides, so you may need to add ¼ in. to accommodate the pan.

CUT OPEN THE WRB

Cut the water-resistive barrier (WRB) flush at the bottom of the opening and leave about an inch of sheathing exposed at the sides and top. Cut up and away from the top corners about 6 in. and tape the flap up out of the way.

LEVEL THE SUBFLOOR

Starting with a flat, level surface may be the most important step in any successful door installation. The strike side of this opening needed to be raised about 3⁄16 in. Laying down strips of self-adhering membrane is a fast, simple, and effective way to straighten and level a subfloor. I started by installing a 16-in. strip away from the low corner. I then added another strip half that size, with another smaller strip on top of that one.

Exterior Doors

STEP BY STEP
STEP BY STEP
STEP BY STEP
STEP BY STEP
STEP BY STEP
STEP BY STEP

I still recall helping install a new-construction door for the first time many years ago. We applied some sealant to the subfloor, centered the door in the opening, and then drove four casing nails through each side brick molding and two through the top—that's it. We didn't even use a level. What this process lacked in finesse it certainly made up for in speed. In my boss's defense, helpful installation guides were often hard to find back in the day, if they existed at all.

While many manufacturers have gotten better at informing and training installers, there's still plenty of room for improvement. I recently completed a job where, due to supply-chain challenges, there were three different brands of exterior doors on the same project. I was amazed at how the manufacturer's installation instructions varied from pretty good to completely incomprehensible. I'm not sure how long that first door I helped install lasted or how well it worked, but I'm confident that any door installed using the installation method I've put together in this article will perform at a high level, last for decades, and all but eliminate the fear of a callback. And no step of this installation requires any fasteners in the brick molding. □

Mark Petersen is technical editor. Photos by the author.

INSTALL THE FLASHING

A sill pan made from flashing tape is an effective way to protect the sill, but with this Therma-Tru door, the manufacturer offers a more comprehensive warranty if the door is set on their proprietary rigid flashing. Choose a window and door sealant rated for both exterior and indoor use. While most of the sealant will be isolated to the exterior side of the home, the sealant between the backdam of the pan and the sill is technically indoors.

1

FLASH THE SILL
Install the sill flashing tight to the subfloor and wall sheathing and adhere it to the WRB with flashing tape and a roller. All sealants and tapes must be compatible with the WRB you're working with—here both the WRB and flashing tapes are DuPont products.

3

GLUE THE PAN FLASHING
After the two outside sections of the flashing are in place, glue the middle section down with PVC cement, which in this case was included with the pan-flashing kit.

2

CAULK UNDER THE PAN FLASHING
This rigid flashing requires three continuous beads of sealant on the subfloor, a bead along the bottom plates, and one bead along the face of the sheathing and up the corners a bit.

4

SEAL THE PAN FLASHING
Caulk along the back edge of the backdam, the top edge on the sides, and the two seams in the middle of the pan. Smooth out the caulk on the sides and middle with a putty knife.

5

FINISH THE FLASHING
Start on the side jambs, and seal the WRB to the sheathing with flashing tape. Roll the tape over the upturned side of the pan flashing and down just past the sill flashing. Then install the head flashing so it extends just past the side-jamb flashing.

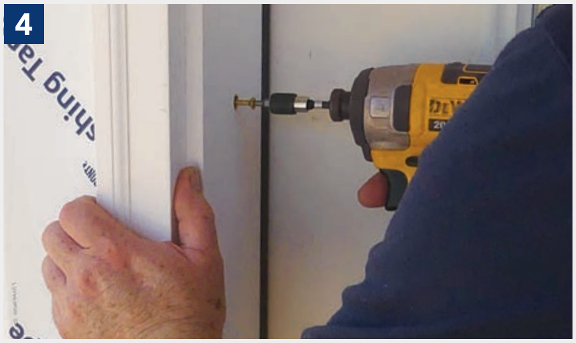
SECURE THE DOOR IN PLACE

The goal of every installation is to end up with a door that opens easily, closes tightly, does not swing on its own, and keeps indoor spaces safe, dry, and comfortable. To achieve this, the door has to be installed plumb in the opening with its brick molding in consistent contact with the flashing behind it. If the wall or opening is out of plumb, these deficiencies should be fixed as part of preparing the rough opening before you've installed any flashing. Failure to fix these problems before setting the door will lead to compromises that can shorten the lifespan of the door and the integrity of its air- and watertightness.

