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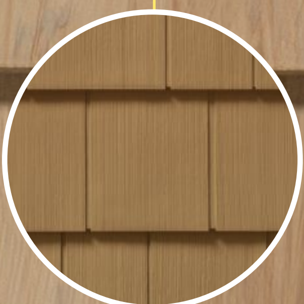

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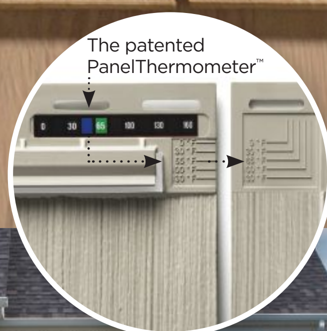

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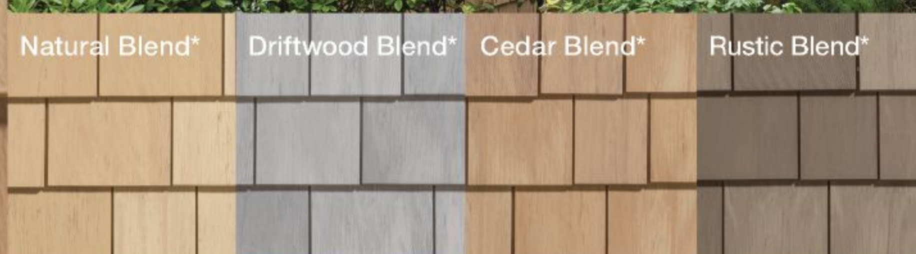

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On the cover: Bangor, Maine, contractor David Kelly hooks up an 8-kilowatt photovoltaic array on the roof of a net-zero home. See the story on page 27. Photo by Ted Cushman.

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BY JLC STAFF

Future-Proofing the Workforce

The monumental task of finding energized and qualified workers—especially young workers—in the construction fields has been all over the headlines since the upturn of the economy. Contractors everywhere in the country are clamoring for workers so they can build houses to meet rising demand.

To explore how building contractors can take a more proactive approach to solving their labor woes, we sat down with two enterprising painting contractors, Scott Burt and Todd Pudvar, who started a program with local vo-tech schools to train and recruit the next generation of workers.

1

Photos by Tim Healey

Scott Burt of Prep-to-Finish guides a student who is spray-painting for the first time in a hands-on program at a local vocational school.

What pushed you to start this program?
SB: When we did research in 2012, unemployment was generally about 9%. But we found that the unemployment rate of kids graduating from vocational programs was 30%. They would graduate from the program and couldn't find a job. On the other side of the coin, there were a million contractors saying, "We can't find anybody to hire." So there was a large gap that needed to be bridged.

What prepared you to work with local schools?
SB: I was a high-school English teacher in the 1990s. That's where Todd and I met. I had painted my way through college and grad school and had an active contracting company while teaching. After 20 years of painting together, Todd and I formed Prep-to-Finish [P2F] and launched a serious outreach effort to schools. The hardest part was getting the schools to understand that it is free skill-building for kids. We don't sell anything. Once we cleared that hurdle, our backgrounds in public education gave us credibility and access.

How would you describe what P2F does?
SB: We want to reach out to vocational schools and work with the kids, not necessarily to teach them how to paint—that's just the vehicle because it's our area of expertise. It's more to get these kids involved in building and teach them what they need to know to get jobs in the trades. P2F is a program to help them understand other career opportunities in the trades.

What is the format of your programs?
SB: Generally, we run one- to two-day workshops in the schools, sometimes multiple times per year. How a workshop is structured depends on what students are building in their program. Sometimes it is furniture, sometimes a whole house. Student participation is a required part of the curriculum.

Has your approach changed since you began?
SB: At our five-plus-year mark, we're able to go deeper with the schools—some schools, we've worked with every year—and we're starting to see kids for a second year, working with them their junior and senior years.

Have you hired anyone from the program?
SB: We've started taking on one student as an apprentice in their senior year. The work the apprentice did with us in the program last year was the thing that made the biggest impression on him.

How have you seen vocational programs evolve in recent years?
TP: There was a trend in the late 1990s and early 2000s that vocational programs had become a dumping ground. Before schools had IEPs (individualized evaluation plans) for students, if a student didn't fit the norm that the "square" classroom provided, they were put into vocational programs.

Now they have guys who've left the private sector—real carpenters, real plumbers, real electricians—guys who've got their degrees. These guys are teaching the classes now, so there's more authenticity to the programs. As a result, we're getting better graduates.

How should other *JLC* readers go about getting involved with vocational schools?
SB: Readers need to realize that teaching is about being a student of the game yourself—being a good listener and providing guidance with patience and reinforcement. We have to be proactive and go out and recruit youth (competing against the appeal and pay structure of the mechanical trades), and we have to be willing to teach and manage the students for it to work.

The best way *JLC* readers can get involved is by contacting their local tech school and requesting to get on the list for internship placements. Here they can provide a work-experience opportunity for a student. For those who desire to pass on their knowledge and be mentors, it's win-win.

Scott Burt of Prep-to-Finish watches over a group of students as they try the spray-and-roll-over technique of wall finishing **(2)**. Todd Pudvar demonstrates how to spray a finish onto a piece of furniture for students in a vocational school program **(3)**.

For a more detailed discussion of Prep-to-Finish, go to **www.jlconline.com/training-the-trades/P2F**.


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Q For years, I've installed 3-foot-wide membrane as ice-dam protection along the eaves of roofs. Recently, though, a local building inspector red-tagged us because the membrane did not go up 4 1/2 feet. I thought the 3-foot width of the rolls met the code requirement. Who's right?

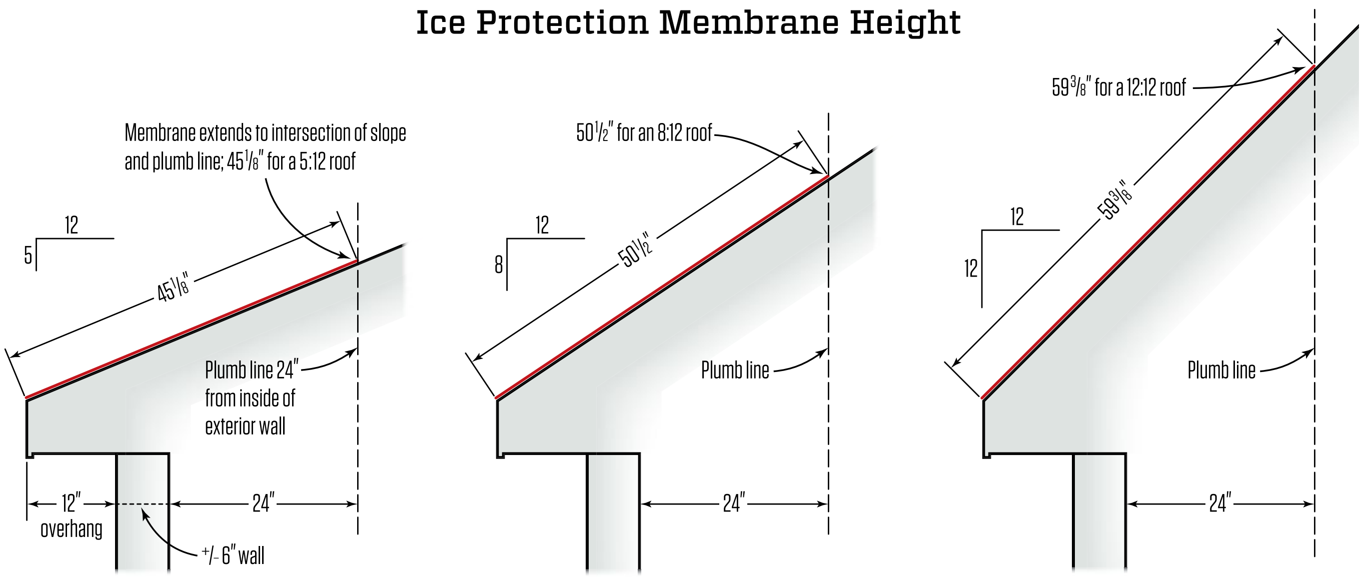
A Mike Guertin (instagram.com/mike_guertin), a builder and remodeler in East Greenwich, R.I., and a Roofing Workshop presenter at JLC Live, responds: The inspector is right, but before we get into why, let's be clear on the function of an ice-dam protection membrane along the eaves edge. Self-adhering membrane does not *prevent* ice-dam formation; it merely helps to prevent water that backs up behind an ice dam from leaking into the house.

Ideally, we want to reduce the chances for ice-dam formation by installing adequate roof and attic insulation, by preventing warm air from the conditioned space from leaking into the attic and warming the roof, and by ensuring good eaves-to-ridge ventilation in unconditioned attic spaces. *JLC* has published numerous articles covering best practices for roof design, roof and attic insulation, and air-sealing. But don't think that the measures described in those articles will prevent ice dams from forming in all cases—under the right conditions, other factors such as sun exposure, weather conditions, gutters, thermal bridging, and roof geometry can contribute to the formation of ice dams.

The 2015 and 2018 IRC require an "ice barrier" on roofs in "areas where there has been a history of ice forming along the eaves causing a backup of water as designated in Table R301.2(2)" [Climatic and Geographic Design Criteria]. Your local code jurisdiction fills out the table. One entry on the table is "Ice Barrier Underlayment Required." So if you build in an area where that entry is filled out with a "yes," then you have to install an ice barrier.

The code section continues on to describe what constitutes an "ice barrier," where to install it, and how far up the roof it has to be installed: "The ice barrier shall consist of not fewer than two layers of underlayment cemented together, or a self-adhering polymer-modified bitumen sheet shall be used in place of normal underlayment and extend from the lowest edges of all roof surfaces to a point not less than 24 inches inside the exterior wall line of the building."

Ice Protection Membrane Height



Ice protection membrane and the code. To set the height of the ice protection membrane according to the code, measure 24 inches from the exterior wall and plumb up to the roof plane. The distance from the lower edge of the roof to the intersecting point of the slope and the plumb line is the minimum required height of the membrane. As seen here, the height of the membrane increases as the roof pitch increases.

Illustration by Tim Healey

As with many code entries, the language is slightly ambiguous, but when you break it down, it simply means that you have to install an ice barrier from the eaves edge up the roof slope until you reach a plumb line that's 24 inches from the exterior wall. The reference point on the roof slope is where that plumb line intersects with the roof sheathing. Without knowing the depth of the eaves overhang, the thickness of the exterior walls, or the pitch of the roof in the specific situation at hand, it is impossible to specify exactly how far up the roof the ice barrier actually has to go to meet code. My guess is that in your case, the building inspector made a ball-park estimate and came up with the figure of 4 1/2 feet.

To illustrate how far up the roof sheathing ice barriers have to reach, here are some examples using common slopes on roofs with a 12-inch eaves overhang (12-inch soffit). With a 5:12 roof slope, the ice barrier would have to extend 45 1/8 inches up the roof; with an 8:12 roof, the barrier would need to extend 50 1/2 inches; and with a 12:12 roof, that distance becomes 59 3/8 inches. If you have deeper eaves overhangs—say 24 inches—the ice barrier would have to be much wider. The one exception to the ice-barrier requirement is that ice barriers are not needed on detached, unconditioned accessory structures (such as sheds and detached garages).

The code language that says to measure from "the exterior wall line of the building" is not specifically defined in the code. Should that measurement be taken from the exterior face of the siding, the exterior face of the sheathing, the exterior face of the studs, the interior face of the studs, or the inside face of the drywall? In these situations, I always try to use the method that goes beyond the minimum requirements, so I'd take the 24-inch measurement from the inside face of the drywall. The Asphalt Roofing Manufacturers Association (ARMA) shows the measurement taken from the interior side of the exterior wall in Figure 7-3 of the *Residential Asphalt Roofing Manual*.

The point is that the ice barrier has to extend far enough up the roof to seal out water leaks if an ice dam does form. Here in the Northeast, the winter of 2015/2016 drove home the importance of installing ice barrier membranes according to the building code. That winter, ice dams—and resulting roof leaks—were common on houses outfitted with a single 36-inch width of ice barrier membrane, much to the surprise of the roofers who installed them. The ice dams grew so large and the backed-up melt water rose so high that the ponding water breached the top edge of the ice barrier, allowing water to pour into the house. The remedy in your case is to install another full course (3 feet) of ice barrier membrane above the one already installed, or cut a sheet to the dimension wide enough to satisfy the inspector's requirement.

Q When I use perforated pipe in a drainage system, should the holes go up or down?

A Steven Baczek, a residential architect from Reading, Mass., who specializes in designing durable, low-energy homes, responds: I hear arguments for both methods, but it really depends on how the pipe functions in your drainage system. Before going any further, the pipe we are discussing here is heavy-duty schedule-40 PVC pipe with either two or three courses of holes with the outer courses usually 120° to each other. I don't recommend using corrugated flex-pipe in drainage systems.

When designing a water-management regimen for a home, I try to drain to daylight ("A Primer on Water Management," Jun/17). In this system, drainage pipe around the perimeter of the house links with the downspouts as well as with a perimeter drain inside the basement, all of which drain by gravity to a pipe that exits the ground at a safe distance from the building. Here, the perforated pipe has two functions: collection and conveyance, with the latter being the primary function. I place the pipe with the perforations facing up and count on the streaming water from the downspouts to help keep silt and debris from accumulating in the pipe.

