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On the cover: A worker with Cutting Edge Woodcraft in Greenback, Tenn., aligns a jig with plumbing locations before transferring them to a sink cabinet. Photo by Chris Land. See the story on page 54.

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The Fatal Four

In the construction industry, two groups of workers account for the most accidents. According to the Bureau of Labor Statistics, workers 25 years old and younger account for the most nonfatal accidents, while those in the 55-to-64-year-old cohort experience the most fatalities.

The first group is easy enough to understand. Those working for the least amount of time have the least amount of training and experience; they don't even know what they don't know.

Why the second group? They have the most experience and training. Based on my own time on site and the stories below, there are a lot of different reasons, but complacency lies at the heart of it. In short, we get too comfortable. Fear is nature's way of telling us that we are doing something potentially dangerous. If we feel too much at ease when scribing with a table saw or bump firing with a nailer, the clock starts ticking down to the "cautionary tale."

According to the Occupational Safety and Health Administration (OSHA), four types of accidents account for 60% of all construction fatalities: crush (caught in or between objects), falls, struck-by incidents (impact), and electrocutions. Let's look at a real-life case for each accident type and break down what went wrong and what we can learn.

CRUSH

I and another junior worker were sent to repair some insulation and vapor barrier in a crawlspace. The only access was a small panel in the skirting around the addition. While I went in, my co-worker waited outside and handed me tools, tape, flashlight, and so forth. After a few minutes of crawling around on my belly, it started to rain. With no place for him to wait out the rain and nothing further for him to do, I told my co-worker he should go home, as it was close to the end of the day. The clearance between the underside of the floor joists and the floor was less than a foot in most places. So, rolling over had to be done between joists after squeezing under them. No need to be a great detective to figure out what happened next: I got stuck—wedged under a couple of joists, face buried in insulation and vapor barrier, with my hands and arms up by my head.

Critical factors. I am alone, it's dark (the flashlight is partly under me), and I had compressed my chest to fit where I am, so I cannot take a full breath. I can't get to my phone because it's on my hip, and I can't maneuver my hands down to reach it. I am also trying extremely hard not to panic.

About an hour later, I got out. Using my toes and my neck to inch my way along, I managed to get to a joist cavity, roll over, and breathe fully.



Lessons learned. Working alone carries great risk. If it can't be avoided, be careful about the tasks that you choose to do.

As we said in Scouts, I failed to plan, so I planned to fail. If I had been prepared, I would have understood that it's always a bad idea to go into a confined work area with no other routes out, no help, and no backup to check on me.

Finally, I was tired, and it was the end of day. There are 8 a.m. jobs and 4 p.m. jobs. People are not as sharp after a full day of work, and mistakes are more likely. Either schedule difficult or dangerous tasks for earlier in the day, or work in extra precautions when doing such tasks later in the day.

FALL

Dan, an experienced roofer with more than 15 years on the job at the time, was removing ice and snow from a four-story condo building in February. The ice buildup was thick, with some icicles thicker than an average person's waist. Dan had been working on this building and others in the complex for a couple of weeks and anchor points had been set up for tying off. As he unhooked his rope from one anchor point to reach for another, his feet went out from him (you can't see the ice under the snow), and down four stories he went.



The doctors told him what saved him was that he passed out on the way down, which kept him from being tense as he hit, with the cushioning effect of the snow assisting. He came to on the ground with his co-worker looking over him asking what he needed. A smoke and an ambulance, he replied. Dan was more than likely in shock; he came to not fully feeling pain or anxiety. Looking up from the ground, his first thought was, “Wow, that seems high. Glad I don’t feel too bad.”

The paramedics strapped him to a backboard, and he was off to hospital. His stay was close to a month with full recovery being close to 18 months. Workers compensation took care of retraining and rehab. He had never desired an office job, so, eventually, he went back to roofing but not until more than a year later.

Critical factors. In February in Ottawa, the temperature can drop to as low as -20°F with an average of around 6°F. Cold temperatures affect equipment and people and how they work. Reaction times are slower, and body movement is restricted due to extra clothing. Catches and clips on safety equipment are harder to operate and adjust. Surfaces are slipperier, not just from the ice and snow; even a clean, shingled roof doesn’t grip as well when cold.

Lessons learned. The weather where you work is a factor, and sometimes the most important one, in jobsite safety. How does your clothing change how you will move? Do you need to adjust your harness and do you know how to do so correctly? Visibility and traction can change with precipitation and temperature. Be aware of your surroundings and prepare and adjust accordingly.

Dan was not inexperienced, tired, or untrained. He was wearing the correct equipment, but the equipment wasn’t attached to the anchor point when he slipped. When Dan works a roof now, two ropes are set up for each worker on large jobs—not just anchor points

but a line available so no one is without attachment when moving positions. Dan invests in the better harness and changes ropes out regularly. He believes that it’s better to spend the money now than lose it later by not being able to work because of an accident. As he tells his crew, the point is to go home at the end of the day.

IMPACT

Mike was new to running a dump truck, having just a couple of years in after doing long-haul trucking. As he was working for a water and sewer company, the days started early and ran long during the summer. The last task of the day was to clear out the box of the truck and work through the end-of-day maintenance checklist at the yard. A cookie of asphalt had gone cold and was stuck to the bottom of the box. Lifting the box part way up, Mike climbed along its edge, using a shovel to try to pry the deposit loose. After a few attempts with no result, Mike climbed into the box to get better leverage.

Working in the box with it inclined, Mike managed to release the asphalt. As it slid out quickly, he lost his footing and slid out of the box right behind the block. The deposit shot out of the tailgate, throwing it open. Mike followed, exiting the box just as the gate dropped back down across his legs.

Lying on the ground, Mike wasn’t able to move his legs at first; the impact of the gate had numbed everything from the thigh down. Slowly, feeling returned, and he dragged himself over to one of the tires and propped himself up to check on his injuries.

No bones were broken, and no hospital trip was taken. Deep, multicolored bruises appeared across both thighs and took weeks to fully fade. Driving, walking, and even sitting caused him pain for well over a month.



Critical factors. Mike was alone, inexperienced, and tired after a long day. With that as his starting point, Mike came to the problem of the stuck asphalt and reacted without an understanding of the possible outcomes. He was fortunate that the gate didn't land on his head or crush his chest; any slight change in how he slid could have resulted in his death or a much more severe injury.

Lessons learned. Luck cannot be a substitute for planning in safety. The company's end-of-day checklist was a list of things to be done but not of how to do those things safely. After Mike's incident, the company wrote up a procedure on how to deal with this recurring situation.

Again, working alone always poses extra challenges, so it should also require extra care if it cannot be avoided. Mike was an inexperienced worker on this task. Training and procedures set up and followed would have helped prevent the accident.

End of day creates its own set of challenges, whether you're experienced or not. You may be in a hurry to finish; you're not as alert or as physically strong. Depending on the time of year, light may be fading along with your energy. A set of well-practiced procedures can act as guardrails to keep you safe.

ELECTROCUTION

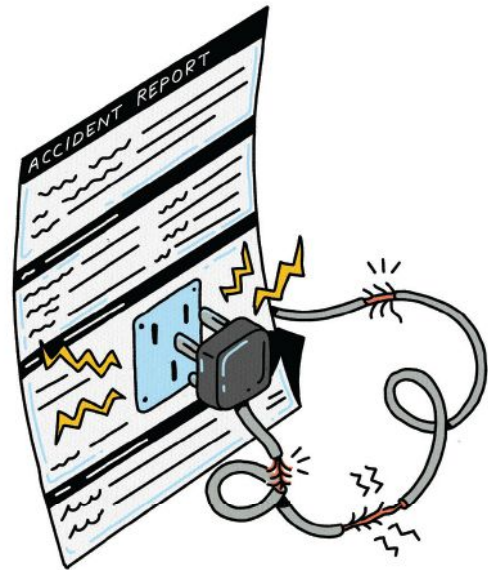
The table saw in my boss' basement shop was an old model, but with its heavy cast top and 30-amp power source, it was able to plow through anything we gave it. I had gone over to it to run some oak posts that I knew my jobsite saw wouldn't be able to handle. I went to plug the saw into the temporary outlet that the electrician had run off the panel—the basement was in perpetual renovation, so a line of BX was hooked into the panel in the mechanical room out to the main working area. I took the plug for the saw, grabbed the outlet box, and woke up a few moments later, on the other side of the room. The connections inside the outlet had come loose from being moved and even kicked out of the way while crew members had been through the space.

My injuries were minor: racing heart, tingling hands with a small burn, and a sore backside from landing on the concrete floor. As with the previous stories, I got lucky.

Critical factors. Someone had noticed that the plug was loose and mentioned it to our boss, who turned off the breaker and was going to tell the electrician the next time he came by, but no note was put on the panel. Someone else turned on the breaker while starting up other tools in the morning but didn't think to ask why it had been off in the first place.

Lessons learned. An electrical outlet should not be a kick toy. A line like this should be better thought out; otherwise, someone is going to get hurt.

The main problem was the lack of procedures and lines of communication. Each person had thought either they had done enough or another individual had taken care of it. A small shop or crew doesn't have the same systems a midsize to large business might



have. However, with fewer employees, change and information can be spread quickly. A phone call, mass text/email, or signage would have prevented me or anyone else from unknowingly being put in danger. Constant lines of communication, even for minor issues, should be a standard no matter the size of the operation.