PREDRILL HOLES FOR JAMB SCREWS
Predrill three ⅛-in. holes on each side jamb with a countersink bit. Drill through the "fat" part of the jamb at same height as the hinges on both sides. Some doors require additional fastening between these hinge-height screws. I like to run the countersink portion of the bit far enough in that I can conceal the screw heads with dowels.

CAULK THE BACK OF THE BRICK MOLDING
Caulk the brick-molding miters and the seam where it connects to the door jambs. Also run a bead around the entire outside edge of the brick molding to help seal it to the sheathing.

PLUMB BOTH SIDES IN TWO DIRECTIONS
Set the door in place and center it in the opening. If your door has a plug holding the door closed that can't be accessed once it's tipped into place, remove it beforehand. Use a 6-ft. level to make sure the side jambs are plumb in both the in-to-out and side-to-side directions.



PARTIALLY SET CENTER SCREWS
Drive #8 2½-in. screws into the center holes on both side jambs. Drive the screws into the framing but don't tighten them all the way. This will hold the door in place while you add the shims.

PREHUNG EXTERIOR DOORS CONTINUED

FASTEN THE HINGE SIDE

Double-check that the hinge side is plumb and drive the top and bottom screws into the framing, but do not drive them in all the way at this point.

5

ADD SHIMS AND DRIVE IN THE SCREWS
At each fastener location, fill the entire gap between the door and the opening with shims so the jamb does not get bowed or pulled out of plumb when fastened. I prefer horseshoe shims, but if the jack studs are twisted, use wedge-shaped shims to prevent the jamb from twisting when driving the screws home.

Timberwolf Stackable Horseshoe Shims

REINFORCE THE HINGES
This door included two #10 $2\frac{1}{2}$-in. screws to reinforce the top hinge, but I like to swap in a long screw for each of the lower hinges as well. I install them in the top hole closest to the weatherstripping. Predrill a $\frac{1}{8}$-in. hole into the framing before installing the screws.

6

FASTEN THE STRIKE SIDE

7

RE-CHECK FOR PLUMB
Check again for plumb in both directions on the strike side.

INSPECT WEATHERSTRIPPING COMPRESSION
With the door pulled closed, measure the top and bottom of the weatherstripping to ensure that it's being compressed equally along the entire length of the strike side of the door. Also check to see that the reveal between the panel and jambs are even.

8

9

PARTIALLY SET TOP AND BOTTOM SCREWS
If the door panel is not contacting the weatherstripping evenly, adjust the strike-side jamb until it does align evenly, and then secure the top and bottom screws into the framing, but don't fully drive them in yet.

SHIM AND FINISH DRIVING SCREWS
Install shims the same way you did on the hinge side and finish driving the screws into the strike-side jamb. Don't install any fasteners through the head jamb. Leaving the head jamb detached from the framing allows the house to settle without distorting the door.

10

SEAL THINGS UP

Setting a door that operates flawlessly is the most satisfying part of the process, but proper execution of these final steps is just as important. Don't rely on the siding contractors to seal up around the door with the same attention to detail that you would. After all, if your door is not air- and watertight, you'll be the one heading back to the job to fix it.

ADJUST THE SILL
If your door has an adjustable sill, raise or lower the sill so that the door-sweep gasket presses down on a dollar bill to create enough tension as you pull it out, but not so much that you can't slide it out without tearing it. Repeat this process near every adjustment screw.

TRIM WEATHERSTRIPPING AND ADD CORNER PADS
Make sure that the weatherstripping on both side jams fits properly at the top and bottom after adjusting the sill. If it's long, pull it out and trim it flush with the sill. Next, install the corner pads per the manufacturer's instructions. Corner pads are designed to prevent the weatherstripping from sucking water up like a straw when the inside of the house experiences negative pressure during a storm—but they don't work if you don't use them.