I also place the perimeter piping in what I call a ground gutter, a trench filled with crushed stone and wrapped on all sides with filter fabric—a pipe within a pipe. Water draining from the walls or dripping from the eaves diffuses through the filter fabric and the crushed stone, with most of the liquid being distributed by the ground gutter. The ground gutter would need to saturate to the level of the perforations before any significant water would enter the pipe, and the likelihood of that happening is usually pretty slim. In this scenario, the pipe would have to be completely occluded with silt and mud to become ineffective.

With the perforations facing down, the primary function is collection and distribution. Even when placed in a ground gutter as described above, the pipe fills with groundwater more quickly. When more water enters one area than another, it flows to another area of the pipe and drains away. This would seem to work best in a French drain system where excess water drains to a sump pit to be pumped out. In the systems I install, it's much more difficult for the debris to be washed away with the perforations facing down. Either way, though, when silt and debris fill the pipe to the level of the perforations—essentially half the diameter of the pipe—it can no longer take on water and no longer is effective for drainage.

So there are good arguments for both methods. Having the holes facing up is just the most effective plan for the systems that I've designed. Regardless of your preference for perforation placement, I always recommend installing clean-outs in strategic locations for clearing the pipe should it become blocked or sluggish.

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FROM THE CREATORS OF AdvanTech

Air-Sealing the Box Sill of an Old House

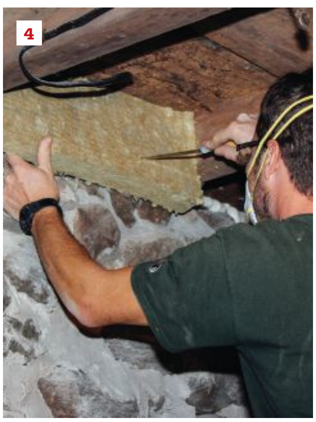
BY JIM BRADLEY

In 2013, my company, Caleb Contracting, performed an energy audit on an old (circa 1797) Cape-style home in Northern Vermont.

The homeowner contacted us because she wanted to live a more sustainable, greener lifestyle—starting with her home. During our walk through, she complained of cold floors along the exterior walls and, tangentially, problems with mice. In the basement, we could see gaps in the fieldstone foundation where cold air (and mice) entered at grade. Also visible were past attempts to air-seal the crumbly stone wall with spray foam.

After our initial meeting, I sent her an audit report with my recommendations (covering air-sealing strategies, photovoltaic panels, heat-pump DHW heaters, and mini-split equipment) and checked in with her from time to time to see if she wanted to proceed with the energy upgrades.

Since that time, the client had a PV panel array installed (it's tied to the grid and powers her electric car), but she held off on implementing our air-sealing and HVAC suggestions until last summer. On reconvening, we agreed to tackle air-sealing the troublesome foundation first (holding off on the more troublesome attic, for now). On the HVAC front, she agreed to install a new heat-pump DHW heater in the basement and mini-split HVAC equipment, which would run, in part, off her PV panel array. A mason was hired to rebuild the fieldstone wall.



The existing home, built in 1797, had a full-height basement (its attic was difficult to access and would be a project for another day) **(1)**. A combination of sealant and spray foam air-sealed the gaps between framing members **(2)**. Layers of Roxul insulation were easy to cut and snug into tight joist bays **(3)** and around the irregular fieldstone and hand-hewn framing **(4)**.

Photos by Tim Healey

AIR-SEALING THE BOX SILL

Using foam to air-seal the box sill would have been easiest, from a labor standpoint. However, the homeowner wanted to avoid using foam products, for environmental reasons. To be honest, I was more concerned about introducing an impermeable material to an old, time-tested building assembly. I didn't want to close off the drying potential to the interior of the home's wood-framed box sill (which was close to grade and prone to long periods of dampness). That had the potential to damage a 220-year-old gem of a house.

So with my Siga rep, Marc Coviello, we came up with a vapor-open solution. We would air-seal the framing with sealant; install 4 to 6 inches of Roxul ComfortBoard insulation into the joist bays; and then cover the foundation-to-floor-framing transition with an air-barrier membrane, sealing it as well as possible to the stone and framing with an assortment of Siga tapes.

Our project manager, Matt Burstein, and my son, Daniel, did the installation work. They first sealed the gaps between the hand-hewn framing members around the basement's perimeter. On gaps less than 1/4 inch wide, they applied DAP Dynaflex 230 sealant, tooling it with their fingers as needed. On wider gaps, we compromised and used Touch 'n Seal All Season spray foam. Gaps between the existing sill beam and the repaired stone wall were sealed with sealant and spray foam as needed.

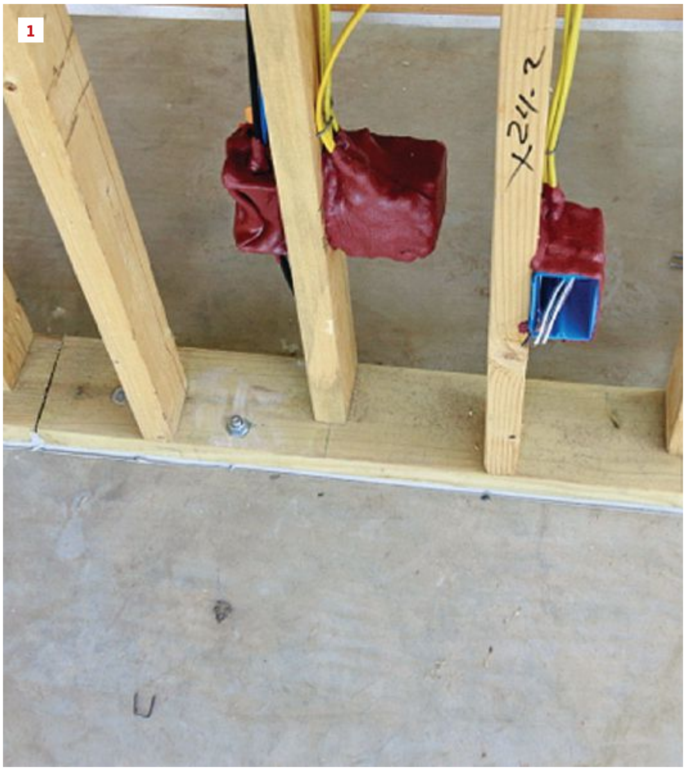
Insulation. Next, we packed out the box sills with layers of Roxul ComfortBoard to the face of the stone wall. The Roxul, as opposed to rigid foam board or even fiberglass batts, worked great in this application. The ComfortBoard is more malleable than rigid foam—an asset when insulating tight spots—and unlike fiberglass, it can be firmly compressed into place without a loss in R-value. In addition, it's water repellent and doesn't promote mold growth, and mice do not like it. Working around the irregular stone and hand-hewn framing shapes, we easily scribed and cut the Roxul into place. We filled in small voids with strips of the material.

Tapes. To seal the air-barrier membrane to the existing framing and stone, we used a few different tapes from Siga. We applied double-sided Siga Twinet tape for most of the air-sealing of membrane to wood, while using Siga Rissan 60 tape to seal tricky spots, such as at wiring and mechanical penetrations. For the trickier stone connection, we used Siga Primur Roll, which is a fairly new product. It's basically a thick, uniform caulking bead on a roll. We applied it along the top of the wall, rolling it out and pressing it into place before pulling the release paper and applying the air barrier.

Air-barrier membrane. For the air barrier, we chose Siga's Majrex membrane. It's a sturdy, airtight membrane that's vapor-open in one direction only. In this case, it would allow moisture to travel from the insulated joist bays into the basement space while preventing moisture intake from the interior. We installed the membrane with its vapor-open side facing against the stone and folded the membrane up, tailoring it around the floor framing and mechanicals and sealing it with the double-sided tape and Rissan 60 tape, as needed.

Jim Bradley is a BPI-certified home-performance contractor, builder, and remodeler based in Vermont.

Siga Primur Roll tape bonded the new air-barrier membrane to the repaired fieldstone wall. First, the tape was pressed firmly to the stone **(5)**. Removing the release tape exposed the tape's outer, sticky side **(6)**. The air-barrier membrane was then pressed firmly to the tape **(7)**. Next, the membrane was folded up and tailored to fit around framing and mechanicals **(8)**. Using long lengths of membrane reduced the number of seams **(9)**.



Photos by Matt Risinger

When trying to limit sound transfer between rooms, build a 2x4 wall with 2x6 plates and stagger the stud layout **(1)**. All the holes in electrical boxes in the wall must be sealed. Putty pads **(1, 2)** provide an easy way to do this quickly and effectively.

Practical Sound Control

BY MATT RISINGER

I've renovated professional sound studios and worked on a fair number of condos in which the party wall needed lots of attention to keep neighbors neighborly. But even in a single-family detached home, there are some relatively easy ways to control sound that will make life much more pleasant for the occupants. Whether it's a media room, home office, master bedroom, meditation room, or home theater—on almost every home I build or remodel, my clients ask me to soundproof at least one room.

When you're trying to limit sound transfer through a building assembly, the goal is to do two things: Limit vibration of building materials and limit air movement. Sound moves as waves through air. When the waves hit a wall, they vibrate the wall materials. The sound waves will also move through any cracks and gaps. So the two basic approaches to stopping sound are to isolate materials so vibrations can't transfer from one to the other and to seal up air gaps to limit air movement.

To achieve these goals, here are the usual methods I employ—for example, between a master bedroom and an adjacent bedroom, or between a child's room and the master bath.

Staggered studs. This is a common method of building a quiet wall. We use 2x6 top and bottom plates, and then fill in the studs with 2x4s on a 16-inch-on-center layout, offsetting the layout by 8 inches. You essentially get most of the benefits of two walls, but it is a lot easier to build. When sound hits one side of this double wall and starts vibrating the drywall and 2x4s, that vibration does not transfer to the other side. Sound can transfer only at the plates, an area that's not very significant compared with the entire surface area of the wall.

Sealing electrical boxes. With codes typically requiring outlets every 6 feet, it's hard to have a bedroom wall without an outlet. But electrical boxes have a lot of holes in them for all the wires to poke through. You also end up with a hole in the drywall around the outlet. All those holes need to be sealed to prevent sound from freely passing through them.

For sealing outlet boxes, we use putty pads. These are made for fire stopping in commercial applications, but they work well for soundproofing electrical outlets. I like the thick red pads from Hilti (CP 617) the best. We get them at commercial supply houses or the Hilti store; they are much better than the thin ones sold at big box stores. The Hilti pads are 6 inches by 7 inches;

we center them over the back of the boxes and fold the edges over the sides of the box. The material has a consistency like Silly Putty and effectively shuts down the air flowing through all those holes that might otherwise carry sound.

Once the drywall has been installed, you also have to go back and use an acoustical sealant to seal between the drywall and the box to complete the installation. We have had good luck with the Noiseproofing Sealant in St. Gobain's Green Glue line or QuietSeal Pro, which is part of the QuietRock line. Acoustical sealant stays flexible; it won't set up and get hard. This flexible seal not only stops airflow, but it also isolates the electrical box from sound vibration coming through the drywall.

Soundproofing batts. Before the wall is enclosed, we insulate the wall cavity. Fiberglass batts will work; wet-spray cellulose works better, but it's not that common. We've had the best results with Rockwool (formerly Roxul) soundproofing batts, which are denser and specifically designed to absorb sound.

The three steps outlined above will do a lot to limit sound transfer through a wall assembly and can be done with minimal investment. To take sound control a step further—for that condo party wall or a home theater, for example—we will add a second layer of drywall that is acoustically separated from the first layer.

Double drywall. The most cost-effective way to add a second layer is with Green Glue (greengluecompany .com), a compound you squeeze out of a caulk gun in a zigzag pattern onto the back of the drywall. This material stays flexible over time and helps dissipate sound energy from one sheet of drywall to the next.

Green Glue can be effective, but you have to get the details right. You need to use two full tubes for each 4x8 sheet of drywall. You can't skimp on the amount. You also need to do a careful job of sealing the edges of the first layer of drywall with an acoustical sealant. When applying the acoustical sealant, apply lots of pressure as you squeeze it out, pushing the sealant into the crack between adjacent sheets or between the first sheet and the subfloor. Here again, don't skimp on material.

I have also used QuietRock (quietrock.com) effectively. This system essentially uses double sheets that have been pre-bonded together, so you cut down on the installation time. Each sheet is installed with acoustical sealant around the perimeter, so it's not as fast as installing one layer of conventional drywall, but it's a little faster than bonding two layers with Green Glue.

Matt Risinger owns Risinger & Company in Austin, Texas. Follow him on YouTube and on Instagram at @risingerbuild.

3

4

5

Electrical outlets need to be sealed to the drywall with a flexible acoustical sealant **(3)**. This stops air movement and limits vibrations transferring from the drywall to the box. Insulation also helps absorb sound; Rockwool Safe'n'Sound batts work well **(4)**. QuietRock panels **(5)** provide one way to further decrease sound transmission

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BY TED CUSHMAN

The Solar Power Island

Photos by Hans Albee

This 5.6-kilowatt solar array (top), combined with a Pika Energy battery and controller inside the barn (above), kept Hans Albee's house powered up during a recent statewide power failure in Maine.