STAYING SAFE

In the United States last year, 1,069 workers died due to on-site accidents, and a little over 1% of workers had an injury that resulted in lost time. Those numbers from the Bureau of Labor Statistics have remained steady for over a decade despite local and national awareness campaigns.

As workers of various levels of experience, how do we help ourselves stay safe? As a new hire, you can start by asking questions. Simply stopping and looking at the situation will slow you down enough to begin to learn. The same holds true for the individual who has been on the tools for a long time. Think things through in the same way you look at a door to be trimmed or a roof to be flashed. Work through the process to create the desired outcome. If you don't know how to get there, ask someone who does.

Larger companies have safety committees and government-mandated procedures that they need to follow. Owner operators or small businesses lack the scale to create these systems, but that does not mean they can't take steps to help keep workers safe: holding a weekly meeting, sharing stories like these, requiring a (often-delayed) safety course. Remember, the point is to go home at the end of the day, hopefully intact.

Marc Forget is an associate editor at JLC. He is a licensed carpenter of 20 years from Ottawa.



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What is the best way to reduce thermal bridging from a cantilevered steel beam protruding from a building for a balcony or canopy? We aim for high-performance enclosures and have been applying closed-cell spray foam along the length of the beam inside the structure, but we are not sure this completely mitigates the energy loss from this massive member conducting heat through the enclosure.

A Marc Forget, associate editor of JLC responds: While working with Kohta Ueno of Building Science Corporation on another question (see page 14), I ran this one by him as well. He agreed that any piece of steel that's projecting through a building's shell is a thermal bridge that degrades the overall value of the enclosure's insulation. "It becomes even worse," he explained, "as you add thicker and thicker insulation levels. You have a tighter bucket, but you have slit the same big hole in it."

According to Ueno, the ideal way to address the thermal bridge is with off-the-shelf structural thermal break products made by Schöck, Armatherm, and others. For a steel-to-steel connection, these are typically made with a high-density plastic pad that interrupts the steel beam at a bolt-through connection. This requires you to create your cantilever with two segments of steel—an interior section and an exterior section. Is this weaker than the typical unbroken, through-steel cantilever? "Absolutely," Ueno responded. "The beam must be designed by your structural engineer to account for that."

If the structure is already built, and a steel cantilever protrudes from the building, a 2-inch-thick coating of

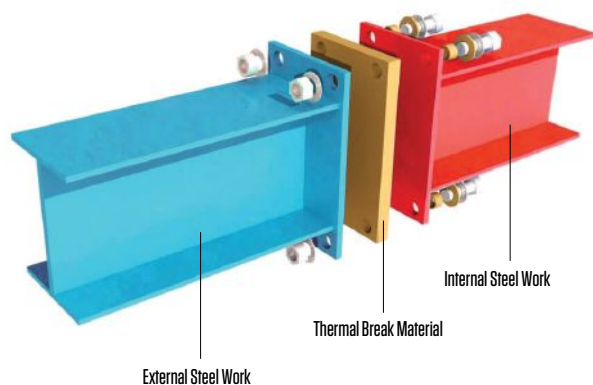
closed-cell spray will reduce the transfer, Ueno said. He compared it to wearing a mitten in winter; it's not ideal, but your hand will be warmer for wearing the mitten. "However, this solution, or coating the steel with an aerogel-incorporated paint, is only going to be as good as it is maintained or protected," Ueno cautions. "If decking is applied without care, or if [the insulation is] left to the elements, its performance will degrade over time."

I also consulted engineer Peter Baker, president of Building Science Corporation, to explore how different structural materials might perform. "Different materials are worse at [energy] transfer than others," he said. "Concrete is worse, steel next, and wood being the least." A concrete beam or concrete slab projecting from the building typically conducts more energy, he explained, because it needs to be bigger. "The bigger the protrusion, the more energy transferred through the building enclosure. A concrete slab coming out for a balcony or canopy generally has the most mass."

To minimize the energy transfer, Baker urged that we need to first think of minimizing the cross section of material that is being used. "Simply make the protrusion material as small as possible to reduce the potential transfer," he said.

Once the materials have been defined, we can add thermal breaks. Thermal break products for steel-to-steel, concrete-to-steel, and concrete-to-concrete connections are available from several sources, as noted above.

"Insulating the material both inside *and* outside of the penetration is a good strategy, too," Baker continued. "But this can be a challenge depending on both the material used and what will be applied to the beam outside of the building." For example, steel beams supporting a cantilevered deck can be insulated, but the connection between the deck and the cantilevered beams will create its own thermal bridge into the beam and through the enclosure. In this case, the steel beam can be fully coated before the deck is attached, and standoffs incorporated into the structure to allow for attaching the deck, minimizing the thermal bridging.



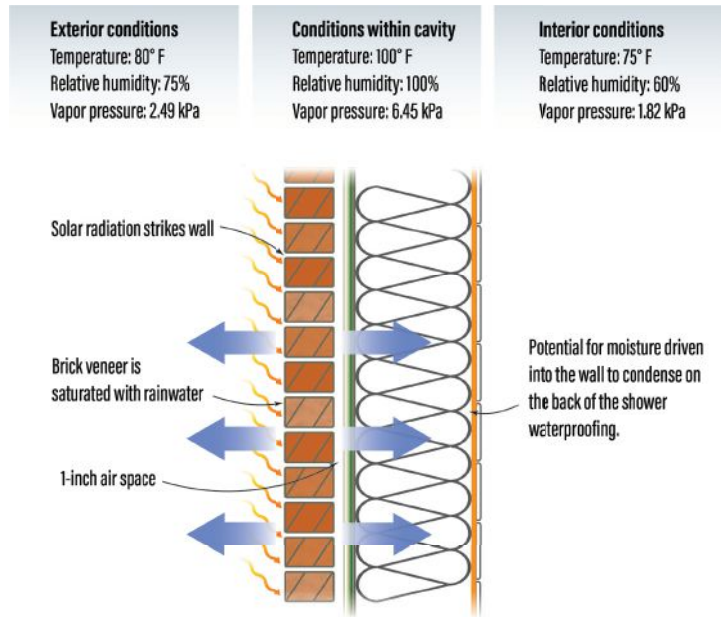
A thermal break material can reduce energy transfer through a steel balcony support.

As construction techniques and materials have advanced, we have gone from simple moisture-resistant drywall or cement board to plastic (polymer-based) bath and shower enclosure systems by Schluter, Mapei, Wedi, and the like. With these systems, do we need to start thinking of the vapor barrier and insulation behind these areas differently?

A Kohta Ueno, a principal of the Building Science Corporation, responds: For the most part, having an impermeable material on the inside is typically not a fundamental problem. In standard construction in a cooler climate, you typically put your less vapor-permeable material on the inside, whether it's polyethylene sheeting or a variable-perm retarder, such as Membrane or Intello. The downside of adding an impermeable layer on the inside is that you've reduced the amount of drying inward through the wall. So, if, for instance, you have a catastrophic water leak like a constantly leaking window in your shower stall, your wall has less of a chance to dry out.

In a shower, you have a lot of warm, moist air building up on the shower side and, in a cold climate, you have a strong vapor drive that wants to draw moisture toward the exterior. If warm, moist air leaks or diffuses into the framing cavity, it would likely condense on the inside face of the exterior wall sheathing. Fortunately, all the care and attention needed to install a shower system to be watertight also helps shut down air leaks. Plus, the mechanical ventilation added to most shower areas helps exhaust the moisture and lightens the interior moisture load. For these reasons, failure (mold growth or rot) tends to be uncommon.

Shower enclosure membranes like Schluter's Kerdi, or Wedi's Subliner and the like, are not as vapor tight as, say, a sheet of plastic. I could see trouble in a hot, humid climate if you had a catastrophic air leak though the exterior into a shower-area stud bay. Inward airflow and condensation on the back surface of that enclosure membrane could become a problem. That's why putting polyethylene vapor barriers or vinyl wallpaper in a wall in Georgia or Alabama is a terrible idea, given all the air conditioning needed in those climates.



The other possible failure in any climate zone is when you have a brick veneer wall with inward vapor drive. Brick soaks up water like a sponge. When the sun hits the brick, vapor moves both inward and outward (see illustration above), but the vapor drive is blocked by the waterproofing system used on the shower walls. Theoretically, this could be a problem if the vapor condenses on the back of the shower enclosure. But in practice, it is extremely rare that problems develop—perhaps if the shower wall was completely impermeable, as you might have for a steam shower enclosure. But again, reported failures are rare.

CORRECTION In the May/June Q&A column, we reported on the volume requirements for a utility closet housing a heat pump water heater (HPWH). Requirements vary by manufacturer and model from 450 cubic feet to 700 cubic feet or more. While we got the volume right, we missed on the dimensions of a 450-cubic-foot space. An example of correct dimensions for a closet of this volume would be 10 feet by 6 feet by 7 feet 6 inches. Reader Wayne Bunker, P.E., also pointed out that the louver door on a utility closet will do nothing to isolate the HPWH from the rest of the basement. He rightly sums up: “These conventional heat pump water heaters work best in moderate climates where the cooling effect is beneficial.”

Illustration: Oia Kwiatkowska, adapted from Building Science Corp.



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SOUND ADVICE

Which hearing protector is right for you?