INSULATE BEHIND THE JAMBS
Fill the gap between the door jambs and framing with low-expanding spray foam.

PREHUNG EXTERIOR DOORS CONTINUED

4

CAULK AND INSTALL RIGID HEAD FLASHING
Caulk both the bottom and back side of the rigid head flashing before you install it. Check with the siding manufacturer to determine if the flashing should be trimmed flush, folded up, or wrapped down over on the ends of the brick molding.

7

COVER THE SCREW HEADS
Glue, install, and trim the dowels, or fill the screw holes with wood filler.

5

6

TAPE THE HEAD FLASHING AND THE WRB
Seal the rigid head flashing to the sheathing with flashing tape, then fold down the WRB and cover the cuts and loose edge with seam tape. When installing a door below large unsheltered walls, I use the skip-tape method and leave gaps in that seam as an escape route for any water that may find its way behind the WRB.

8

CAULK THE BRICK MOLDING
Tool the caulking into the edge of the brick molding so a trim board is able to sit flush against it.

New Window in an Old Opening

A leak-free installation depends on compatible materials and multiple layers of defense

BY BILL ROBINSON

A flanged new-construction window in an existing opening can be difficult to install. The difficulty is integrating the new window's nailing flange into the house's existing drainage plane so that any water leaks are directed outside the building.

A leak-free installation is important because water in the wall can give mold, rot, and insects a foothold in the wall cavity. In my hot, humid Southern climate, I've seen poorly installed windows create major problems in only a few months.

Fortunately, you can install a new window in an existing opening without problems if you just remember the four Ds: deflection, drainage, drying, and durability. Deflection means that rain is naturally moved away from the window and the opening. Drainage allows water that does infiltrate to find its way outside the assembly unimpeded. Drying suggests that any material that does get wet shouldn't stay wet for long. Durability tells us that the products we use to shed water should last at least as long as the window itself.

You'll also want to follow the window manufacturer's installation instructions to the letter. If you can't find the instructions or if your situation is unusual, follow the guidelines in ASTM E E2112 07, which is titled "Standard Practice for Installation of Exterior Windows, Doors, and Skylights."

Another important consideration: A properly installed window starts with a unit that's the right size. You may be able to measure the inside of the existing window and guess the jamb thickness and rough opening, but that's a potentially expensive mistake. A better approach is to remove the interior casing and measure the actual opening. □

Bill Robinson is the founder of Train2Rebuild (www.train2rebuild.com), a worker training/consulting firm in New Orleans.
Photos by Patrick McCombe, except where noted.