At the end of October last year, a major windstorm knocked out power to more than a million customers in the northeast United States. My own street, near Bangor, Maine, went dark as trees fell on wires at three locations between my house and the main road, just two blocks away.

Utilities in Maine took almost two weeks to get power back to all their customers; the linemen didn't reach the end of my road for 10 days. But the lights stayed on at my house, and my ordinary life continued on as usual. That's because my house is equipped with an 8,500-kilowatt propane-fueled Generac generator. As soon as the power from the street failed, the generator started up, and it ran continuously for 10 days. While tens of thousands of Mainers dined by candlelight, cooked with camp stoves, and took sponge baths from a spackle bucket, my family enjoyed hot showers and regular meals, and I kept right on working in my home office.

The solar option. A half-hour's drive away, in the little town of Brooks, Maine, homeowner Hans Albee had a similar experience. When the power from the street failed, Albee's backup system kicked in without so much as a hiccup. Albee, however, doesn't have a gas generator. Instead, Albee—a professional engineer who works for ReVision Energy, a major supplier of photovoltaic power systems in Maine and New Hampshire—has a 5.6-kilowatt solar panel array.

By themselves, Albee's panels wouldn't keep the house going around the clock—in fact, most solar panel arrays don't work at all when the grid power fails. But Albee's home is a special case, because the house also has backup batteries and a power control system, manufactured by Pika Energy, an energy technology startup based in Westbrook, Maine (pika-energy.com). The Pika Energy Island control system, paired with Pika's Coral battery, took control of the home's power and kept the lights on until the utility company came back on line. While the power was out on his road, Albee's backup batteries soaked up excess solar power during the day and fed it back to the house as needed at night.

Three flavors of solar. Solar electric power has been growing by leaps and bounds in the last few years. But most solar arrays installed on houses don't include batteries; they're the more economical "grid-tied" systems.

In a grid-tied setup, panels feed the electric loads in the house when the sun is shining; if the panels make extra power, it flows out to the grid and supplies other buildings nearby. In return, whenever the panels don't make enough power for the house, the house draws what it needs from the grid.

"Off-grid" solar power systems, which aren't connected to an electric utility, work differently. They require on-site batteries and a control system in order to function effectively as the stand-alone power supply for the house. The batteries have to be beefy enough to power the house through the night, and the solar array has to have enough capacity to charge the batteries during the day, while also meeting the daytime requirements of the house.

Unlike my propane-fueled generator, a solar array by itself can't keep a house running without batteries. A generator can ramp up or down as needed whenever people in the house turn the lights on or plug in a vacuum cleaner, but solar-panel output depends on the sun. As electricity production rises and falls in response to the sunshine, and residents turn lights or equipment on and off, the batteries and controller on the system play middleman, balancing the loads and the supply throughout the 24-hour day.

Setups like Hans Albee's, which have all three elements—solar panels (or "modules"), a grid connection, and storage batteries—are a third flavor of system. When a grid-tied photovoltaic array also has batteries, like Albee's, the possibilities proliferate. You could use surplus solar production to charge up the batteries by day, and draw the batteries down at night. You're also free to charge the batteries up any time, day or night, using grid power. For instance, if your utility offers a lower off-peak rate at night, you could store up power at night when it's cheap and use it later instead of higher-priced daytime power. In addition, if your array and your battery are sized appropriately, you can run as a freestanding power island whenever you choose—or whenever you have to, as Hans Albee did in the days following Maine's October wind storm.

The early adopter. A few weeks after the storm, *JLC* talked with Hans Albee to ask about his system and to learn a little more about the ins and outs of battery-equipped photovoltaic power systems (or, to use the solar industry's catchphrase, "solar+storage").

"We started out with a basic PV system in 2013," said Albee, "an ordinary grid-tied inverter with 13 modules, to meet our annual usage at the time. Over the next couple of years, our usage increased, and we wanted to expand the array. At the same time, Pika was interested in doing some beta testing with some of its equipment. We ended up getting some of the first inverters it produced. Then, when it started to bring its batteries to market, it wanted a place to put that battery in a real live situation as well. We were a willing guinea pig."

"So what we have currently," Albee said, "is a 5.6-kilowatt array (22 modules), and a 7.6-kilowatt inverter, the Pika Energy Island, and the Pika Coral battery. The Coral is a sealed lead-acid absorbent glass mat (AGM) battery. We chose that type of battery because our batteries are in an unconditioned barn, where it's cold, and the lead-acid batteries handle that better than some other kinds of battery. We also get a little bit higher power out of the lead-acid; the Coral has about 15 kilowatt-hours of total energy storage, and it can produce 8 kilowatts of continuous power and up to 12 kilowatts peak output."

How long could Albee's house function in a power failure? "The short answer," said Albee, "is forever—as long as the sun keeps shining. We can use more energy in summer than we can in winter, just because there's more sunshine. But we can run as long as the batteries are functionally serviceable. The inverter should last for 20 years, and you can get 30 or 40 years out of the panels. You would never have to connect to the utility again. It's more convenient to hook to them, but I don't have to."

Flexible options. Even when a house is connected to the grid, batteries give the customer more freedom of choice. "Having storage adds quite a lot of flexibility to an ordinary grid-tied system," Albee explained. "It allows the owner to have a lot more control over when they are a producer or a user of energy. With a grid-tied system, you use the energy in real time. If there's excess, it just goes straight to the grid, and if you need more than your solar system is producing, it comes straight from the grid, and you don't have much to say about that choice. With the addition of storage, you get some of that control back.

"There can be real financial value in taking control back into your own hands."

"For example, you can use a mode called 'self supply,' where energy is produced, used in the house, and stored in the batteries, and it's only sent back to the grid if there's more than the batteries and house can use. Then, if the house is using more than the solar array can produce at a given moment, that extra power, instead of coming from the grid, will come from the battery. Only if the battery runs down and the solar array can't keep up will you draw from the grid. So it minimizes the interaction of the home with the grid. That can be beneficial, in some cases, depending on what the net-metering rules are in that jurisdiction."

"In Maine," Albee noted, "there is not a financial reason to do that. But in other parts of the country, there can be real financial value to taking that control back into your hands and deciding for yourself whether you interact with the utility or you don't."

Marginal economics. ReVision Energy has started to offer the Pika setup to customers in New England. ReVision also sells the Tesla Powerwall, which has similar capabilities (see "Tesla Powerwall: Not Just for Solar," May/16). "We're seeing quite a bit of interest," Albee said, "but it's in the early-adopter stage still. For pretty much everyone, it's hard to make a financial case, because the only benefit is the backup power, typically, and that's hard to value."

"You can easily make an economic case for installing grid-tied PV almost anywhere that has decent sun exposure," Albee explained. "But adding batteries—let's say that starts at $12,000. That sinks the economics of your grid-tied system quickly. You have a grid-tied system that is making power for you every day, but the battery is just like your propane generator—99% of the time, it's just sitting there, until you need it. When you do need it, you're glad you have it, but most of the time, it's not doing anything."

The big picture. Nationally and globally, however, solar+storage setups are gaining a strong toehold. The reason is that these systems offer benefits not just to the individual power customer, but also to the whole power system—and to the community. In Puerto Rico, where last fall's devastating hurricane strikes left the power grid in a shambles, Tesla has installed solar+storage systems at several critical facilities.

Solar+storage can also be the answer in less dramatic situations. Massachusetts, for instance, recently offered $20 million of grants to fund solar+storage projects for places like Nantucket and Martha's Vineyard, where batteries can eliminate the need for costly new power cables from the mainland. The U.S. military has ordered large solar+storage installations for islands in the Pacific, where stand-alone self-sufficiency has a strategic value.

On the national scale, Tesla's biggest-ever solar and battery system is already proving its worth in Australia. Last month, Tesla's batteries responded in a fraction of a second to a coal-burning plant's sudden drop in output. Tesla's story in Australia is a large-scale example of the critical role that batteries will assume as time goes on and as batteries continue to drop in cost. That's because small batteries in houses can play the same stabilizing role as Tesla's massive plant in the outback—if there are enough of them.

"That is a big topic of discussion right now," said Hans Albee. "While the interests of grid owners and homeowners are not perfectly aligned, they can be pretty darned close. If you just have a bunch of systems like mine operating at the whim of their owners, without any interaction with a central planning group, then that doesn't really add to or take away from the grid. But if you allow those small systems to talk to each other and coordinate through some sort of organization that aggregates a bunch of residential systems, then all of a sudden you have what looks a lot like a power plant.

"Instead of the plant being centralized, though, and owned by some organization, it's distributed and it's everywhere. It can be either a source or a sink, depending on what is needed on the grid, so it's much more flexible than a traditional power plant. And it's much more efficient, because that energy production is happening close to where the energy is being used, instead of being produced and then transmitted over long distances. So there are benefits to having distributed energy production and energy storage, but you really can't access it until you get good data to allow the grid operators to know what's going on and what's available, and then dispatch those resources in a way that makes sense for the whole system."

Ted Cushman is a senior editor at JLC.

Practical Net Zero

Balancing the shell and the mechanicals, on a budget

BY TED CUSHMAN

Photos by Ted Cushman, David Kelly, and Mark Dwyer

These days, building a house that complies with the energy code can involve a lot of trade-offs. And if you're aiming for above-code performance, where the stakes are higher, the trade-offs become even more challenging to evaluate. High-performance builders are pioneers, and each high-performance house is an exploration of uncharted territory.

In this story, we'll look at one such adventure: a net-zero home in Bangor, Maine, designed and built by civil engineer Mark Dwyer and custom builder and remodeler David Kelly.

While Dwyer has previous experience in spec remodeling, this house is a side project for him; in his day job, he's a research engineer with the Advanced Structures and Composites Center at the University of Maine in Orono. For builder and remodeler David Kelly, of Bangor-based House Revivers, the collaboration with Dwyer is a chance to deepen his expertise in high-performance home building, adding to the experience he gained in earlier House Revivers projects (including three net-zero "Eco Homes" built on an infill lot in Bangor).

As the two worked together, they fine-tuned the balance between envelope characteristics and mechanical systems, aiming to optimize whole-house performance. In the process, they had the chance to try out a few unusual methods.

High-performance houses in Maine tend to emphasize superinsulation, but for this house, after months of weekly planning and design meetings, Dwyer and Kelly settled on a different approach. Although the house is extremely airtight, its insulation levels are only moderately above the code-required baseline. Advanced mechanicals—an air-to-water heat pump supplying a radiant slab, with site energy provided by a rooftop solar array—push the home's efficiency to the net-zero goal.

The home is small—just 1,400 square feet of living space, plus a 700-square-foot heated garage with storage. It's all on one level, with a monopitch truss roof (the main house roof slopes from a high south wall towards the north, while the garage roof, topped by solar panels, slopes from north to south). Large windows on the tall south wall let in daylight and provide solar heating of the living room and kitchen; bedrooms and closets are located on the north side.

FOUNDATION

Bedrock at the home's location lies only 1 foot to 3 feet below grade. To minimize digging and reduce foundation costs, Kelly and Dwyer chose a frost-protected slab on grade, with 4 inches of R-5 extruded polystyrene (XPS) under the slab and 2 inches at the edge.

"At this point, I've done four different flavors of frost-protected slab," says Kelly. Some of his previous designs have included as much as 8 or 10 inches of sub-slab and slab-edge insulation. "This one isn't the best example from an energy-performance standpoint," he says. "We have R-20 under the slab and R-35 in the wall assembly, but then that one little area at the slab edge is only R-10 [see illustration, page 32]. That's the weak spot. But as with all the details we've chosen, there is a cost trade-off."

On the other hand, the method chosen for this house has practical advantages. "The nice thing about this slab method," says Kelly, "is that you can show it to any earthwork or foundation contractor anywhere, and they will know exactly what you are talking about. You haunch the gravel, you put your radon system in and pack gravel around it, and you have a nice base to put your XPS on."

One downside is that the labor of "haunching" the gravel and piecing in the XPS **(1)** takes time, notes Kelly. "Our foundation contractor is attentive to details," he says, "but you'll never get all those miter cuts in the XPS perfect."

In researching slab insulation, Dwyer says, he found wide agreement that R-10 (2 inches of XPS) would be sufficient. Even so, adding a second 2-inch layer, for R-20, seemed cheap enough to be cost-effective. The second



The slab detail was familiar to trade contractors **(1)**, but the radiant-slab tubing **(2)** was time-consuming. The conventional slab edge detail **(3)** received an economical stucco finish.

Concrete “cookies” used to brace the wall framing were only partially effective **(4)**. Kelly taped the sheathing joints at openings **(5)** before screwing on window bucks **(6)**.

layer also allowed Kelly and Dwyer to try something new: They routed channels for the domestic water lines into the lower layer of foam and embedded all the tubing in the grooves. “It took maybe eight or 10 man-hours to rout the grooves and push all the pipes in,” says Dwyer, “and we saved maybe $400 in pipe insulation.”

Running hydronic tubing above the XPS **(2)** for the five-zone radiant slab system was a more significant labor cost. A simple mini-split setup would have been far less expensive, Kelly notes, and would have allowed easy access for maintenance or repair. But the hydronic system is extremely efficient and offers the comfort of a warm slab during Maine’s frigid winter months.

To finish the vertical slab-edge foam, Kelly and Dwyer chose a common low-cost detail: acrylic stucco troweled over the foam **(3)**.