In the world of construction, it is crucial to prioritize our health and safety. One aspect often overlooked is our hearing health. As we know, jobsites can be loud from the variety of power tools, compressors, heavy machinery, vehicles, and demolition work. Exposure to these excessive noise levels can lead to irreversible hearing damage, which can significantly decrease your quality of life. What's even more unsettling is that it usually happens without you realizing it, until it's too late. By wearing hearing protection on the jobsite, you can help safeguard your hearing and prevent long-term damage.

Sometimes it's hard to know when to protect your hearing, though. A good rule of thumb is to wear hearing protection for any sounds over 85 decibels (dB). But how can you gauge that? A simple

way to remember is if you need to raise your voice or shout to someone that's an arm's length away from you, then the ambient noise is over 85 dB and it's best to wear hearing protection.

With so many different types of hearing protection out there though, how do you choose? When it comes to earplugs and earmuffs, there are different advantages for each of them. Let's go through some of them.

Earplugs. To begin, earplugs are less expensive than earmuffs, making them more economical if you don't need to wear them often. They're convenient to use since they are compact and disposable. Some people also find earplugs to be more comfortable to wear than earmuffs since they are lightweight and cooler during warmer months since they don't cover your ears. They also

fit well with other PPE such as safety glasses, respirators, and hard hats.

Earmuffs on the other hand can be more expensive upfront, but their durability and longevity make them a worthwhile long-term investment. Plus, many users find earmuffs easy to put on and take off, making them convenient for quick and frequent use. Some earmuffs come with electronics to provide additional capabilities, like Bluetooth wireless technology, so you can stream your favorite music or podcast while working, and the ability to take phone calls without removing the muffs. Advanced electronic earmuffs even have level-dependent technology, which uses built-in microphones that pick up the noises around you and then plays them through the headset speakers. This feature not only allows you to have a conversation while wearing the muffs, but also helps give you situational awareness on the jobsite, helping enable you to hear important sounds like warning signals, verbal communications, or approaching vehicles. This technology also limits incoming sounds to a safe level to help protect your hearing automatically against sudden loud noises.

In short, there are many different types of hearing protectors with features and advantages to each. Find the one that's right for you, and remember to always wear them when necessary to help protect your hearing and ensure you can enjoy your favorite sounds for years to come.

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Solution for a Quiet Party Wall

BY ROB CORBO

Last year, a customer we had worked for six years earlier called to inquire about our availability. Previously, we had renovated her home in Hoboken, N.J., and she was now in the process of buying the attached brownstone next door. She wanted us to work with her and the architect again. The project called for gutting and renovating the first and second floors of the new home and leaving the basement level alone; the basement, an existing finished space, was in the flood zone of the Hudson River and could only have been renovated for storage. Although the project required a significant amount of detail work, including lots of structural work (not unusual for a 125-year-old attached home in Hoboken), the one detail the homeowner emphasized during our initial phone conversation was soundproofing the common wall between the two homes. If she was going to buy the property and renovate it for resale or as a rental, she wanted to make sure there was no sound coming through the common wall on the west side of her home.

The two properties were separated by an 8- to 12-inch-thick brick party wall, and our client heard little in the way of conversations from next door but often heard music. When I examined the plans, a mass loaded vinyl (MLV) membrane was specified as the major component of a soundproofing system outlined by the architect. MLV was not a product I was familiar with; over the years, we've done little soundproofing beyond insulating bathroom walls. So, of course, I put the plans down and did an internet search on MLV. That revealed what MLV is, but opinions varied regarding its effectiveness and associated cost for varying soundproofing needs. Technically, MLV consists of viscoelastic materials such as polyvinyl chloride or vinyl filled with dense inert compounds such as barium sulfate or calcium carbonate. For those "chemical" laymen out there like me, it's dense, flexible, thin (we used $\frac{1}{8}$ inch), extremely heavy, and expensive. Its density, weight, and flexibility are what give MLV its ability to reduce and absorb sound. We weren't building a sound stage or sound studio, so I didn't let the diversity of online opinions keep me up. All we wanted was to reduce the sound of voices and music at a Hoboken party wall. A professional architect designed a soundproofing system to do that, and all I had to do was implement it.

I learned from my research that a sound transmission class (STC) of 65 would eliminate most sounds. STC ratings assign a measure to the acoustical performance of household materials; in our case, a wall made up of numerous components, each of which provid-

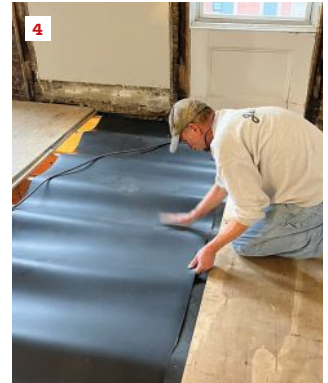
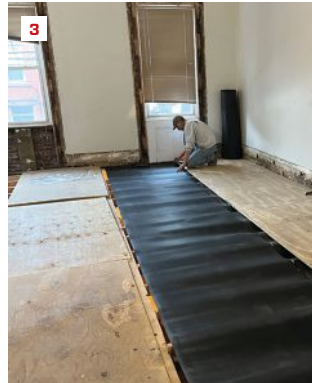
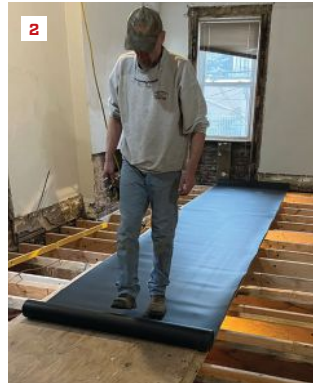


Mass-loaded vinyl is installed over a row-house party wall.

ed a degree of soundproofing. Those components were an 8-inch-thick brick party wall, a 1-inch space, a $1\frac{5}{8}$ -inch metal-stud wall with mineral-wool soundproofing insulation, a $\frac{1}{8}$ -inch-thick MLV membrane installed on the metal studs, and $\frac{5}{8}$ -inch drywall on the interior side of the stud wall but not on the party-wall side. (We used $1\frac{5}{8}$ -inch studs because the building was only 14 feet 6 inches wide, and every inch counts.) An 8-inch-thick solid brick wall has an STC rating of 52, mineral wool is rated at 40, and the MLV is rated at 26. The total of those three components is 118. I didn't include the $\frac{5}{8}$ -inch drywall because it was applied to only one side. The brick party wall made achieving an STC rating of 65 easy. For comparison, and using a more suburban construction example, a 2x4 wood wall with batt insulation and $\frac{5}{8}$ rock on each side has a 39 STC. Add MLV, 26, to one side, and you get a 65 STC rating. Add MLV to both sides, and you get 91.

Second-floor joist system. The architect specified that, in addition to the party wall, the second-floor joist system be soundproofed with MLV. The entire second floor, a footprint approximately 15 feet

On the Job / Solution for a Quiet Party Wall



The architect called for adding mass-loaded vinyl (MLV) to the floor assembly as well as to the party wall (1). By rolling it out over plywood (2), a crew member was able to slide it into position (3) and align it so sheets abut each other at the edges (4).



The MLV sheet is nailed in place to the top of the joists (5) before the seam is taped. Seen from the first floor, the MLV drapes between joists (6). The staircase stringer was secured to the party wall with a double 2x6. The combined 4 1/8 inches leaves room for a 1-inch air space, steel studs, MLV, and 5/8-inch drywall (7). This plane carries up to the second floor (8).

by 40 feet, had to be leveled. There was a 4 3/4-inch difference from the high point of the floor at the front wall to the low point at the stair opening, over a distance of about 20 feet. The floor level then rose from the stair opening to the back wall, with a net 2 3/4-inch difference between the front and back walls. The variation was significant enough for us to give it a “fun house” nickname. (Framing for stair openings in Hoboken often failed because the mortise-and-tenon connections split at the header and/or trimmers.) With the joists exposed, I am sure the architect figured, why not add soundproofing to them.

Joists in Hoboken are pocketed 4 to 5 inches into party walls. Sounds and vibrations on the second floor would be transferred both into the brick party wall and down to the first floor. By draping the MLV into the joist bays of the second floor and insulating with fiberglass up from the floor below, we created a layer of soundproofing in each joist bay that absorbed and deadened vibrations

and sound. We installed the MLV tight across the walls, but we draped the MLV into the joist bays to expose more surface area and create a looser, more absorbent buffer.

Staircase. A 1 5/8-inch metal wall is wimpy. As mentioned, the soundproof wall was specified as 1 5/8 inches to conserve space. Normally, to save space, we would plumb a 1 5/8-inch wall up against any party wall it was covering and make a few attachments for added support and stability. For soundproofing purposes, however, we left a 1-inch space between the brick wall and the metal wall so there was no contact and no sound would be transferred. This meant there would be no attachments to strengthen the wall. Ordinarily, this wouldn't be a problem, except in this case, we had a new staircase in the middle of the 40-foot soundproofing wall. We were not comfortable attaching the stair stringer to a 1 5/8-inch metal wall. So, we brainstormed over lunch and found a solution.



The steel-stud cavity is filled with mineral-wool insulation before the MLV sheet is installed (9). All penetrations, including electrical outlets (10), must be sealed with acoustical caulk and the seams in the MLV sheets taped off (11) before the 5/8-inch drywall is installed (12).