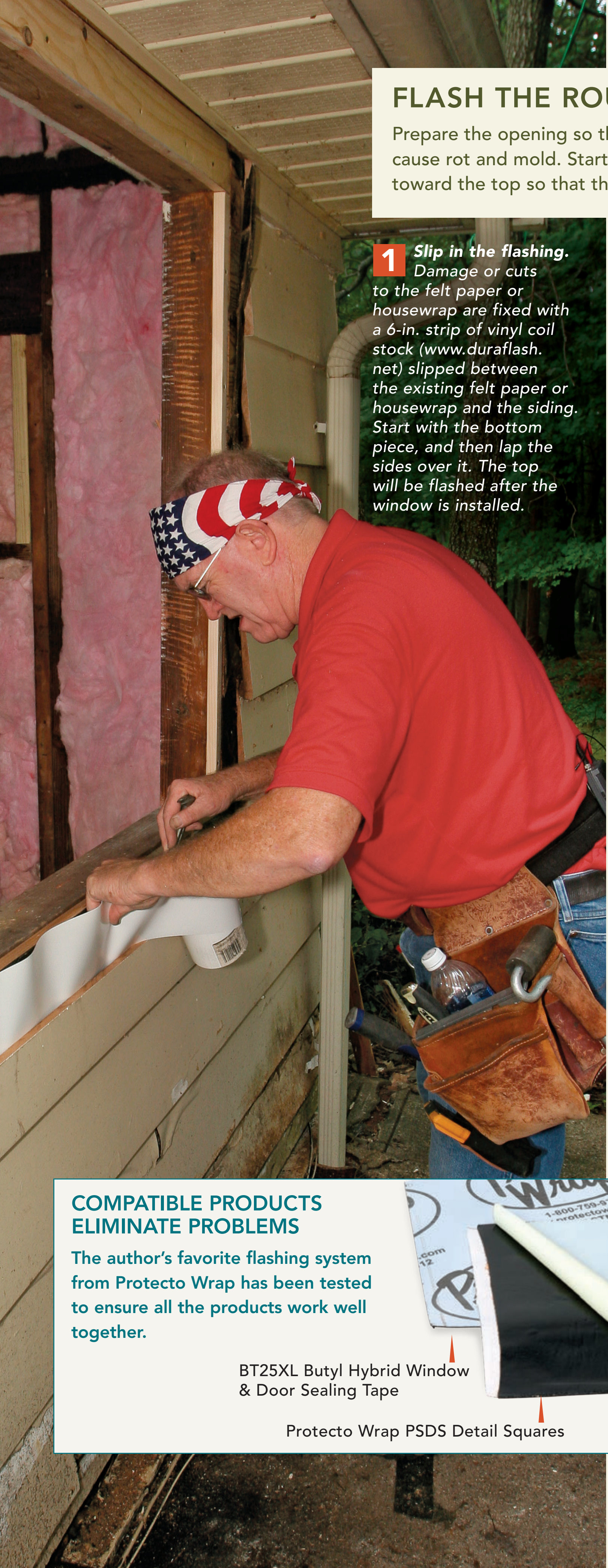
REMOVE THE OLD WINDOW

The first step is to cut back the siding with a circular saw and oscillating multitool so that you can pry out the old window and integrate the new flashing materials into the existing housewrap or felt paper. Keep the cuts straight with a plywood saw guide, and take care not to cut the felt or housewrap.

1 ***Cut the siding.*** *Use a circular saw and a cutting guide (see "Building Skills," FHB #216) screwed to the house to cut back the siding around the window. The cut allows you to integrate the new flashing into the existing housewrap or felt and makes room for casing that will surround the window. Plan the cuts to account for the height and width of the new window, the width of the casing, and an extra ½-in. space for a ¼-in. caulk joint on all sides of the window.*

2 ***Connect the corners.*** *An oscillating multitool is perfect for finishing the cut without overshooting the corner. Plunge the multitool into the sawkerf, and nibble away at the cut. Again, try not to damage the felt paper or housewrap. Once the cuts are complete and the siding is removed, pry out the old window.*

Product photos: Dan Thornton



FLASH THE ROUGH OPENING

Prepare the opening so that water won't get inside the wall cavity, where it can cause rot and mold. Start all flashing layers at the bottom of the opening, and work toward the top so that the laps shed rather than catch water.

1 ***Slip in the flashing.*** *Damage or cuts to the felt paper or housewrap are fixed with a 6-in. strip of vinyl coil stock (www.duraflash.net) slipped between the existing felt paper or housewrap and the siding. Start with the bottom piece, and then lap the sides over it. The top will be flashed after the window is installed.*

2 ***Work from the bottom up.*** *Flexible flashing is installed over the vinyl flashing and lapped inside the opening. Flexible corners are then installed on top. A seam roller is good for applying the self-adhesive materials in corners and other tight spots.*

3 ***Sill pan is next.*** *Protecto Wrap's Protecto Sill Drainage System is self-adhesive with an integral back dam. Made with a fibrous top layer, it allows water to move through capillary action to the outside, even with the window sitting right on top.*

COMPATIBLE PRODUCTS ELIMINATE PROBLEMS

The author's favorite flashing system from Protecto Wrap has been tested to ensure all the products work well together.