WALLS AND WINDOWS

Throughout the project, Kelly and Dwyer worked to balance the home’s energy goals against the cost and buildability of the assemblies.

“David has built three net-zero houses using various wall details,” says Dwyer. “We considered all of those possibilities for this house, starting with Larsen trusses with dense-pack cellulose. But David came up with a turnkey price for that 20-inch-thick Larsen-truss wall, and it was very high. Just the dense-pack was about 18 grand. So we decided that wasn’t affordable.” Another option was a double 2x4 stud wall. But that would also be costly to frame and insulate, and it would call for complicated finish details at the deep window openings.

In the end, says Dwyer, “we came back around to a basic 2x6 frame with 2 inches of XPS on the outside.” The exterior foam would cut down on thermal bridging through the wall framing, and insulating the wall cavities with Roxul mineral wool from the inside would be quick and easy.

Bracing the walls during framing—especially the tall front wall—was a challenge. The site soil was too shallow for stakes to bite, and the framing crew didn’t want to risk penetrating the hydronic tubing by spiking blocks for braces into the slab. Instead, they set precast concrete “cookies” on the slab and spiked their braces into those **(4)**. Dwyer says that method didn’t work well—the concrete-to-concrete contact surface was too slippery, and some of the walls ended up out of plumb by more than 1/2 inch. “Next time,” he says, “I’d try my luck with the stakes in the dirt.”

To frame out the window openings, the team first applied a 3M 8067 tape air seal to the corners of the rough openings **(5)**, then fastened on bucks made from 2x6 lumber ripped to a little over 4 inches **(6)**. This depth would accommodate a wall pack-out consisting of 2-inch XPS foam, $^{3}/_{4}$-inch rainscreen strapping, and $^{5}/_{16}$-inch fiber-cement siding; the bucks would project out another inch as a backing for metal trim. After applying the bucks, carpenters cut the foam to fit tight to them **(7)**, taped the foam to the bucks with 3M 8067 tape, and applied strapping over the foam.

"The bucks worked out well," says Kelly. "I would do it again. Also, you could accommodate a fatter wall that way if you were to use thicker insulation on the outside."

Kelly notes that this method requires careful attention at the rough-framing stage. "The window heads all need to line up based on the layout for the siding and trim," he explains. "We didn't have that perfect, so we had to adjust some of the bucks to line up on the exterior. At the bottom, a couple of them ended up a little below the rough sill on the inside. That's going to make it a little difficult to install our concrete windowsills."

RAINSCREEN CLADDING

For the home's cladding and window trim, Kelly and Dwyer borrowed a detail from commercial construction—they used metal trim for the windows and applied 4x8 panels of fiber-cement HardiePanel siding, cut tight to the windows and installed over 1x4 furring. This system isn't common on homes, but for a small house in a modern style, it can provide a clean, simple look.

In addition to the standard color-coated panels, Hardie supplies a variety of manufactured metal flashing and trim profiles. But for this job, Kelly and Dwyer opted for custom metal details crafted by their own subs.

Over the window bucks, they used vinyl-coated steel coil stock, custom-bent on site and applied by the crew that installed the home's white standing-seam metal roof **(8)**. The same roofing company also installed the home's fascia using the same heavy-gauge material, so the window and door trim matches the roof and the eaves. (Soffits are pearl-gray Hardie Panel.)

Kelly used a commercial caulker's "sausage gun" to apply white Tremco caulking to the joints between the white window frames and the white metal trim **(9)**, tooling the caulk carefully for a clean, sharp finish look.

Behind the joint locations between cement panels in the field, carpenters applied a detail made with lighter aluminum coil stock to the wall, before installing the panels. Gapped about $^{3}/_{8}$ inch, the blue panels stand proud of the recessed white trim, creating a sharp shadow line.

The unfamiliar cladding system proved troublesome for the carpentry subs on site. Surprisingly, many of the panels were about $^{1}/_{8}$ inch out of square, which caused problems with the careful layout and cuts required to fit the panels to the windows **(10)**. Production was slow at

XPS foam was fastened over the Zip sheathing **(7)**. Roofers installed metal window trim **(8)**, and Kelly caulked the window joints **(9)**. Cement siding was installed over strapping **(10)**.

The high-performance roof proved economical. Setting the monopitch trusses **(11)**, installing the OSB air barrier **(12)**, and insulating from above **(13)** all went quickly.

first, says Dwyer: "I was paying them to learn." In the end, Dwyer decided to run most of siding himself with a hired helper.

"What I found is that you just learn to fudge it," says Dwyer. "You stop thinking about the panels being out of square, and you play with the gap. You stand back and use your eye to make things look right overall." An experienced finish carpenter himself, Dwyer had freedom as the general contractor on this job to make judgment calls—"but as a hired carpenter," he says, "you'd always be second-guessing yourself."

"Hardie's trim packages would have made it easier," Kelly points out (although at higher cost). "They supply a bottom rail you can set the panels on, and the trim pieces overlay the panel and give you a quarter inch of play. But that might not have given us this custom look."

THE ROOF SYSTEM

In a one-story house, the roof represents a relatively large surface area. "Your best building for net zero is a cube," Dwyer notes. "That maximizes your volume and minimizes your surface. And the other net zero houses that David has done were more compact boxes. But this house is all on one level, so we're throwing that out the window. This is a big roof."

Accordingly, superinsulating the roof while limiting its cost was an important challenge. "First we looked at wood I-joists," says Dwyer, "but they had to be 16 inches on-center, and they cost \$3 to \$5 a lineal foot. So that quickly became too expensive."

Trusses at 16 inches on-center also weren't cheap, says Dwyer, "But I got on the phone with the truss designer and asked, if we go to 24 inches on-center, how deep do we need to go?" Changing the trusses from 24 inches deep to 32 inches deep, it turned out, allowed 2-foot-on-center spacing. "That dropped out 15 trusses," says Dwyer, "and the price went down four grand."

Although it was unusual, Dwyer says, the roof construction process was one of the few steps that went exactly as planned. Trusses went on quickly **(11)**, and applying the OSB air barrier to the underside of the trusses (see photo, page 27) was straightforward. "The walls were flopping around a little before that," says Dwyer. "But I just put a string on them and set the first course of OSB. Once we got that on, everything stiffened right up." Beneath the ceiling OSB, carpenters built down a service cavity using 2x4s on edge, where wiring and ductwork for a Zehnder energy recovery ventilator (ERV) could be installed without penetrating the air barrier.

With the ceiling OSB in place, the crew from Penobscot Home Performance could efficiently blow in the cellulose from above **(13)**, while carpenters worked behind the insulators and decked the roof.

"We had five or six guys on site that day, and we had excellent weather—no wind to blow the cellulose around. They blew the cellulose in six hours. We were decking right behind them, and by five o'clock, we had weather-tight underlayment in place and we were dried in. Ninety sheets of sheathing in one day."

The deep trusses allowed room for ample R-value in the roof system. "Originally, we were going to insulate the roof with 14 inches of Roxul, shooting for about R-60," says Dwyer. "But once the truss depth got bumped up, we said, 'Let's just blow in 24 inches of open blow cellulose. That gives us R-84 and it leaves a 6-inch gap at the top for ventilation.' We got a price of $3,500 for the insulation, installed—versus $6,000 plus labor for a lower R-value worth of Roxul."

CRITICAL JUNCTURES

From foundation to roof, Dwyer and Kelly chose construction methods and insulation levels that balanced performance against cost and buildability.

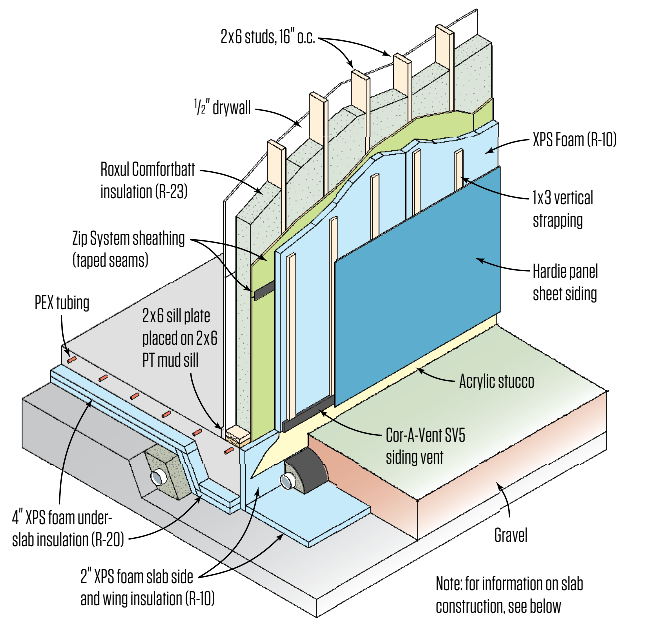
The 4 inches of insulation beneath the slab and the 2 inches at the slab edge aren't much of a departure from code, and the construction method didn't pose much of a challenge to the trades on site. By the same token, the wall system the pair chose isn't far above code either, and the method—exterior foam applied over a sheathed stud wall—is becoming commonplace in much of the country. The roof system—loose-blown cellulose in a truss—was also conventional, even if the construction process was a little out of the ordinary.

In a high-performance house, however, it's not just the main assemblies that matter—it's also the transitions from one assembly to the next. And at the major junctures in the house—the foundation-to-wall joint, and the wall-to-roof joint—Kelly and Dwyer faced a few challenges.

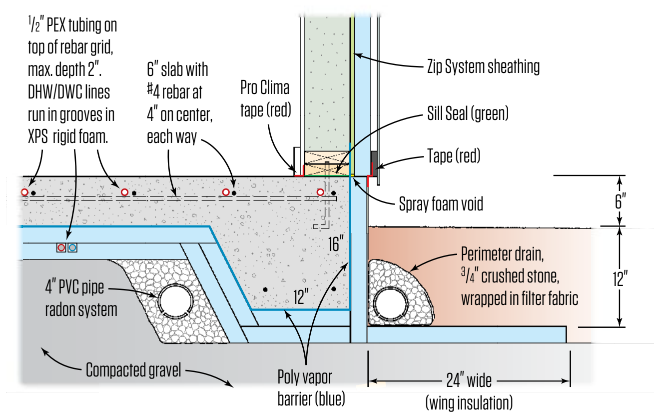
"The big issue with our slab edge," Kelly points out, "isn't so much the insulation level, but the air leakage that you typically get between the bottom plate and the slab. The transition between the foundation and the wall can often be a weak juncture." For this house, the original plan for air-sealing that joint had been to continue the sub-slab poly vapor barrier up onto the Zip System wall sheathing, and tape the plastic to the wall.

That detail turned out to be impractical to construct, however. Kelly's original idea for the slab pour had been to set the XPS slab edge foam against the wood foundation forms, chalk a line, cut the foam off at the line, and use the edge of the foam as a guide for leveling the slab. "But our foundation contractor advised us that the foam was going to be so loosey-goosey that there would be no way to keep it dead level where

Wall-to-Slab Detail

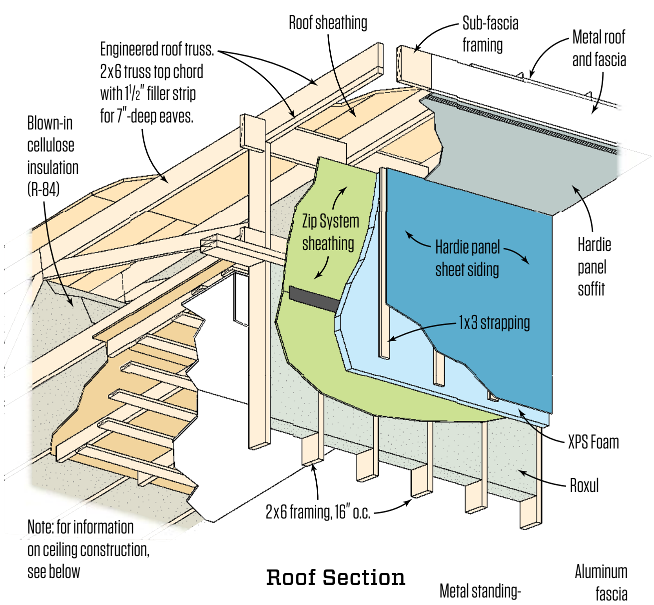


Frost-Protected Slab

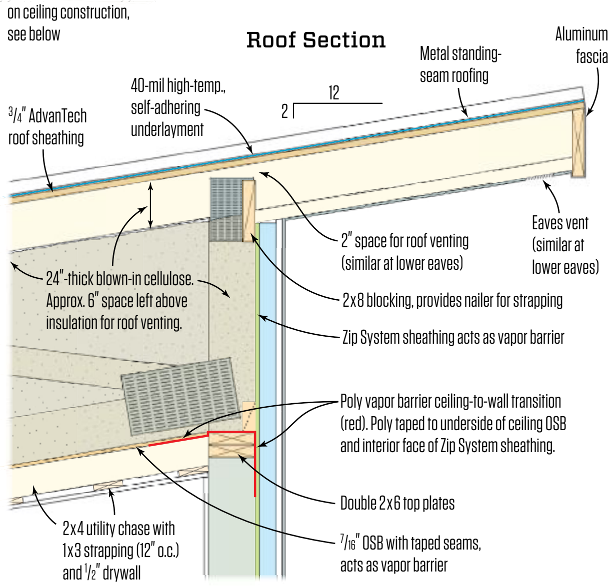


The foundation-to-wall juncture was a relative weak spot in the building envelope. The slab-edge insulation is thin compared with other parts of the building, and while the low-cost slab forming approach was familiar for the sitework and concrete contractors, the air-sealing detail where the wall met the slab turned out to be trickier than planned.