The solution took into consideration that a brick wall, due to its mass, is more effective than most walls at reducing sound transmission. We glued and screwed a double 2x6 ledger to the brick wall to attach the stair stringer to the wall. In hindsight, we should have put MLV on the first 2x6 attached to the brick party wall. The double 2x6 plus the stringer provided a 4 1/8-inch surface on which to run the soundproofing wall up to the second floor. The wall didn't run alongside the stairs but over the double 2x6 and the stringer. The 4 1/8-inch surface allowed us to have a 1-inch space off the brick wall, a 1 5/8-inch wall, 1/8-inch MLV membrane, 5/8 rock, and a molding where the drywall sat on the stringer. We didn't feel great about making contact with the party wall but felt we had no choice.

We purchased nine rolls—1,215 square feet—of MLV from Acoustiblok and used eight full rolls and a bit of the ninth (acoustiblok.com). Rolls measured 4 1/2 feet by 30 feet, or 135 square feet. Each weighed 135 pounds and cost \$390, plus tax and delivery. Delivery was about \$600. Accessory products we purchased that were recommended by the distributor were two rolls of tape at \$30 each, and two tubes of sound sealant, \$26 each. We know we paid dearly for the accessories, but we wanted to use the manufacturer's recommended products. We used backer-board screws

for the walls and used a coil gun with 1 1/4-inch siding nails for the second-floor MLV installation. Both types of fasteners were selected for their larger head. All in all, we spent approximately \$4,500 on MLV materials. The 1 5/8-inch metal studs, mineral wool, and labor were additional.

We didn't have any before or after sound tests to compare and judge the effectiveness of the soundproofing we installed, so I interviewed our customer to get her firsthand experience. Not very scientific, but if the customer is happy with "living results," then I am happy, and I am able to report the customer is happy with the results. It's been 10 months since we finished the project, the house has been rented to a family, and our customer hasn't heard a peep. The common wall she shares with her tenant includes a combined living room and kitchen, stairs to the second floor, and two second-floor bedrooms. The new tenants have a living-room stereo and TV, and the kitchen and living room are the center of many of their activities. The second-floor bedrooms each have TVs. Our customer doesn't hear voices, music, TVs, or the use of the stairs. To quote our customer, it's "all quiet on the western front."

Rob Corbo is a building contractor based in Elizabeth, N.J.



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BY DAVID GERSTEL

Construction Contracts and Legal Education in a Digital Box



The new, online edition of the *Contractor's Legal Kit* includes editable construction agreements and forms. Along with them, it provides a *User's Guide* that amounts to a basic legal education for building contractors.

Early in my career as a builder, I was lucky to be told by wiser heads that I needed a comprehensive contract to regulate relationships with my clients. Just a handshake and verbal agreement would not do. But I discovered that when it came to contracts, I had three bad options: a skimpy off-the-shelf “proposal and agreement,” a contract from The American Institute of Architects, or a contract drawn up for me by an attorney who specialized in construction law. The first was near worthless. The second took good care of architects but left construction contractors out in the cold. The third was brutally expensive.

Fortunately, help soon arrived in the form of a concise and reasonably priced book. Its author, Gary Ransone, is both a general contractor and an attorney. His *Contractor's Legal Kit* offered succinct contracts for the homebuilding and remodeling jobs I was doing. Now, a few decades later, Ransone has both updated his *Legal Kit* and upgraded it as an internet download (available at thecontractorslegalkit.com). Its numerous forms and contracts are provided as Word documents readily adjustable to conform to requirements of

your state and fit your projects. Further, the documents are accompanied by an excellent *User's Guide* that clearly explains the legal necessities underlying each of their clauses.

After working my way through it end to end, my reaction to the *Kit* was “Wow!” It is a hugely valuable resource for any construction contractor—especially those just starting out or not yet in possession of reasonably priced and viable contracts for their projects. The *Kit* can help you clearly establish mutual obligations and expectations with a client before a project begins. The contracts and other documents it provides can protect you in case of lawsuits. Better yet, they will forestall litigation altogether by preventing misunderstandings and bitterness.

The core of the *Kit* is a series of construction contracts. These range from a short agreement suitable for a small remodel to be built for a fixed price to a comprehensive design-build agreement. If you are a residential builder, one or the other of the contracts will likely suit any homebuilding or remodeling project you will take on. Along with the contracts, Ransone provides useful contract addendums and informational forms, including:

- A material price escalation clause. It is notable for its fairness. While it protects builders against brutal spikes in material costs, it also provides that no additional overhead or profit will be charged on top of any increased charges for material.
- An addendum that limits clients to a single punch list upon substantial completion of a project. Of course, for it is the best marketing they can do, a sensible builder would return to a project to clean up a few items the client might notice post-punch list. But the addendum protects you against the occasional client who calls you back over and over to touch up imperfections, some of which they may have created.
- A letter to the client titled “Ups and Downs of Remodeling.” When I sat down with clients to go over our contract for a remodel job, I’d alert them to the stress they were about to experience. I’d caution them about “the 90% blues”—how, as it neared completion, a project would seem to slow to a crawl, with completion receding into the distance. Ransone’s letter, with its forecast of the emotions a client is likely to experience at each stage of a remodel—dismay during demo as strangers tear the home apart, relief during framing, and happiness upon completion—is a step up from my conversation with clients.

The full range of provisions embedded in the *Kit*'s contracts forms a protective wall around a builder. Among them: A reminder to owners that they must promptly make the decisions necessary

KEY CONTENTS OF THE LEGAL KIT

Preconstruction Agreements and Forms

- Estimating and preconstruction services agreement
- Design-build preconstruction services agreement
- Change order contingency fund information form
- Subcontractor information form
- Preconstruction conference form

Construction Contracts

- Short-form fixed-price agreement
- Long-form fixed-price agreement
- Time and materials agreement
- Cost-plus-percentage-fee agreement
- Cost-plus-fixed-fee agreement
- Construction management agreement
- Design-build agreement
- Short- and long-form subcontractor agreements

Forms for Use During Construction

- Short-form change order
- Change order with an accounting summary
- Short-form construction invoice
- Long-form construction invoice

for workflow and a caution that if they are not decisive, they can be required to compensate the contractor for lost time. A clause emphasizing that perfection is not promised but that “deviations (do) arise” and citing minor cracking in drywall and concrete along with other examples. And another declaring that though he will give it his best shot, the contractor cannot guarantee, due to explicitly stated factors, that new finishes will exactly match existing finishes.

Ransone, however, cautions users of the *Kit* that it cannot, in and of itself, protect them from all the hazards of construction contracting. They share in the responsibility. He is particularly insistent on that score when it comes to client requests for extra work during projects, a danger zone where countless contractors have crashed financially. Ransone insists that you must be persistent in the processing of written agreements that call for work beyond that provided for in the original contract: “A builder/remodeler who has been around the block knows certain owners, who tell you on Monday to finish the extra work at all costs (‘Just get it done, whatever it takes!’), may not feel the same way about paying for the extra work when the bills come due ... A signed change order will almost entirely eliminate arguments over the owner’s obligation to pay for the additional work.”

Ransone emphasizes the need to process a change order even for work covered by an allowance should it turn out to be low. A young builder I admire could have used that advice. He set an allowance of some \$4,000 for dry rot repair during a remodel. The extent of the work exceeded his expectations by 10x. Thinking he was covered by the allowance, he did not create a change order for additional labor,

material, and markups. The owners refused to pay anything more than the contract allowance. Enraged, the builder hired a lawyer at considerable cost and sued. He lost, of course. He did owe it to the owners to keep them informed of rising costs rather than ambushing them with a steep upcharge.

The *Kit* gives you what you need to effectively handle change orders: A short change order form and a longer form with an accounting summary. Plus, a change order contingency fund form that lays out for owners the causes of change orders and advises them to set aside funds to pay for them. I placed similar information in my own contracts. As a result of that—and of persistent processing of change orders—I never went unpaid for extra work. Abide by Ransone’s guidance on change orders and use his contingency form, and you can have the same fortunate experience.

The new digital Kit goes far beyond providing contracts and related forms. Its *User’s Guide* amounts to a basic legal education for builders. Ransone delivers that with a stroke of brilliance—annotations explaining and commenting in jargon-free language on every significant clause in every contract.

For example, an annotation to the “preconstruction estimating services agreement” explains that a key clause in the agreement is intended to communicate 1) the contractor’s hopes and 2) the owner’s obligations. “The clause,” Ransone writes, “indicates that the Contractor is interested in performing the actual (construction) work once the preconstruction phase of the project is completed” while making clear that “the owner is under no obligation” to award a construction contract to the contractor.

That said, Ransone continues: “Developing a positive relationship with the owner during preconstruction may well lead to a contract for construction.” (Amen to that! I built virtually every project for which I provided estimating and value engineering services).

In his cost-plus-a-fixed-fee contract, Ransone provides that clients be charged for the work of preparing their billings. With any T&M job, billing is a laborious task. A contractor can legitimately require compensation for the work so long as he is not also charging for it in his overhead markup.

Here Ransone again balances protection for the contractor with protection for the client. He calls for the client to be provided with documentation (invoices, time sheets, etc.) that backs up the billings. And, strikingly, he suggests a cap be put on the charges for preparation of the billings. In his annotation, he explains, “Providing the hard copy documentation ... will help maintain the trust between the owner and contractor.” And, of course, capping the charges will likewise support that trust.