Protecto Sealant 25XL

Protecto Sill Drainage System (PSDS)

BT25XL Butyl Hybrid Window & Door Sealing Tape

Protecto Wrap PSDS Detail Squares

INSTALL THE WINDOW

Place the window in the opening, and make sure it can be made plumb, level, and square. Get help lifting heavy units so that you don't injure yourself or damage the window. You can eliminate the possibility of damaging the window with errant hammer blows by using screws rather than nails for installation. Be sure to follow the manufacturer's instructions for the number and placement of fasteners.

1 ***Test-fit and seal.*** *After test-fitting the window, remove it, and apply sealant to the top and side nailing flanges. Don't seal the bottom flange, or water that leaks in will be unable to get out. Sealant should squeeze out the nail holes.*

2 ***Square the window.*** *Check for plumb and level, then use a truss-head screw to secure one of the top corners. With the window in place, pull diagonal measurements to ensure that the window is square. Then go inside and check the window's operation. If it works correctly, install the rest of the screws according to the manufacturer's directions.*

FLASH THE WINDOW

Flexible flashing tape covers the side nailing flanges, while the top is protected by a rigid-aluminum head flashing with the housewrap and flexible flashing layered over it. The bottom nailing flange is left exposed so that water can escape.

1 ***Flash the flanges.*** *Apply a layer of flexible flashing to the side nailing flanges. The flashing should be lapped onto the window frame and rolled vigorously to ensure a good bond. Don't cover the bottom flange, or it will trap water.*

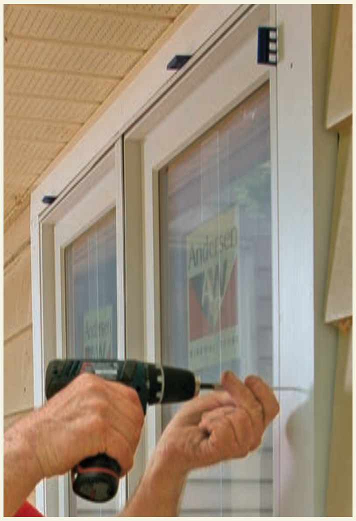
2 ***Install the head flashing.*** *A rigid-aluminum flashing is the window's first defense against water intrusion. Install the flashing over the top nailing flange with roofing nails or truss-head screws.*

3 ***Cover the head flashing.*** *A layer of flexible flashing directs water over the aluminum head flashing. When possible, tuck this under the housewrap or felt barrier so that water running down the building is directed away from the window opening.*

CASE THE WINDOW

New casing hides the window's nailing flange and fills the gap between the unit and the existing siding. Select casing stock that's slightly thicker than the siding, and choose a width that complements the house's other trim elements.

1 ***Install an assembled casing.*** *Using pocket screws and glue for assembly, run the head casing over the side casing, and put the bottom between the sides. Remember to make the assembled casing ½ in. larger than the window so that you can apply a bead of sealant.*



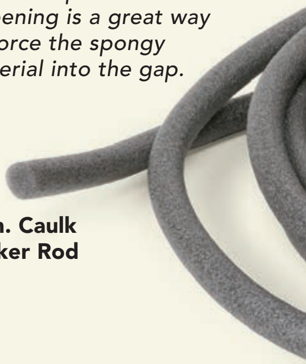
2 ***Fasten the casing.*** *Plastic spacers from Handi-shim ensure an even gap that will be caulked later. The author prefers color-matched screws to fasten the casing to the window framing because they eliminate hammer dents.*

Handi-shim

CAULK AND AIR-SEAL

Paintable polyurethane caulk and spray foam are the last steps in protecting against air and water infiltration. Be sure to use a sealant that's compatible with the window and the flashing materials.

1 ***Install backer rod.*** *Fill the ¼-in. gap around the window frame with backer rod so that the caulk will be slightly thinner than it is wide. A spline tool used to replace window screening is a great way to force the spongy material into the gap.*



½-in. Caulk Backer Rod
Dap

2 ***Air-seal the inside.*** *Use low-expansion spray foam to fill the gap between the window and the rough opening. A professional spray gun applies a more precise bead, and its high-yield canisters are a better value than straw-dispensed foam.*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— Jake Bruton,
Aarow Building
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