Roof-to-Wall Detail



Roof Section



The roof-to-wall air-barrier transition was another tricky element. Poly overlapping the wall plate had to be taped to the inside face of the wall's Zip sheathing by hand, one stud bay at a time. But the walls and roof were quick and easy to frame, and the loose-blown insulation in the deep truss roof went in quickly at the same time as roof sheathing was applied.

we wanted it," says Kelly. Instead, the concrete crew ran both the wooden forms and the insulation higher than the slab elevation, then set a string line to guide striking and screeding the wet concrete.

After the plywood forms were stripped, "I couldn't cut the foam back to the slab level without making Swiss cheese out of the vapor barrier," says Kelly. "So we sacrificed the poly." Because the sub-slab poly ended up being trimmed off flush with the top of the slab, Kelly needed another way to complete the continuous air barrier at the base of the wall. So he applied Pro Clima tape to the wall plate and the slab from the inside, later.

"In the future," Kelly says, "I don't care what the extra cost is—I'm going with the L-shaped foam forms at the foundation edge. Because errors at this stage, either in square or in level, compound one another as you move forward. We did the best we could in getting this right, but you are adding work in each future step. So even if you spend more money on that L-shaped form, you're still saving, because it makes everything else a little bit easier."

The intersection between the wall and the roof system offered a similar puzzle. There, Kelly and Dwyer maintained a continuous air barrier by draping poly over the top plate before setting the trusses, and taping the poly to the OSB applied to the underside of the trusses.

But connecting the lower edge of the poly to the wall was a challenge. For structural reasons, the Zip sheathing on the walls had to extend up onto the heels of the monopitch roof trusses. So the poly at the wall joint had to be taped to the inside face of the Zip sheathing, between the studs. It's not a perfect air seal, Kelly admits, because the poly isn't sealed to the sheathing behind the studs.

On the outside, the Zip System wall sheathing is sealed with Zip tape. Windows are sealed into their openings with both tape and caulk. And the ceiling under the roof trusses has only two penetrations (the vent stacks for the home's plumbing drains), because all the ventilation tubing and ceiling wiring runs in cavities created within the 2x4 build-down. Even with the challenges at the wall base and the wall top, Kelly says, he expects the home's airtightness to test out well below 1 ACH50.

SITE ENERGY AND MECHANICALS

Photovoltaics play a key role in the home's net-zero strategy. "The idea was to spend a little more on the heating system, spend less on the insulation, upsize the PV system so it covers the energy to run the heating system, and come out net zero in the wash," says Dwyer.

Kelly saved cost by installing the PV brackets and panels **(14)** and making some of the basic wiring connections himself **(15)**. Electrician Joe Sewell oversaw the work **(16)**.

Kelly learned how to install solar panels himself on previous projects, on the advice of his electrical contractor. Now that he has multiple PV installs under his belt, he has set up a side business as a PV contractor. Kelly says learning to put in solar panels yourself could be a good move for any custom builder. Anyone with good carpentry skills can easily master installing the brackets and panels **(14)**, he says, and the simple plug-and-play inverter and wiring harness systems **(15)** make the hookups easy after a little study. On this job, Kelly says, he delivered the solar array at cost for about $1.80 per watt; the going rate from specialty contractors is more like $2.50 a watt.

An electrician oversees the job, installs and connects the breaker panel, and steps in whenever his skills are needed **(16)**. "My electrician is like a magician with conduit," says Kelly. "He eyeballs complicated bends without measuring, and they come out perfect."

As for the loads, Dwyer designed the air-to-water heat pump hydronic radiant system for a peak winter heating load of 17,500 Btu/hr., based on a Manual J calculation. That Manual J estimate is probably high, given Kelly's rigorous attention to airtightness details. Windows on the home's south face will bring in sunshine on cold days, satisfying some of the home's heating loads. And the system's five zones and two hydro-air fan coils (one in the living room and one in the master bedroom) mean that the system can be fine-tuned to match individual room needs throughout the year.

"It's always hard with a new house to size a PV array," Dwyer points out. "You don't have years of electrical bills to document energy demand. And I didn't take the time to calculate out every load. David installed 5.2 kW on his other net-zero houses, which also heat with heat pumps. So here we just went a little bigger. And it turned out that 24 panels fit on the garage roof perfectly, so it ended up at 8.5 kilowatts."

With annual net metering, surplus summer power is sent into the grid; in winter, when production drops below daily demand, the utility credits the difference back to the customer. Any annual surplus is a gift to the power company. "What I always tell people about net zero," says Kelly, "is that you want to come as close to it as you can without hitting it."

"This array may be slightly oversized," Kelly says. "But there is a little bit of shading from the trees on the site, and there's a little in-row shading of the panels at low sun angles. So this will probably be golden."

What if the array produces too much? "The utility will love us," says Dwyer. Says Kelly: "Maybe they'll put in a hot tub."

Ted Cushman is a senior editor at JLC.

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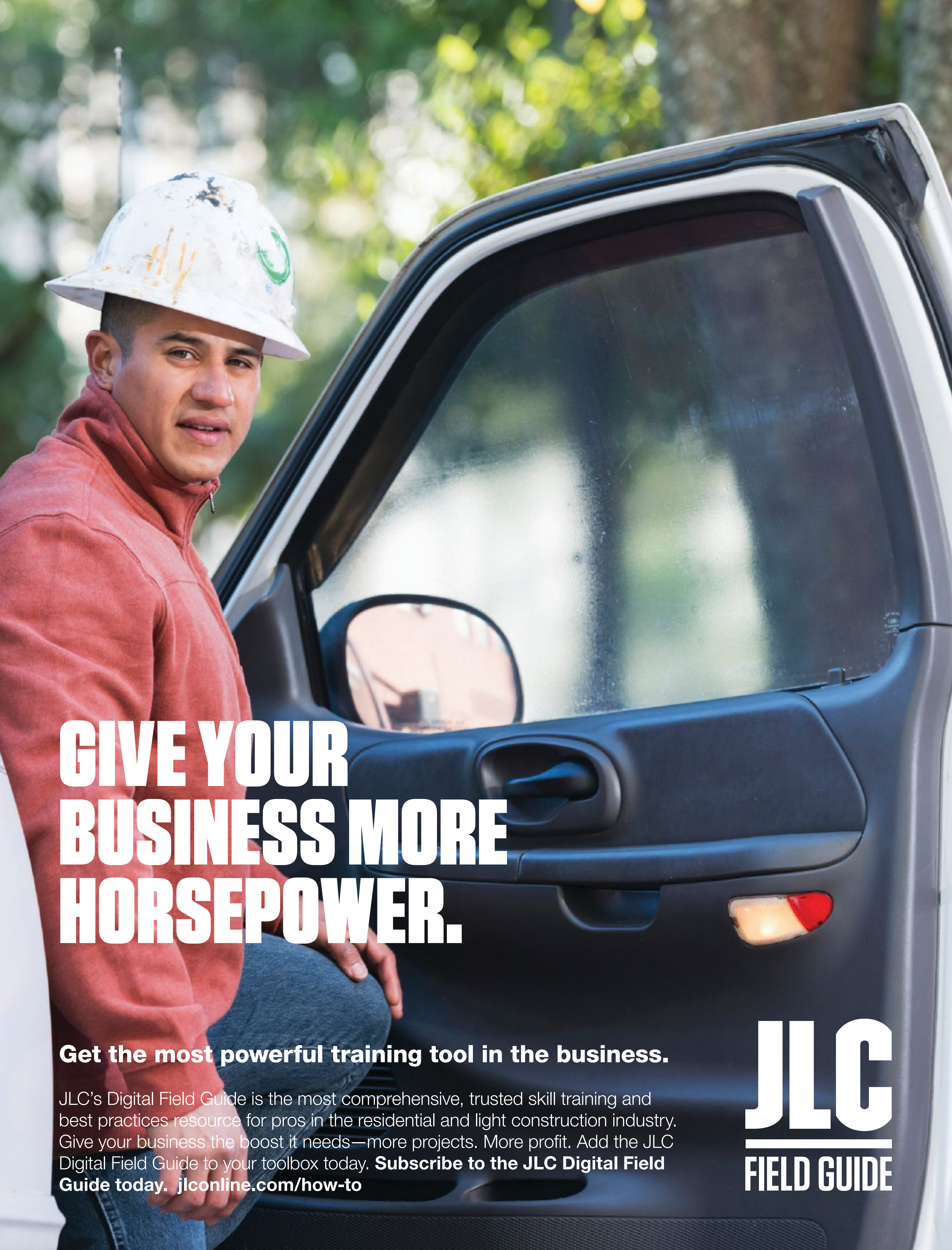
hanley wood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FIELD GUIDE

Setting a Long Ridge

Proper prep work pays off for a fast and safe installation

BY NATHANIEL ELDON

When I'm framing a building with a long ridge span, I always prefer to set one long, straight ridge rather than fuss with multiple, shorter pieces of dimensional lumber in the traditional way. Recently, we framed a house that had two very long non-structural ridges—one just shy of 44 feet and the other nearly 46 feet long. I decided to make the ridge out of $1\frac{3}{4}$-inch-by-$11\frac{7}{8}$-inch LVL. We lucked out because the longest length of that dimension LVL that was readily available locally was 48 feet. (You can special order longer lengths, but I would never delay a job for one ridge beam.) I ordered the lengths for both members about a foot longer than we needed.

Photos by Seth Stafford

MEASURE THE RIDGE

Because the ridge ties into the gables, we frame and raise the gable-end walls first. While the gables still lie flat on the second-floor deck, we sheathe them and attach the rake overhangs before we raise them. At the peak of the gable, we hold the top plates back half the width of the ridge on each side. This space will allow the ridge to slip into place once the gables are raised and braced.

We find the length of the ridge directly from the floor deck, measuring to the outside of the exterior wall framing at either end. On this project, the design called for a bay that projected from

To find the length of the ridge, the author measured to the outside of the wall framing **(1)**. The crew member at the other end of the tape held it at 1 foot for the measurement **(2)** and did the same when measuring the ridge stock **(3)**. The crew laid out the rafters on one side **(4)**, squared the layout around the edge **(5)**, and then transferred the layout to the opposite side **(6)**.

each gable. I had continued the plates for the main walls through the bay space, and we were able to quickly measure to the outside of the plates without the sheathing being in the way **(1)**. (On projects that don't include projecting bays like these, I simply measure between the inside edges of the wall plates and then add twice the thickness of the walls—11 inches for 2x6 walls and 7 inches for 2x4 walls.)

To measure the ridge length, I used a 100-foot tape **(2)**. Because I don't trust the accuracy of the hook on long tapes, the carpenter at the hook end of the tape, Justin Cline, "burned a foot" when he held the tape for the measurement. To avoid confusion, I made sure that he held the tape to burn the same foot when I measured the actual ridge to cut **(3)**. I didn't trust the factory cuts on the ends of the LVL to be square, so I made a fresh square cut on one end and then measured and cut the ridge to length.

RIDGE LAYOUT

The next step was laying out the ridge. We always maintain "stack framing." All framing members align vertically—rafters over studs over floor joists. So to lay out the ridge, I needed to locate my original layout point and work from it.

For this house, I had started the layout from the north wall on the first floor. The second-floor gable wall stepped back 7 feet from the first-floor exterior walls, so to lay out the ridge, I extended a tape 7 feet past the north end of the ridge and marked $95\frac{1}{4}$ inches. Here I drew an "X" to the south of the line. At that point, I tacked in a nail and pulled a 16-inch-on-center layout for the length of the ridge. Next, Cline marked both sides of the rafter layout on the ridge using the $1\frac{1}{2}$-inch tongue of a framing square **(4)**. To complete the layout, we squared the layout around the edge **(5)**, flipped the ridge to the other side, and marked the rafter positions on that side **(6)**.

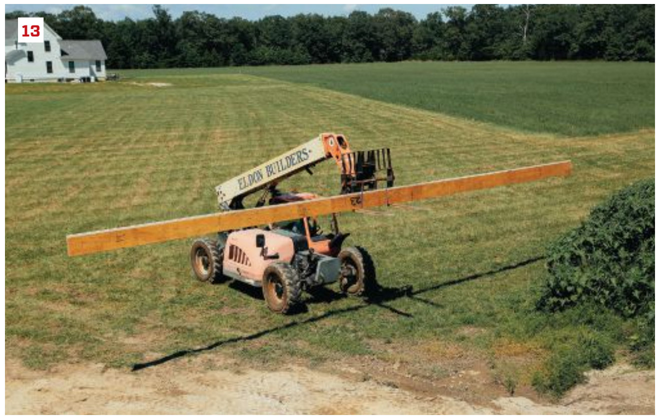
The crew attached a ripping of 2-by stock to the top of the ridge for setting the height of the rafters **(7)**. Strong aluminum staging provided a good working platform for the crew **(8)**. To set the height of a supporting ledger, the author set a scrap of the ridge stock into the slot on the gable **(9)**. The ridge would be nailed to the rake plates at that height **(10)**.