Reading the annotations and learning the reasons for the clauses in the *Kit*’s contracts and forms, you realize that you’re being instructed by a guy who’s been in the trenches. In fact, Ransone tells us that as a general contractor, he has made and learned from the very mistakes he cautions us about. Thus, he underscores lawyerly advice on change orders by reporting that he learned the lessons himself from losing thousands of dollars by doing extra work without signed change orders.

A worthy theme unites the many clauses and annotations in the *Kit*: Be candid. Be clear. Put all your cards on the table. Avoid

surprising the client. Before construction begins and during it, make sure the client knows all there is to know about their obligations to you and yours to them.

Ransone's longer form change order with its accounting summary (below) exemplifies complete communication. Like the shorter form, it describes the change in the scope of work and the charge for it. Then, with additional lines, it shows owners how much additional cost they have taken on due to change orders and provides them with an update on their new total financial obligation.

II. ACCOUNTING SUMMARY

- A. Original Contract Amount: \$ _____
- B. Net Change by All Prior Change Orders: \$ _____
- C. Adjusted Gross Contract Amount Prior to This Change Order: \$ _____
- D. Amount of This Change Order: \$ _____
- E. Adjusted Gross Contract Amount Including This Change Order: \$ _____

My own experience with change orders underscores the value of another feature of Ransone's longer change order form. A prospective client once told me that she'd heard only one complaint from the past clients she'd talked to: They'd said their projects took longer than expected. I was nonplussed, then saw my blunder. Though I had updated charges, I had gotten lazy and failed to update project completion dates in the change orders. The clients reasonably kept the original completion date in mind and consequently thought their projects had run longer than provided for in our contract.

By providing lines for schedule changes along with lines for cost changes, the *Kit's* longer form change order sets you up to do an even better job of preventing misunderstandings with clients. Clients appreciate updates on completion dates as well as on cost. Along with the quality of the work, those are their main concerns. Keeping them up to date maintains trust.

Ransone's preconstruction services agreement could be enhanced to further his astute balancing of protections for builders with those for clients and thereby keep the peace between them. The *Kit's* agreement is a good start toward a needed contract for estimating and other preconstruction work—a service that seasoned builders worldwide now offer to their clients. It covers essential topics such as schedule, permits, hazardous material, and fees.

However, I believe the agreement includes two provisions that might reduce a contractor's chances of getting construction jobs when providing preconstruction services. One of those provisions allows the contractor to charge without limitation for these services. The other allows the contractor to terminate services at will and walk away from a project—and do that without refunding to the client any of the preconstruction charges. These two provisions are a departure from the *Kit's* usual balancing of interests. They can turn clients off. Thereby, they will reduce a contractor's chances of winning jobs via preconstruction services. (A more equitable fee

The full range of provisions in the *Legal Kit's* contracts forms a protective wall around a builder.

provision along with a more extensive specification of preconstruction services than the *Kit* provides can be found in my book *Nail Your Numbers: A Path to Skilled Construction Estimating and Bidding*.)

Elsewhere as well, as he maintains that protective wall around builders, Ransone occasionally strays from his consideration for clients. Thus, he encourages builders to bill clients weekly (an amplification of his wise advice to builders to never fall further behind in billing than by an amount you can pursue at low cost in a small claims court). But then he goes on to require that clients pay each bill by the very next day.

Reading that, I envisioned a tired client getting home on a Thursday night after a long day at the office, finding a bill accompanied by the extensive documentation Ransone suggests, and being required to digest the paperwork and pay the bill within 24 hours—and to do that week after week as a project crawls forward. That's a good way to make a client hate you by the end of the job. Instead, I find it works out fine to give clients a few days to pay.

Lastly, the otherwise sound material-cost-escalation clause leans too far toward builders. If clients must, as Ransone's form provides, pay extra when the cost of materials markedly rises, should they not likewise get a credit if material costs markedly decline? Providing for that possibility, remote though it might seem, would sound another note of fairness that could strengthen client trust.

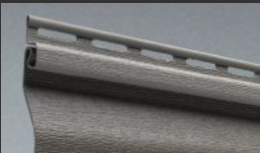
Ransone emphasizes throughout that contracts cannot substitute for workmanlike construction and well-run projects. Do lousy work and no contract will protect you from your clients' wrath. Clear and comprehensive contracts are, however, part of the workmanlike production of a project. They are critical to the crafting and maintaining of the human relationships that undergird a project. Use Ransone's contracts with the wisdom that the annotations in the *User's Guide* impart, and you will be on your way to producing workmanlike contracts.

I find the *Kit* easy to use. The *User's Guide* with its annotations is a single document with a table of contents. Each of the individual contracts, as well as the optional clauses and forms, is included as a separate and clearly labeled Word document that, as noted earlier, you can readily modify. For about the cost of a Skil 77, you can buy the new digital *Kit* at thecontractorslegalkit.com and download it to your computer. You will then have a tool that enables you to build understanding and trust with your clients while also constructing a protective wall around your prosperity and happiness as a builder.

David Gerstel is a builder and author. His books include Nail Your Numbers: A Path to Skilled Construction Estimating and Bidding and Building Freedom: A Construction Pro's Path to Financial Independence.



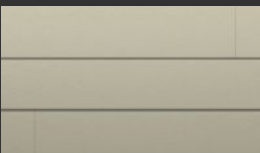
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A House Needs to Breathe ... Or Does It?: A Conversation With Allison Bailes

This past summer, JLC editor Clay DeKorne had a chance to sit down virtually with Allison Bailes to speak with him about his book, A House Needs to Breathe ... Or Does It? An Introduction to Building Science. The following is a portion of that discussion.

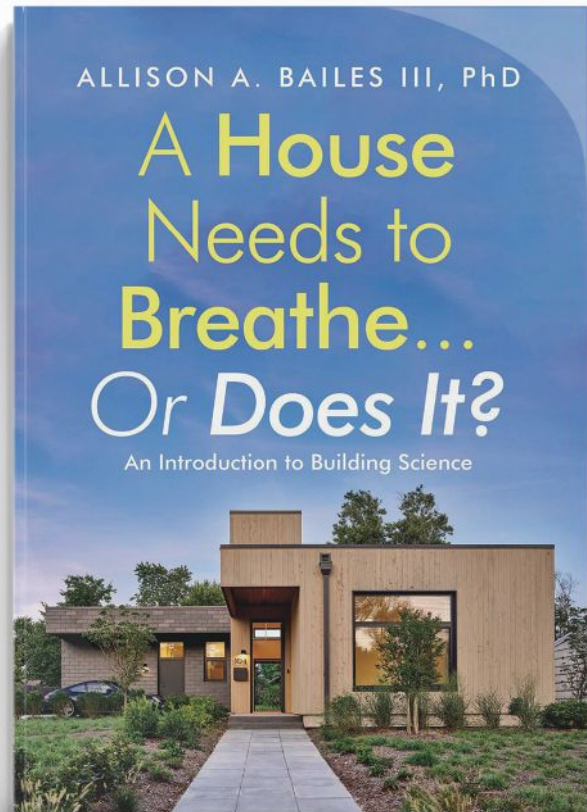
Clay DeKorne: If there's one book on building science I would recommend to builders and remodelers, it's yours. Here, I want to first give readers an overview of that book before we delve into a few of the topics I have previously found difficult to understand and that your book helps me understand much better for solving real-life building problems.

To begin, the book is organized into three parts, and the first is titled "Start at the End." Can you explain what this means?

Allison Bailes: Well, if you start down a path and don't know where you're going, who knows where you're going to end up. Now that's a valid way to travel sometimes, but if you're building something, you want to know what it is you want to end up with. It's not just: What should it look like? It's also going to be: What's the experience of the people who occupy that building? I'm talking about residential—about homes—and these are places where people raise their families. It's where they spend a lot of time. They sleep, they breathe a lot of air inside that house. They want to be comfortable, and they want to be able to have conversations without having to speak over the noise of the air conditioner. By beginning with "What's the Purpose of a House?" I'm just reminding people why building science is important. As I explain in the book, I'm inspired by the work of Robert Bean, a retired engineer who had a big impact on me and others. And he always says: "Design for people and good buildings will follow." For me, that is how we must begin. It's good to remember building is not all about the joinery and the materials; it's about the people who are going to occupy that house.

CD: Still keeping with the 30,000-foot view of the book, the remaining two parts are "The Building Enclosure" and "Mechanical Systems," in that order.

AB: I put them in that order intentionally. You have to start with the building enclosure. When you're talking about heating and cooling and ventilation, you need to first know how much heating and cooling a house needs and that depends on the building enclosure. Really, you want to minimize the amount of heating and cooling you need. You also want to minimize the pollutants that come from outside and from buffer spaces like the garage. So, you've got to start with the building enclosure because that's where all the action happens.



CD: I love the way you organize the building enclosure around controlling the various elements. In our industry, people often frame building science around the four "control layers"—water, air, vapor, and thermal. But I like how you don't just throw those terms around. You focus on the principles governing the interactions of elements that our buildings need to overcome, before you start talking about the things, the layers, that control these elements.

AB: Yes, language is very important. And defining the different control layers clearly, not just throwing these terms around without explanation, is important.