This roof assembly was to be ventilated from the soffit to the ridge. In this part of the country, we would typically hold the rafters above the ridge slightly to provide the necessary space for ventilation. For a wider structural ridge, I usually notch the plumb cut of the rafter to wrap over the ridge, but for a narrow non-structural ridge like this, the extra cuts didn't make sense. Instead, we ripped a temporary 2-by strip and tacked it on the top of the ridge for setting the rafters to **(7)**. Once the rafters were installed, we would remove the strip and hold the roof sheathing down an inch or so from the tip of the rafter plumb cut, which would provide a clear ventilation path at the peak of the roof.

STAGING AND SUPPORT

When you're working with long and unwieldy pieces of lumber like this ridge, a solid work platform is a must. Normally, we would set up a couple of towers of pipe staging and run long aluminum planks between the towers. But with this project, the rafters sat on intermediate walls running parallel to the ridge between the exterior knee walls (at the bottom of the rafters) and the ridge. We bridged between these walls with aluminum scaffolding planks perpendicular to the ridge line. These planks then supported longer aluminum planks that ran along both sides of the ridge **(8)**.

Because this ridge was non-structural, I installed a temporary ledger across the wall on the inside of each gable to support the ends of the ridge until everything was tied together. If the ridge had been structural, we would have framed-in permanent posts below the ridge to support it, with the loads transferred down to the foundation. For this ridge, though, posts would not be necessary. We would be bolting collar ties to the rafters to help them resist outward push from the weight of the roof.



Before the ridge was brought over, the crew stacked the rafters for the back of the house, keeping them low and out of the way **(11)**. On the front of the house, they leaned the rafters up, closer to their final positions **(12)**. The crew centered the ridge on the telehandler forks and held it in place with ratchet straps **(13)**. The telehandler then slowly and carefully lifted the ridge into position **(14)**. After releasing the straps holding the ridge on the telehandler forks, the crew was ready to install the ridge **(15)**.

To set the height of this temporary ledger, I inserted a short cut-off piece of the ridge (with the ventilation packer) into the slot at the top of each gable **(9)** before nailing the ledger in place **(10)**.

As part of the preparation for setting the ridge, I cut all the common rafters based on the rake measurement of the gable walls. We used a telehandler to lift the stacks of rafters up to the second-floor deck. The best access for setting the ridge would be from the back of the house, so on that side, we put the rafters in low stacks to keep them out of the way **(11)**. On the front side of the house, we tilted the rafters up so they'd be within reach for installation **(12)**.

LIFTING THE RIDGE

The crew loaded the ridge onto the forks of the telehandler. The long LVL wasn't that heavy, but its long length made it floppy and difficult to handle. To minimize this effect, we rolled the ridge up to a vertical position and then secured the middle of the ridge to the forks of the telehandler with ratchet straps **(13)**. Jerry Beasley, my best telehandler operator, slowly drove the ridge around to the back of the house, and then brought the ridge as close to position as he could with the boom. We would do the rest **(14)**.

I unstrapped the ridge from the forks **(15)**, and we dragged it back until the north end was just inside the gable framing. One of the crew took the north end, lifted it on his shoulder **(16)**, and slipped it up onto the ledger, and then we pushed the ridge into the slot between the gable wall plates **(17)**.

The south gable was a bigger challenge. Instead of sliding the ridge into the slot between the plates as we did on the north end, we had to lift it up and drop it in **(18)**. When we lifted the ridge, the lift angle added a little length to the ridge, so we loosened one of the gable braces to give us a little play in the walls. With the gable

The crew pulled the ridge back so that one crew member could shoulder the end of the ridge onto the ledger **(16)**. They then pushed the ridge into the gable slot **(17)**. At the other end, they had to lift the ridge to drop it into the slot from above **(18)**. One of the crew tapped the ridge down into place **(19)**.

slightly loose, we slipped the ridge into the south slot and tapped it down to seat it at the proper height **(19)**. We then moved the gable wall back into position against the end of the ridge.

STRINGING THE RIDGE

The ridge was in position, but as to be expected over such a long length, it had a huge bow and a sag due to its own weight. To gauge the straightness of the ridge, I ran a tight nylon string along the bottom edge of the ridge from end to end. I first used the tight string to find a center post height. (With the variations that were possible in two floors of framing, I thought this method would provide a more accurate measurement). To make a temporary center support, we held a 2x4 up against the string and marked the length. After cutting the 2-by, we stuck it under the ridge to hold it at the proper height.

The center post took care of the sag, but we still needed to straighten the bow. I usually install two pairs of rafters as close to the center of the ridge as possible to brace it straight. But the center of this roof had two intersecting gable dormers that we would build later. So to straighten the ridge, we nailed a temporary diagonal brace to the center post and anchored it back to the second-floor deck, using the tight string as a guide **(20)**.

PLUMB THE GABLES

After the ridge was set in place and braced generally straight, we took the time to double-check the gable-end walls for plumb. Although we had rough-plumbed the gables when we raised them, installing the ridge and taking the bow out can affect how plumb the gables are. So I prefer to plumb the gables for good after the ridge is installed and relatively straight.

There were no common rafters at the center of this house, so the crew supported the center with a temporary post and braced it back to take the bow out of the ridge **(20)**. The low ends of the rafters were secured first **(21)**, and then the top of the rafter on one side was attached **(22)**. The author toenailed the opposite side so that it could be driven into place to straighten the ridge **(23)**.

For the plumbing process, we used a laser level, shooting from the floor to the ridge. I started by making a mark on the floor about 8 feet from the inside of the plate line and at the center line of the building. I adjusted the location of the mark so that it was clear of any braces, scaffolding, or planks that might block the beam of the laser. Then I marked the same measurement from the inside of the wall on the bottom of the ridge. I set the laser at the mark on the floor and looked to see how it referenced the mark on the ridge. The marks lined up perfectly—indicating that the gable was plumb—and we braced it in that position.

If we hadn't been so lucky, I would have adjusted the gable in or out until the marks lined up. I always check both gable ends this way, but if one gable has been braced perfectly plumb and the ridge has been cut to the right length and installed properly, the opposite gable is usually plumb as well.

INSTALL THE RAFTERS

With the ridge in the correct position and the gables plumb, it was time to set the rafters. With rafters this long, this task is best done with a four-person crew: two crew members at the ridge and two others at the exterior walls—on each side of the building, and each with a framing nailer. The planks on the staging put the ridge at a comfortable working height for me, so I took the ridge duty along with another crew member who was close to me in height. Beyond the comfort factor, a good working height makes installing rafters faster and more efficient.

As a general rule, I always have the crew at the low end of the rafters nail them to the exterior walls before we secure them to the ridge **(21)**. Fastening the low end first helps us straighten the ridge, because we're using the weight of the rafter to our advantage to push the ridge into line.

Pairs of rafters straighten and support the ridge. If the ridge needs to be tweaked in the opposite direction, the opposite side goes in first **(24)**. The last of the rafters goes in, leaving the ridge nice and straight **(25)**. The author removes the temporary strips on top of the ridge, leaving a space for ridge ventilation **(26)**. The intersecting gable dormers complete the roof framing **(27)**.

Fastening in this order also sets the ends of the rafter in a straight line, which saves us time when we're trimming soffits later. (These particular rafters transitioned to shallower-pitch porch rafters, so there were no rafter tails or soffits to deal with).

When the low end of the rafter was secured, my partner at the ridge set the rafter on his side in place so that the top was flush with the top of the temporary 2-by strip. Standing on the opposite side of the ridge, I then shot nails through the ridge to secure the rafter in place **(22)**. After nailing the rafter on one side, I set the opposing rafter on its layout and toenailed through the top of the rafter so that I could drive it into place **(23)**. My ridge partner then nailed it at an angle from the opposite side.

As we continued down the ridge installing the rafters, we would reverse roles if my partner's side seemed looser than mine, and I would tap my side into place first **(24)**. We also kept checking the straightness of the ridge by eye. If we've cut our rafters accurately, securing the rafters straightens the ridge and holds it straight **(25)**.

Once we installed the common rafters along the ridge and knee walls, we nailed the rafters to the layout on the intermediate walls. We then removed the temporary packing strips from the top edge of the ridge **(26)**. Over the next couple of days, we installed the framing for the two intersecting gable dormers, which included LVL headers between the common rafters that flanked the openings. The ridge for the intersecting roofs extended from the headers to the dormer gables. Then it was just a matter of filling in the valley rafters, jacks, and the intermediate rafters above the headers, and we were ready to sheathe the entire roof **(27)**.

Nathaniel Eldon owns Eldon Builders (eldonbuilders.com), a custom home-building and remodeling company in Cape May, N.J.

Photos: Post Pattern Woodworking

Clear Finishes for Wood

Attaining a flawless surface always takes work, but it may be much easier than you think

BY MARK LUZIO

There are four basic choices for clear coating bare wood: oil, varnish (including polyurethane), sprayed lacquer, and shellac. For most of the architectural woodwork I do, I lean on the first three, and those are what I will focus on in this article.

The fourth finish—shellac—is usually used for fine reproduction furniture. Its solvent is denatured alcohol, which can create problems (think spilled drinks) for architectural millwork. But while I avoid its use in homes, I will cover French polishing techniques, which are traditional methods for applying shellac, that can be easily adapted for the other three finishes to provide a sought-after rubbed, or waxed, look.

SANDING

I have a quote on the wall of my shop: "The test of devotion to a craft is being comfortable with the drudgery of the task." I don't know who first said it, but I sometimes read it before I get ready to sand a large project.

There is no way to achieve a fine finish without taking great care during sanding. It needs to be a progression. I start with 80- or 100-grit, which I follow with 120, then 180, then 220, and finish with 320. It is important to stop after 180 and hold each part at an angle in even light (a north window works best) to check for scratch marks. If you can see obvious scratches, work them out. This will

For sanding bare wood, the author relies primarily on a random orbit sander, but on most projects he can't avoid hand sanding. Then he uses Preppin' Weapons—colored rubber blocks (each color is a different grit). For detail work, he uses a spray adhesive to attach sandpaper to a variety of wood blocks **(1)**. For applying all oil finishes, he brushes on a thick coat, lets it soak in for several minutes, and then rubs it out with blue shop towels, which don't leave annoying lint behind **(2)**.

save time, because the finer papers won't be able to get them out easily. If you get to 320-grit with underlying 120 scratches, you have to start over. Modern random-orbit sanders attached to a good shop vacuum are the best choice. The combination of vacuum and sander clears the dust and allows you to sand across any changes in the direction of the wood grain without creating obvious scratch lines. The vacuum also helps reduce the buildup, or "loading," on the paper. The flatter the surface, the better the final finish, so a delicate touch is sometimes better than brute force.

I do my hand sanding with colored rubber blocks sold under the name "Preppin Weapon" (Time Shaver Tools; timeshavertools.com). They are available online and from supply catalogs. They hold a quarter sheet of paper, using a quick-change clamp that never fails.

For detail work (for example, getting into tight corners of a profile or rabbet), I spray the back of a sheet of sandpaper with a multipurpose adhesive and stick it to a block of wood or MDF. I trim the edges flush with a utility knife.

For sanding bare wood (by machine or by hand), use only the best open-coat paper and avoid the less-expensive garnet paper. Closed-coat papers, which have 100% of the paper surface covered with grit, clog up too fast. I prefer ProSand paper from Norton/Saint-Gobain. Festool also has some good-quality papers. And never use dull paper. It's cheaper to change the paper—the extra labor needed when sanding with dull paper costs more than new paper.

I use foam-backed 400-grit and 600-grit pads for sanding between coats of finish. This sanding is done by hand and should be done with a soft touch. That allows me to catch any small defects; it is a quality-control step that also prepares the surface for the next coat.

FILLER

For most work, you need to fill the pores to create a top coat that reflects light evenly. This can be done with clear finish or with a grain filler.

From a finisher's perspective, there are two types of hardwood. Oak, mahogany, walnut, and ash are examples of woods that have open pores. Examples of woods with small or closed pores are birch, maple, beech, and cherry. With small pore woods, sprayed lacquer or brushing varnish is sufficient. It will take at least four coats on a counter or tabletop. For vertical surfaces, like trim and panel jobs, three coats are often enough.

To speed up the filling of open-pore woods, a grain filler can be used. It may seem like a huge, time-consuming step in the finishing process, but it actually ends up saving time. Without it, you'd have to apply multiple coats; and even then, in most open-pore woods, you would not achieve that flat, mirror quality that is the mark of an excellent finish.

Grain filler creates a mirror-like surface reflection because of

To achieve the flat, mirror-like sheen that is the mark of an excellent finish, the author filled the open pores of this mahogany with a grain filler before applying four coats of Murdoch's Hard Oil and then rubbing out with Behlen's Deluxing Compound. All the woodwork was prefinished before installation on site.

the extremely fine-ground silica (glass) in the filler. I use Behlen Pore-o-Pac natural filler and add the company's master color pigments to match my wood. (Woodworker's Supply is one source for Behlen products.)

Pigmented Behlen filler acts a little bit like a stain, in that as you rub it into the pores, it helps to even out the color. True staining, however, is an entire topic unto itself. Suffice to say here that if you need to stain the wood, you must do it before the filler step. I rarely stain my projects with oil-based pigmented stains. There are other ways to enhance the natural color of some woods with chemicals that react with the natural tannins in the wood. You can find references to these compounds in the books listed at the end of this article.

For large panel jobs, or for ceilings and walls done in T&G, try not to fall into the trap of installing all the woodwork first and then sanding, staining, and finishing it. Clearly, it's easier and faster to work in a shop or in another protected location at ground level rather than trying to stage the area on site.

The panels in my August 2016 article, "Curved Paneling for a Circular Room," were all filled and finished in my shop. After the install, I only had to fix nicks and scratches and fill nail holes, whereas sanding and finishing a job like that in place would have taken weeks. My goal on most projects is to be on and off the site as quickly as possible.

OIL

I lean heavily on tung-oil-based finishes for a lot of the work I do. I typically use those produced by Sutherland Welles (sutherlandwelles.com), which has a complete line of polymerized tung-oil finishes. Polymerizing is a cooking process that helps speed up drying. (Most people know about boiled linseed oil, which is similar.) I avoid pure, or raw, oils because the dry time can be a nightmare.

I generally use Murdoch's Hard Sealer or Murdoch's Hard Oil; both are from Sunderland Welles, and both are mixtures of tung oil and resin. The nice thing about the Murdoch's line is that it uses a citrus-based solvent instead of mineral spirits. If you have to finish a room in an existing house, the homeowners will appreciate this citrus base.

Completely read the label directions on any finish you purchase. Sutherland Wells has excellent one-page PDF instruction sheets for all its products.

Waterlox is another brand of oil-resin mix. This one uses a linseed- and tung-oil mix with phenolic resins, and while I don't use it as often as the Sunderland Welles oils, it performs well. I also use sealer and the oil-urethane top coat made by General. This is the least expensive of the three that I use; it is a good choice when you have large areas to finish on a limited budget.

With all these finishes, you should brush on each coat, wipe it off after letting the oil penetrate for 5 to 15 minutes, and then rub

While preparing sample boards, the author sands between coats of clear finish with foam-back 400- and 600-grit pads (the ones above are from Festool **(4)**. French polishing techniques work for all clear finishes (not only shellac, for which they were originally developed). For all final work, the author always tries to set up near a window for the natural light **(5)**.

the surface bone dry. For the wiping off and rubbing, I use blue shop towels. They are widely available; I often use the ones made by Sellars, which are sold at Lowe's. Another brand is Scott's Paper, which is available on Amazon and from a number of large auto-parts and retail outlets. Blue shop towels are a huge modern improvement because they are lint-free, unlike 100% cotton white t-shirts cut into squares, which is what I used to use.

The great advantage of wiping oils is that you are able to speed up the dry time by rubbing. The surface does not attract dust particles that otherwise would fall to the surface during the dry time. Be aware that wiping oils do not have a flattening agent. If you lay on the final coats without wiping them dry, you get a high sheen. You can cut this sheen using the French polishing techniques to be explained later, but it takes a lot of elbow grease.

Typically, I lay down at least three coats. On surfaces, such as kitchen countertops, that need an extra layer of protection, I suggest brushing a satin tabletop varnish as the final coat over three or four coats of oil.

VARNISH AND POLYURETHANE

Technically, an oil finish, varnish, and polyurethane are all related on the spectrum of clear finishes—they all contain oil and resins in varying proportions. Essentially, an "oil finish" becomes a "varnish" when the amount of resin gets high enough that the material has to be brushed on; wiping it on and rubbing it out becomes impossible because the resins would gum up on the cloth. Varnish, like oil finish, also contains solvents to help keep the resins pliable, and these evaporate during the drying process. Flattening agents can also be added to create a satin sheen.

Most "varnish" made for interior applications uses alkyd resins, while "polyurethanes" use a combination of alkyd and polyurethane resins. The overall effect of polyurethane is a bit more plastic. I do not use it a lot, preferring the warmer quality of alkyd- or phenolic-resin varnishes that contain tung oil.

The percentage of resin solids is lower in a waterborne polyurethane than in oil-based ones, so you need to lay on more coats—usually about four coats of water-based to match the performance of two coats of an oil-based poly. There are water-based grain fillers that are specifically made for these waterborne products.

For exterior applications, spar varnish has a higher ratio of oil to resin, creating a more flexible finish that can better withstand dimensional changes. Marine varnish is a spar varnish with a lot of UV inhibitors to better withstand exposure to sunlight. I have made many mahogany entry doors and finished them with marine-grade spar varnish. For these and other exterior applications, I like the McCloskey line. Over time, all wood with a clear finish that is exposed to sunlight will bleach. An additional coat will be required every few years.

With all varnish, follow the label directions and you should not have any problems. I typically thin the first coat 30% to 50% with mineral spirits.

SPRAY LACQUER

If I have a large millwork project with a lot of surface area, I will often switch to spraying. This work needs to be done off site. Spray lacquer provides a durable clear coat, but you want to handle the work carefully during installation.

Spraying is a big subject that deserves its own article, but lacquer is an important clear finish in the finish carpenter's bag of tricks, so I'll touch on a few quick tips here.

Check the weather forecast. This is true for any clear finish, but it is doubly important for sprayed lacquer. All clear finish will dry (oxidize) when exposed to air, and the relative humidity of that air has a big impact on that process. If the humidity is above 75%, proceed at your own risk. Forget about finishing if there is prolonged rain in the forecast, or if it's a soupy, 90% humidity day in the summer. (On the humid days, I suggest spending a few hours sanding and then taking the afternoon off for a lake swim.)

HLVP systems are the best for a small shop. I stick with basic lacquer and stay away from the catalyzed versions.

Thin your lacquer to the correct viscosity and add enough retarder for your current humidity and air temperature (more for high humidity and hot weather). Retarder is a form of lacquer thinner that slows dry-time. When an atomized finish dries too fast, you end up with the dreaded "rough overspray." This overspray will require additional labor time.

Clean up periodically. The cleaner you keep your guns, the better your day will go.

Seal first. On each part of a large job, I spray sanding sealer on each part as I finish it. For example, with cabinets, I'll spray sealer on each piece when completed. The sealed surface can be left for weeks before I sand everything out. I spray final coats only on what I can completely coat in one day.

Don't wait until coats cure. Spray each finish coat as soon as the previous coat is dry to the touch. You don't want to wait for each coat to fully cure. The solvents in the next coat will eat into the base coat, creating a chemical bond. (With varnishes and oils, the coats bond mechanically; you need to sand lightly between coats.)

Ask your supply house for "fish-eye eliminator." I add two drops to every gallon as a precaution against silicon contamination, which can be a real heart breaker. If you haven't experienced this, just trust me and use the drops. My four-ounce eyedropper bottle is almost empty after 35 years and has saved many jobs from silicon contamination.

RUBBING OUT AND WAXING

There are three surfaces you can create with clear finishes—high gloss, satin, and a wax, or rubbed, effect. Clarifying these differences is an important discussion to have with your client. If the budget allows, rubbing out and waxing a clear finish will provide a high-end touch.

Once the finish has cured, I use "Behlen Deluxing Compound." It is a mix of cutting agents like pumice and rottenstone with carnauba wax. Follow the directions on the label and you can achieve a finish surface close to a true French polish on any clear finished project.

Most of the dust particles that have landed on a clear finish can be rubbed out. Sometimes I need to start with a micro-mesh finishing pad. These are color-coded, and grey (600- to 800-grit) is usually the best choice. The deluxing compound will create that waxed, or rubbed, effect to the finished surface. The finish must cure for at least 24 hours before you rub it out. Even better is to wait three to seven days.

> "The test of devotion to a craft is being comfortable with the drudgery of the task."

Wax can be the final step, but often the deluxing compound is enough. If I use wax (for example, on a countertop where I want the extra layer of water protection), I stick with a true carnauba and bee's wax mix and use a clean cotton rag to apply it.

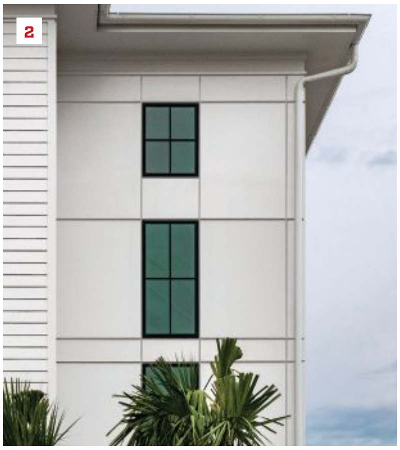
No finish will stick to wax, so make sure you buy a can of de-waxer. The wax must be removed anytime you need to go back and fix a finish (and trust me, after you bring the project to the site, you will need to go back here and there to fix any dings or spots you missed during prefinish). Wax is a great material to fix scratches, and it's also a good water repellent. The only downside is that it must be applied every few months to keep that glossy look, so you'll want to make sure the client knows this.

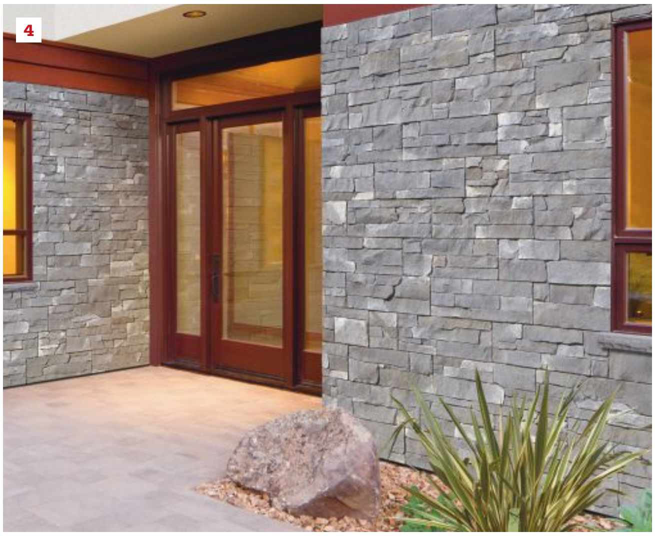
SAMPLE BOARDS

On almost all projects, plan on making sample boards to show your clients exactly what they will get. Making them is time-consuming, but it can't be avoided. I take advantage of these sample preparations to work out any problems with the particular wood I am using, so that I am confident with all the steps required to achieve my final finish. Make notes on the boards. Pick the three best and present them to your client.

As a final word of advice, I recommend reading a comprehensive "text" to form a broad understanding of wood finishing. The edition I keep on hand is "Staining and Polishing," by Charles Hayward (Evans Brothers Limited, 1946; several used reprint editions are available on the internet). The language is antiquated, but the knowledge is still sound. A more up-to-date and readable edition is "Understanding Wood Finishing," by Bob Flexner (Fox Chapel Publishing, 2010). The book I recommend the most is "Adventures in Wood Finishing," by George Frank (Taunton, 1981). It is not a complete how-to on finishing, but it does give an important overview on achieving a quality finish.

Mark Luzio owns Post Pattern Woodworking in Brooklyn, Conn.





1. A Smart Vent Hood
The newest addition to Elica's Techne Plus series is the Stoney Island vent hood, which communicates with the company's Gold induction cooktop. Available in 36-inch and 42-inch widths, the glass and stainless steel hood reportedly uses wireless sensors to monitor cooking vapors and temperature, automatically adjusting to maintain optimal settings. The hood also features glass touch controls, a 600-cfm blower, and LED dimmable lighting. Pricing ranges from $1,530 to $1,730. elica.com

2. Versatile Exterior Siding
James Hardie's Aspyre Collection of fiber-cement exteriors encompasses the company's Reveal Panel System and its Artisan siding. The Reveal Panel System offers smooth, 7/16-inch-thick exterior siding panels. Options include recessed or surround trim, and countersunk or exposed fasteners. The 5/8-inch-thick Artisan siding is designed for modern, streamlined settings and is offered in six styles. Both products are available primed for paint. Pricing varies by square footage, model, and distribution market. jameshardie.com

3. A Sintered Stone Surface
Retrostone, from the Fusion Collection, is Neolith's newest sintered stone decor for flooring, interior wall cladding, and countertop applications. A mosaic of marble and granite chips set in concrete, Retrostone is composed of clays, feldspar, silica, and natural mineral oxides, making it recyclable, durable, and low maintenance. Retrostone is available in 6mm and 12mm thicknesses and a silk finish. Pricing varies by slab size, fabrication, color, and finish selection. neolith.com

4. Integrated Rainscreen for Masonry Veneer
Certainteed recently introduced Stonefacade, a concrete masonry veneer that doesn't require mortar; instead, panels attach over the wall's weather barrier with screws through a stainless clip. This installation system creates a 3/8-inch air space and weep channels behind the stone that promise to alleviate water-intrusion problems that have plagued conventional "faux stone" products when poorly installed. The ledgestone-look panels are 8 inches high in 10-, 14- and 24-inch widths. Pricing is not yet available. certainteed.com

Products

BY KATHLEEN BROWN

5. Smart Water Monitoring
The Flo water security and management system from Flo Technologies monitors water flow, temperature, and pressure, reports that information to the homeowner, and learns the home's typical water-usage patterns over time. The Flo system consists of a Wi-Fi-connected monitor installed on the home's main water supply and an accompanying smartphone app. The company says Flo can detect small leaks, shut off water supply if a pipe bursts, and alert homeowners if pipes are about to freeze. Pricing starts at $400, which reportedly includes installation. meetflo.com