Part 2 on the building enclosure begins with Chapter 5, "Building Science 101," in which we have that initial definition of control

CHAPTER 7

Controlling Liquid Water

Now that we understand the properties of water, we can discuss controlling it. Because liquid water is the most important one to control, we'll begin there. The exterior of a house is covered with some kind of cladding, like brick, siding, or stucco on the walls and shingles, metal, or tile on the roof. Although the cladding stops a lot of the rain from getting through to the materials behind, it doesn't stop all of it. Wind, for example, can drive rain through gaps and into the space behind the cladding. That's why we need a liquid water control layer back there.

Before we get into the details, though, let's discuss vocabulary. Here are some important terms used for this part of the building enclosure:

Water control layer: Combination of the drainage plane, flashing, and other liquid water management details on the outside of a house. Sometimes it's called the liquid water control layer or the rain control layer.

Drainage plane: Water-repellent materials used in the field of roofs or walls to drain the

"You can't trust water: Even a straight stick turns crooked in it."
—W.C. Fields

liquid water, integrated with flashing and other liquid water management details to form the continuous water control layer. They may also act as the water vapor control layer, or they may allow water vapor to pass through. Common types include house wrap, building paper, and peel-and-stick membranes. (More on this below.)

Water-resistant barrier (WRB): Another term for the material used as a drainage plane; it's also called water-resistant barrier, weather-resistant barrier, or weather resistive barrier.

Flashing: Components that divert water away from parts of the building. It must be integrated with the drainage plane and is used around windows, doors, and transitions, such as where a roof meets a wall.

Drain the Rain

Draining a house properly is the aikido of building science. Just as an aikido master uses an opponent's momentum against him, an effective liquid water control layer incorporates slopes and diverters to keep water moving down and out from a house. Here's Joseph Lstiburek, PhD, PE, explaining the objective:

"The fundamental principle of water management is to shed water by layering materials in such a way that water is directed downwards and outwards out of the building or away from the building."¹⁰

The water wants to go down, and you design and install a series of layers that will ensure it also goes out. Down and out is the rule for draining the rain (Figure 71).

Think of it in personal terms. When you wear rubber boots, rain pants, and a raincoat, you have to put them on correctly to stay dry in the rain. You don't tuck the rain pants into your boots or your raincoat into your pants. You layer them the other way to keep the rain moving down and out.

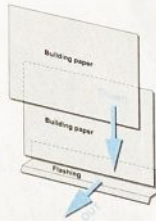


Figure 71. Layer your liquid water control materials to keep the water moving down and out from the house. [Courtesy of Joseph Lstiburek]

¹⁰ RR-0103. Water Management. <https://www.buildingscience.com/documents/reports/rr-0103-water-management/view>. (9/15/01)

A sample page from Allison Bailes' best-selling book on building science.

layers. Then I devote a whole chapter (Chapter 6) to the properties of water before addressing why we need to control liquid water, air, water vapor, and heat in chapters 7, 8, 9, and 10. Chapter 11 is about applying those to an actual enclosure.

CD: Chapter 9 is on controlling water vapor. What I like about reading this chapter is that you force me to constantly go back and make sure that I've read and understood Chapter 6 on the properties of water. Water vapor seems an elusive substance in a building. It reminds me of how way back in the early '90s, *JLC* published an article called "The Last Word (We Hope) on Vapor Barriers" (Aug/1993). Of course, it wasn't the last word by a long shot. Why are condensation, water vapor, and diffusion so hard to understand?

AB: As you were talking there, something popped in my head that could be an article for one of my newsletter columns or a LinkedIn post—that is, which one of these things is not like the

others: liquid water, heat, air, and water vapor? Well, for liquid water, air, and heat, we absolutely need control layers in every single house. Every assembly must have control layers for those; for water vapor, though, we may or we may not need a layer.

In general, we do need things to be able to dry out more than we need to be able to stop water vapor from moving through the materials. In really extreme climates—for example, in a very hot, humid climate—vapor retarders can be important on the outside of the structure. And in very cold climates, vapor retarders on the inside are often required. But even in these extreme climates, the vapor retarders may not always be Class 1 [such as poly]. These can end up causing more trouble than they prevent because they trap water.

When you go with Class 2, in the 0.1 to 1 perm range, the vapor retarder lets some water vapor through, but it stops enough to prevent problems; to prevent condensation on the cold exterior sheathing in a wall, for example.

CD: I like "one of these is not like the other." I see the point that there's no absolute rule, no one way to control water vapor. Sometimes the answer is to add nothing so the wall can dry. Don't add poly to the wall assembly; just make sure your interior paint is permeable. But we're going to paint the interior wall anyway and more likely than not with latex. With liquid water, on the other hand, we have to be much more purposeful.

AB: Yes, for liquid water, it's down and out and watch out for capillary action.

CD: So, can I throw a case study at you relating to vapor control?

AB: Sure.

CD: Imagine a crawlspace below an addition off the back of the main house. The house has a full basement, and there's no access to the crawlspace through the foundation wall between the addition and the main house. And there's very little space in the crawlspace. Above the dirt floor, the crawlspace varies between about 8 and 16 inches below the joists.

AB: In what climate zone?

CD: Climate zone 6. And because it's cold, they want to insulate the floor when they renovate what will become the kitchen.

AB: Are there vents to the outside of the crawlspace?

CD: No vents. It's an old house, built in the 1850s. When they opened the floor, it was super dry. But with dry dirt, there still might be moisture coming up through it, so the first thing they did was put a 6-mil poly vapor retarder over the dirt. And to insulate the floor, they used a combination of 2-inch rigid foam cut and fit between the joists at the bottom, sealed at the edges with can foam, and then the cavity above the foam was filled with Rockwool. So, they have a nice air barrier with the foam, along with insulation as a thermal barrier.

AB: Is a rubble foundation holding up the walls?

CD: Yes, there's a rubble stone foundation under the addition. When they ripped up the existing floor, they used spray foam to seal and insulate the perimeter. So, they've created this sealed space with poly on the bottom, spray foam on the sides and rigid foam

on the top. If moisture gets in this space, can it dry out? With no access, how would you tell if you were creating a moisture problem? To me, it creates a risky space that can't dry. How would you deal with this, maybe place monitors in there?

AB: Yes, real data beats hypothesis and theories every time. You can't go wrong putting a data logger in there to "see" if it ever gets bad enough to cause any issues. If I wanted to understand what's going on in there, I would put a temperature and relative humidity monitor down there to see if the relative humidity ever goes really high. And if it does, how long does it stay there? Here's another case study: my in-laws' house two blocks from where I am right now. They have a 1962 Midcentury-Modern house with a basement in the center, a crawlspace on one side, and a crawlspace on the other side. So, two separate crawlspaces with the basement in between.

Both have ductwork running through them, so I encapsulated both of them and put a thermo-hygrometer with a remote sensor in each of the crawlspaces. One of them stayed below 60% relative humidity all the time; the other one was 70% and higher sometimes. So, one of them needed a dehumidifier, the other didn't.

With existing homes, it's difficult to predict if you're going to get it dry enough. You can seal the heck out of it and do your best, as I did on both crawlspaces. I thought I sealed them equally.

CD: Yeah, old houses get funky fast, right? There are just so many pathways that you can't predict because you can't see them.

One reason I wanted to zero in on vapor control is I feel like this is one of the areas where the energy code needs some work. The code seems well aligned with building science around air-sealing and insulation requirements but maybe falls down a bit on vapor control. The insulation requirements in the code [Table R402.1.2] could lead to a risky wall [prone to condensation] if you use a Class 3 vapor retarder [such as latex paint] in climate zones 6 and 7. (For more on this, see "Avoiding Wet Walls," *JLC* May/2017.)

I also think that the code needs work on mechanical ventilation. This seems to be a part of the building code that code officials often don't understand well, especially whole-house airflow rates. I feel like this is a danger zone for our industry because we have solid air-sealing requirements now making tight buildings, without having a similar solid understanding of ventilation beyond installing bath fans. And in this post-COVID world that we inhabit, people are much more attuned to indoor air quality and to the impact of indoor pollutants and their impacts on our health.

ASHRAE 62.2 [the standard for whole-house ventilation airflow rates referenced in the energy code] seems fraught with challenges: There's been the Max Sherman versus Joe Lstiburek battle for a long time; it's kind of like health versus energy, where Lstiburek is saying we shouldn't over-ventilate and compromise energy performance of buildings by exhausting all the conditioned air away, and Sherman is reaching for a health-based ventilation standard. Lstiburek has a strong point when he says the problem is we don't have any sound epidemiological studies of indoor air that would give us a solid grounding of what's needed for airflow to control

• A building assembly's ability to dry out is generally more important than stopping the diffusion of water vapor.

• When you do use assemblies that need to slow down vapor diffusion, you need to know how well all the materials in that assembly transport water vapor by diffusion. The materials specified may already have a low-enough permeance for the whole assembly, making an additional vapor retarder unnecessary. In short, most vapor control is done with methods other than vapor retarders. Sometimes, though, you do need to limit the amount of vapor diffusion through an assembly. One case where you need a vapor retarder is when you have an unvented attic with open-cell spray foam insulation against the roof deck in a cold climate

Another case where a vapor retarder is required is when you have thick walls with a lot of insulation on the conditioned space side of the sheathing and none outside. The more insulation in the wall, the colder the sheathing will be in winter. And we know about humid air (inside the conditioned space in winter) and cold materials (the wall sheathing). Even the most airtight walls may not be able to keep the sheathing dry. A class 2 vapor retarder—which could be a vapor retarder paint—can prevent the sheathing from getting wet.

A few other situations that require a vapor retarder are beneath a concrete slab, on foundation walls, and on the ground in a crawlspace. In Chapter 11, we'll go deeper into some specific examples of assemblies and spaces where vapor control is needed.

Chapter Takeaways

- Controlling water vapor is not simply a matter of installing a vapor control layer.
- Cold air is dry air. When you heat it up, the relative humidity is very low.
- Cold materials are generally wetter than warm materials.
- To prevent humidity from causing problems, keep humid air away from cool materials.
- Because more water vapor moves with air flow than by diffusing through materials, air sealing is one of the best ways to control humidity.
- Indoor relative humidity should be between 30 and 60 percent. Homes with weak building enclosures need to stay near the bottom end of that range in winter.
- The higher the water vapor permeance of a material or assembly, the more easily water vapor can pass through a material.

At the end of each chapter, Bailes has included a short list of "takeaways." When DeKorne commented on how helpful these are, Bailes cautioned that they might not include every key point. "As an author, you have to make decisions and maybe somebody else wouldn't pick those same things," he said.

health. So, I wanted to throw that out and get your take on whole-house ventilation airflow rates within buildings and what you think is enough.

AB: As you may know, I was a big Joe follower on this 10 years ago, but my thinking has evolved away from what you're asking about. You're talking about indoor air quality, but you just zoomed right in on ventilation. Indoor air quality is about airtightness. It's about source control, filtration, moisture control, pressure balancing, and then ventilation. We've been persuaded for decades by that one saying, "build tight, ventilate right," and people believe that's all you have to do: Build a tight house and ventilate, and you get good indoor air quality. That's not the answer.

With the pandemic and learning about COVID-19, we found you can solve that with filtration. Infectious particles are things you can filter out of the air with a media filter. That's why, of course, the Corsi-Rosenthal Box became so popular, because once we realized COVID is airborne, we got these little particles that become aerosolized and float around for hours, maybe days. Filtration can reduce the number of those particles and the chance of getting sick.

So, when you combine ventilation with those other things—airtightness, filtration, source control, and pressure balancing—then we don't need a super high ventilation rate. Airtightness

CHAPTER 17

Ventilation

The imagery of wearing someone else's dirty underwear may shock you, but we essentially do something that could be worse whenever we take a breath in a room full of other people. It's not just air recently expelled from other people's lungs we should worry about, though. Indoor air is often more polluted than outdoor air. It's a soup of particulate matter of various sizes, volatile organic compounds, skin flakes, dust mite carcasses, mold spores, and more. We suck all that nasty stuff into our lungs with every breath.

Good indoor air quality is a team effort. Filtration (Chapter 15) can take care of the particles when done properly. To handle gases like volatile organic compounds and carbon monoxide, source control and ventilation are the best options. Source control means keeping the bad stuff out (Chapter 2). Yes, electronic air cleaners promise to zap all the bad stuff in the air, making a home's indoor air as pure as a hospital operating room. However, the available independent research mostly shows their effectiveness is dodgy. (See the sidebar "Two Reasons to Avoid Most Electronic Air Cleaners"

"Most civilized men and women are unwilling to put on underclothing that has just been taken off by another person or to put into their mouths articles of food or drink that have recently been in other people's mouths, but they take without hesitation into their lungs air that has just come from other people's mouths and lungs or from close contact with their soiled clothing or bodies."

—John Shaw Billings, 1893

on page 258.) Stick with the big three—source control, filtration, and ventilation—and your indoor air quality will be excellent.

Here, I'll start by explaining the three types of ventilation used in homes: local, buffer-space, and whole-house ventilation. Then I'll further divide whole-house ventilation into three types—exhaust-only, supply-only, and balanced—and give you the pros and cons of each.

Three Types of Ventilation Used in Homes

Local ventilation: This is basically exhausting air from the kitchen and bathrooms. It's source control for places where we put stuff into the indoor air that we'd rather not breathe or, in the case of moisture, stuff that might create other problems. In the kitchen, the big culprit is cooking. In bathrooms, it's moisture. We'll talk more about this type of ventilation in the next section.

Buffer-space ventilation: The great outdoors is unconditioned space. The living space inside our homes is conditioned. And then there are the buffer spaces. Attics, crawl spaces beneath the

house, some basements, and garages are neither indoors nor outdoors. Do you need to do anything about the air in those spaces?

Whole-house ventilation: Here's the main attraction of the ventilation chapter. Local ventilation and buffer-space ventilation are critical to managing moisture and eliminating pollutants at the source. But carbon dioxide from breathing, PM_{2.5} from cooking, volatile organic compounds from furniture and carpets, and other pollutants floating around in a house need to be removed from the home or diluted with outdoor air using a whole-house ventilation system.

Putting It All Together

The best way to deal with complex systems like homes is by following that old advice about how to eat an elephant. Take it one bite at a time. And plan on it taking a while. The information in this book is an elephant. If you're new to this field, don't worry about learning it all at once. It will take a lot of reading, watching, doing, and discussing to understand building science on a deep level. But there's at least one thing you should feel confident about.

A house does *not* need to breathe. But people do.

The chapter on ventilation (top) comes in Part 3 after chapters on heating and cooling systems, on filtering indoor air, and on dehumidification. This organization underscores the point Bailes makes in this interview that ventilation comes after other strategies for improving the quality of indoor air. The closing of the book (above) brings readers full circle back to the purpose of building better homes: improving life for the people who live in them.

keeps the bad stuff from the outdoor air from getting in. We want a good air barrier between the house and the garage and the moldy basement and a dirty attic or outdoor air with lots of pollen and PM 2.5 [particles that measure 2.5 microns]. You want source control so you don't bring the bad things into the house or do bad things that create pollutants inside the house. You want moisture control so you don't grow mold in the house or inside the walls. Pressure balancing can create infiltration in some areas, exfiltration in others, and that can bring bad stuff into the house. And when you do all this, that's where good indoor air quality comes from. It's not just one or two things you have to do. You really have to do all of them. And when you do all of them, you don't need as much ventilation.

The other thing about ventilation is a lot of people think, "Oh well, you only need ventilation for houses that are at a certain level of airtightness, like below 5 ACH50. Well, I live in a house built in 1961 that probably was like 16 or 17 ACH50 about 12 years ago and now it's down to 8^{1/2} ACH50, and with my basement remodel I'm working on now, I'm going to get it down, I hope, to about 5 ACH50.

Yet, even with ACH50 above that, it doesn't mean we always have infiltration happening. And if you do have infiltration, you know the best possible air is not coming from the garage, or from the crawlspace or the attic. And even if it's all coming from outdoors, the amount of infiltration that you have, I'm sure you know, depends on how much stack effect is going on and on how much wind is blowing and on what's happening with your mechanical systems. Often, if you don't have mechanical systems running and it's not windy and it's a spring day, you have pretty much no infiltration. You can sit inside a closed house on that day and build up some serious levels of indoor pollution. So even in old leaky houses, mechanical ventilation can be a good thing.

CD: I know that from my leaky old house when I started using an Airthings Plus monitor up in the kids' bedroom at night and seeing the carbon dioxide levels spike.

You're right that I am influenced by the "build tight, ventilate right" mantra that focuses attention on mechanical ventilation in front of everything else. I formed the notion that it doesn't make sense to put a mechanical ventilation system in an old house until I've gotten it down, you know, to a real blower-door tightness level. I guess that's fallacy #1. And then you're right, I'm pulling away from all these other variables besides the ventilation rate. Thanks for clarifying that for me, as you do so often in your work, the Energy Vanguard blog, and this book included.

I know we've barely scratched the surface of everything you cover in your book. It's such a readable book, and I'm enjoying rereading it. I'll probably need to go through it many times before I consume the whole elephant [see "Putting It All Together," at left, for this reference]. I hope JLC readers will be intrigued enough by this discussion to search it out on Amazon and EnergyVanguard.com, right?

AB: Thank you ... Yes, it's available on EnergyVanguardStore.com and is \$10 cheaper there than on Amazon.



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BATH



Aging-in-Place Bath Upgrade How to transform a small space with modern design and wall-hung fixtures

BY ERNEST MUELLER

When the topic of an aging-in-place remodel comes up, some people imagine grab bars, ramps, wide doorways, and not much else. Of course, those may be needed, but they're not the whole story.

If you want to succeed with this type of project, you need to think deeply about how every product and design element will help or hinder someone with mobility needs and how the home can adapt as those needs change. You should also be willing to consider the use of products that aren't common in standard homes, such as wall-hung fixtures.

When done right, however, upgrading a space to support aging-in-place goals—also called remodeling for accessibility—is worth the effort. It will make the home more appealing to people of all ages, even those with no physical limitations.

A good example is the recent bathroom remodel I complet-

ed on a home I own in East Brunswick, N.J. Built in 1982, the semi-contemporary, two-story structure has three baths—a second-floor bath for the primary bedroom, as well as first- and second-floor hall baths—which, by 2022, were looking more than a bit dated. Moving walls to expand the room sizes was not an option, so the challenge was to create more usable space within the existing footprints.