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6. New Palm Nailer
Estwing has partnered with Prime Global Products to manufacture and distribute a line of pneumatic nailers, including a Mini Palm Nailer ($50). It weighs 1.4 pounds and is designed for working in tight spaces and installing joist hangers, decking, and fencing. Its air filter and anti-dust cap help keep it clean, and a 1/4-inch NPD swivel rotates a full 360 degrees. It takes 6D to 16D nails 2 to 4 inches long and operates at 80 to 100 psi. estwing.com

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7. A Highly Efficient Toilet
Niagara Conservation's Nano Toilet uses vacuum-assist technology to achieve an average of 0.6 gallons per flush. WaterSense certified and MaP premium rated, the toilet is touted as one of the most water-efficient toilet fixtures on the market. The Nano's compact design is ideal for tight spaces or tiny homes, the company says, while its elongated bowl preserves user comfort. The toilet also includes a noise-cancelling water tank and 10-year warranty. Prices are $204 for the Nano single flush and $214 for the double flush. niagaracorp.com

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8. A Tankless Gas Water Heater
Rheem's Prestige Series Mid-Efficiency Indoor Tankless Gas Water Heater with Built-In Recirculation provides continuous hot water on demand while reducing cold-water waste. The Prestige runs only when turned on by the user; when activated, it recirculates cold water through a return line instead of letting it run down the drain. The company claims that this recirculation can save a household a significant amount of hot water and energy. Rheem's Prestige heater is priced from about $1,200. rheem.com

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9. A Strong Composite Subfloor

LP's newest composite subfloor panels are bonded at the molecular level with Gorilla Glue Technology and retain their shape and size when exposed to moisture or the elements, the company says. The LP Legacy sports exceptional fastener holding, reduced chances of nail pops or movement over time, and higher performance for finished materials, including hardwoods, according to the manufacturer. Pricing varies by market, but according to LP, panels are typically available for a modest premium over commodity Sturd-I-Floor panels. lpcorp.com

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10. Streamlined Duct Installation

Panasonic Eco Solutions North American's new EZ Soffit Vent allows contractors to complete ducting work before the soffit panel is installed. Its low-resistance backdraft damper helps eliminate drafts in the home and improves blower-door test results, the company says, while the grille can be rotated 180 degrees to align discharge with ductwork. By streamlining duct installation, the EZ Soffit Vent enables better fan performance, lower callback rates, and increased energy efficiency, Panasonic says. Prices start at $34.50. panasonic.com

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11. Three Trim Adhesives

Azek Building Products added three new solutions to its line of professional adhesives and sealants. The Fast Cure solution is designed for core-to-core bonding and cures within five to eight minutes. The Slow Cure is designed for surface bonding, assembling larger parts, and creating fills and blends, curing within 20 to 25 minutes. The Fill and Flex is made to seal gaps around windows and doors, as well as expansion–contraction joints in PVC trim boards. Prices range from $11 to $32. azek.com

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12. A Screwless Door Frame

Trimlite's Solution Series is a one-piece, screwless door frame that cuts down on installation time, with no frame plugs needed. Its low-profile appearance and clean lines integrate with modern, Craftsman, or mid-century architectural styles, the company says. Trimlite's Solution Series frame features a 3/16-inch Shaker-style profile and a compression seal to protect from water infiltration. ABS plastic frames are available in white or tan vertical wood patterns, and pair with 11 energy-efficient glass styles. Prices start at $27 and increase depending on glass and frame size. trimlite.com

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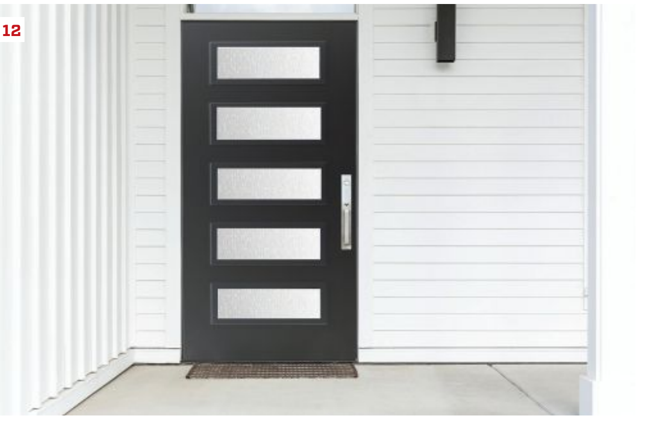

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Weigh In!
Want to test a new tool or share a tool-related testimonial, gripe, or technique? Contact us at JLCTools@hanleywood.com

Smart Subcompacts

BY CHRIS ERMIDES

In 2013, Milwaukee brought its brushless technology to the M12 line, creating the M12 Fuel drill/driver and impact driver—a product line that uses compact, 12-volt batteries. Last month, Milwaukee finally released this new generation of the tools, which the maker says are its most compact versions to date. I had the chance to compare the old with the new at the company's media event last year, and I can attest that they are impressively compact. There are three new M12 Fuel subcompact options available: a drill/driver, a hammer drill, and a 1/4-inch hex impact driver.

The drill/driver and hammer drill both feature an all-metal 1/2-inch chuck. Their brushless motors run up to 1,700 rpm and deliver 350 inch-pounds of torque (peak). Both drills have 17 torque settings and two speed settings, and weigh 2.8 pounds with a 2.0-Ah battery. The drill/drivers are 1 inch shorter than previous generations.

The most intriguing tool in the new subcompact line is a 1/4-inch impact driver, which is designed for HVAC contractors and electricians, as well as plumbers—trades that regularly use self-tapping screws in sheet metal or tap cons in block and concrete. Its brushless motor runs up to 3,300 rpm and delivers 1,300 inch-pounds of torque.

What's new about this driver, aside from its weight and size, is that it has four modes, which offer added control depending upon the application. Mode 1 allows for greater precision, keeping rpm at 0–1,300. Mode 2 is meant to prevent snapping heads and stripping screws by maintaining 0–2,400 rpm. Mode 3, which Milwaukee calls "performance," runs at the full 0–3,300 rpm. The fourth mode—a new "self-tapping" mode—does three things. To start the screw, it spins it up to 3,300 rpm. Once the threads engage, it lowers rpm to max out at 2,400. As the screw tightens, the driver slows further to 800 rpm to reduce stripping.

As with all 12V tools, keep in mind that these are not designed for high-demand applications that new-construction electrical and mechanical contractors might encounter on a regular basis. The M12 Fuel drill/drivers and impact driver are ideally suited to be the primary solution for MEP, HVAC, MRO, and many remodeling contractors where the M18 Fuel equivalents would offer unnecessary power and weight for a lot of routine tasks.

All drivers will be available in kit form or as bare tools. The drill/driver and hammer-drill kits will come with one M12 2.0 battery, one xc4.0 battery, a charger, and case and will cost $170 (drill/driver) and $180 (hammer drill). The impact driver will come with two M12 2.0 batteries, charger, and case ($180). A kitted version of the impact driver and drill/driver and one of the impact driver and hammer drill will also be available, for $230 each. milwaukeetool.com

Chris Ermides is editor of Tools of the Trade. *Follow him on Instagram @toolmagazine.*

The new M12 Fuel drill/driver (top) weighs a little over 3 pounds when equipped with a 4.0-Ah battery (shown) and 2.8 pounds with a 2.0-Ah battery. At just over 6 1/2 inches long, it is Milwaukee's smallest drill/driver and can handle drilling in steel and wood. The impact driver (above) weighs 2 pounds with a 2.0-Ah battery (shown) and has four modes, including a self-tapping mode.

Auto-Start Power for Cordless Tools

Makita announced 20 new products at STAFDA this past November, so 2018 will be a big year of releases for the company. The biggest news at the event was a new wireless communication system, which Makita calls AWS (Auto-Start Wireless System). AWS-equipped tools use Bluetooth technology to communicate power on/off between the tool and a cordless vacuum or dust extractor that's also equipped with the technology.

The system revolves around a HEPA dust extractor (model XCV08Z), which is Makita's latest cordless dust extractor/vacuum. Equipped with AWS for wireless power and on/off communication with AWS-equipped tools, the extractor is powered by two 18-volt batteries and features a three-stage HEPA filtration system and automatic filter cleaning. The extractor supports up to 10 connected tools and has a 32-foot range.

This winter, five cordless tools that are equipped with the AWS technology will be released: a 10-inch dual-bevel sliding compound miter saw, an SDS-Max rotary hammer, two 4 1/2-inch/5-inch grinders (one with a slide switch and one with a paddle switch), and a 6 1/2-inch plunge circular saw. makitatools.com —*C.E.*

Until now, dust extractors and vacuums had to be turned on separately from the cordless tool they were attached to. Makita's new AWS Bluetooth technology allows the equipped tools to communicate, so they operate in the same way traditional plug-in auto-start switches do. Each AWS-equipped extractor can be paired with up to 10 tools. Currently, there are five cordless tools available with the technology (including two grinder models). Makita plans to release more AWS-equipped tools in the future.

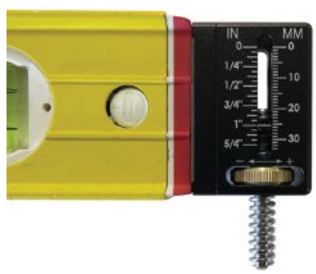
Dial-in Level and Plumb

BY MATT JACKSON

The How Far Out Gauge is an accessory for consistently finding level or plumb reliably and accurately. The gauge attaches to almost any level type (at least 2 3/8 inches tall) and length, and it's interchangeable between levels (with extra connectors available separately), allowing it to be easily adapted to a wide range of leveling tasks.

Designed by a career tradesman, the How Far Out Gauge shows hands-on sensibility from the real world of construction in its simple, practical features. Made with high-quality brass, stainless steel, and CNC-machined aluminum, the tool seems well-made to withstand the conditions of today's demanding and fast-paced jobsites, with dependable accuracy. Keyed lugs in the male-female connector insure the gauge is always installed correctly. A strong magnet in the connector holds the gauge to the end of my favorite level; then a quick spin of a knurled brass knob on the finely machined adjustment screw while eyeballing the levels' bubble is all it takes to make it spot-on in seconds. The gauge costs $50. fastcap.com

Matt Jackson is a carpenter living in the Black Hills of South Dakota. Check out his YouTube channel, Next Level Carpentry.



Made with high-quality brass, stainless steel, and CNC-machined aluminum, the How Far Out Gauge is like an analog app for spirit levels. With the level set true, a simple spin of the brass knob allows you to fine-tune the bubble, giving you a precise measurement of how out of plumb or level you are. The gauge ranges from 0 to 5/4 inches and can be attached to any level.

BY ELIOT LOTHROP

Breaking Down a Silo

My company, Building Heritage, specializes in the preservation and restoration of timber-frame structures in Northern Vermont. As you can imagine, working up here in dairy country, we spend a lot of time repairing barns. The agricultural industry in the state has been changing, though, and many of the folks we work with are gravitating towards smaller, diversified farming rather than dairy, choosing to house a mix of smaller livestock in the barns we refurbish. Other owners want us to completely restore their barns for assembly use—wedding barns, for instance, are currently popular in Vermont.

With the changes in use, storing large amounts of feed for a herd of hungry cows is no longer necessary—and neither are the silos that used to hold the feed. Even so, our clients typically want to keep their silos. Some have managed to successfully incorporate them into their plans (in an upcoming job, we're converting a 16-foot-diameter-by-30-foot-tall wood silo into a bar; the main barn is going to serve as a large function hall).

However, not all of the silos are worth keeping. Over the years, we've come across a few silos that have deteriorated to the point that we had to remove them for safety reasons. Such was the case on a job we did last fall.

The client's silo, shown in the photos above, was a "concrete stave silo." Roughly 18 feet in diameter and 30 feet tall, it was built with interlocking concrete blocks (or staves) held in place by steel tension rods. The individual blocks were roughly 10 inches wide by 30 inches tall by 2 inches thick and were dry-laid—that is, interlocked together with no mortar. The interior was then skim-coated with concrete to help keep the silo somewhat airtight (to reduce spoilage) and to protect the block from the acids that leached out from the stored silage.

Early into the barn repair (we jacked up the whole barn, then replaced the foundation and slab), the owners wanted us to look into the possibility of turning their silo into an observatory. When we inspected it with our lift, we knew within a few minutes that it was too far gone to save. There were numerous fist-sized holes through the block and a large, continuous crack along the top block course, giving the appearance that the top course and domed roof were well on their way to shearing off. With this news, the clients agreed to demo the structure.

Because we had aerial lift equipment that could keep the crew above and out of the way of the silo, we felt that it was safest to remove the silo from the top down **(1)**, in case something went wrong. First, we carefully cut the uppermost steel tension rod from above using a grinder. These rods tend to violently snap when cut, and the lift's steel basket offered protection **(2)**. With the top rod cut, we removed the domed roof. We then cut a few more tension rods and sledgehammered the block debris into the silo **(3)**. Demoing a course or two at a time, we worked our way down the silo to about 12 feet off grade. At that point, our excavation sub was able to safely remove the debris and the silo's concrete pad using his excavator.

Eliot Lothrop operates Building Heritage, specializing in timber-frame restoration, in Huntington, Vt.

Photos by Eliot Lothrop