I've traveled quite a bit in Asia and Europe, where modern architecture is the norm. As a result, I've seen many examples of how that style can support accessibility goals while offering a clean, appealing look. A lot of baths in those parts of the world have walk-in showers and large-format gray tiles, as well as wall-hung fixtures and vanities. The spaces are small but feel bigger than they are.

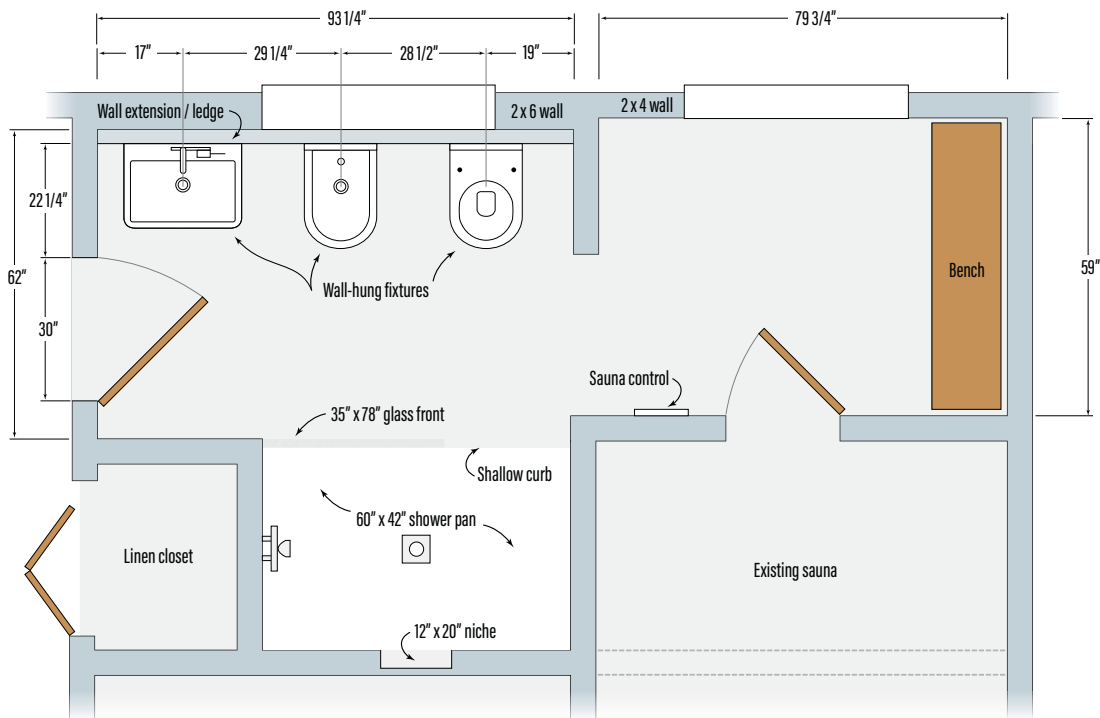
The upgraded baths described in this article follow that style. They're bright and modern and include features that make them



Before. After 40 years, the home's bathrooms were dated (1). The author wanted a modern look, while also making the spaces more accessible and roomy. The challenge was how to do this within the existing room sizes.

Upgrade. The renovation was confined to the “wet” area (illustration, below) of a larger space that includes a full sauna and, opposite the linen closet but not shown, a sink and Roman tub, none of which was changed in the remodel.

Primary Bath Floor Plan



easier for everyone to use and will make the house more appealing to potential buyers.

DESIGN AND PLANNING

The photos show the results. A comparison of photos 1 and 2 demonstrates the transformation of the upstairs primary bath from an outdated bath to a more usable and pleasant space. I've also included a few photos of the downstairs baths, including the lead

photo (see previous page), which shows how one first-floor bath was enlarged and fitted with a fixed-glass splash panel. This panel can be removed and a shower curtain added, in case wheelchair accessibility is needed in the future.

Good planning helped ensure the success of these upgrades. I'm an electrical and mechanical engineer by training, so I spend a lot of time planning project details. I sketched piping layouts and made comprehensive material lists before starting work, then

Photo: Ernest Mueller; Illustration: Oja Kwiatkowska



Wall-hung fixtures. The author replaced the existing fixtures with wall-hung models (2), which don't protrude as far into the room as floor models, so there's more usable floor space. Being raised off the floor makes them easy to clean around, too. Height above the floor can be chosen during installation; the author opted to install the bidet and toilet at an ADA-compliant height of 19 inches. The sink, toilet, and bidet are supported by Geberit (geberitnorthamerica.com) steel carriers bolted to the framing (3). The carriers require 20 inches between studs and a 5 1/2-inch depth for the toilet's water tank. To get the needed spacing and depth, the author built a 2x4 wall, 48 inches high, in front of the existing wall. This created a 3 1/2-inch shelf above the fixtures. Carriers include adjustable legs so the installer can choose the fixture height (4). The fixtures are supported by threaded rods that protrude from the carrier.

reviewed them to make sure I was accounting for everything.

The materials for this project included ABS for vent, drain, and waste piping, PEX for water distribution and hydronic baseboard heating, copper manifolds, brass fittings and valves, and water-hammer arresters. I asked all my suppliers for estimated delivery dates and created a project schedule based on those dates.

Thorough planning takes time and effort, but I believe it shortens the project time line. In this case, there were few unwelcome surprises because I knew what to expect at each step.

DEMO AND PLUMBING

Demolition was straightforward. I removed fixtures, baseboards, door and window trim, a closet in the second-floor hall bath, and floor and wall tiles. I removed drywall only in the areas where the framing had to be exposed for plumbing or electrical work, such as in the shower areas and behind the wall-hung fixtures (vanities, sinks, toilets, and a bidet).

Those wall-hung fixtures are a defining feature of the remodeled baths. Although these fixtures aren't standard in the U.S., they're readily available from several companies, including big names like Duravit, Kohler, and Toto. While the final installed costs will be higher than for entry-level fixtures from Home Depot or Lowe's, they shouldn't be much higher than for premium floor-mount models.

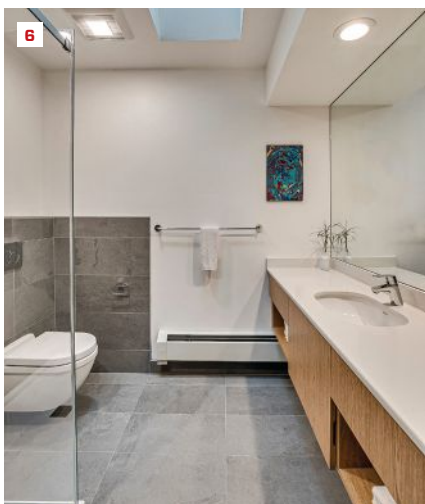
Installation isn't difficult; this was the first time I had installed wall-hung fixtures, and it went smoothly. Manufacturers offer clear installation instructions that need only be followed; if you've successfully assembled something from Ikea, you'll get the hang of it quickly. There are also some helpful YouTube videos from installers.

The rest of the plumbing was fairly standard. I replaced the original copper supply piping to the bathrooms with PEX-b. I used crimp rings for PEX-to-PEX connections and compression fittings to connect the PEX to the existing copper supply piping where needed.

Most remodels require compromises, and one place I had to compromise here was with the shower bases. I wanted zero-curb



Large-format floor tiles reduce the number of grout lines, helping the space feel uncluttered (5). The tiles have nonslip surfaces for safety. Note the lack of trim around the door: Drywall returns in this and the other baths add to a clean, modern look. Placing heaters above the tile baseboard makes for easier floor cleaning (6). The wall-hung vanity is supported by steel brackets bolted to wall framing (IronSupports.com makes left- and right-hand versions of the brackets) (7). The Hansgrohe surface-mounted shower armature is thermostat-controlled to prevent the chance of hot or cold bursts (8).



showers, but that would have meant reframing the floor below, which would have added too much cost and time. So I opted for an acrylic shower base with a shallow curb from MTI (mtibaths.com). It came with a foam backing that allowed me to set it on the plywood sub-floor without the need for a bedding compound.

The curb height is 2 inches above the finished tile floor and just 1 inch on the inside. The curb is 2 1/4 inches wide at the top. The low-profile design makes entry and exit easy enough.

I used surface-mounted shower armatures with wall bars for the fixed and adjustable hand-held showerheads. The shower is thermostatically controlled to eliminate worry about hot or cold

bursts and, in practice, it has maintained desired temperatures well. Showerheads are low-flow, 1.5- to 2-gpm models.

SURFACE FINISHES

Since I removed drywall only where necessary, there wasn't much of it to be installed. I did replace the trim at doors and windows with finished drywall returns for a cleaner look. I primed the new drywall with Sherwin-Williams ProMar 200 zero-VOC white latex primer and then applied two coats of Valspar Ovation Plus ultra white, eggshell, zero-VOC antimicrobial paint.

Large-format tiles are the showstopper in modern bathrooms.

Photos: 5, 6, Ronn Chaudemarche; 7, 8, Ernest Mueller

Part of designing for accessibility is realizing that how a space feels is as important as its actual measurements, and that if it feels bigger, it will be more pleasurable to use. Large-format tiles create an illusion of more space and, because they have fewer and narrower grout lines, are easier to clean.

I chose 12-by-24-inch porcelain stoneware tiles, in slide grey, from Ceramica Gazzini (ceramicagazzini.it). They look and feel like stone, are rectified, and can be installed with narrow grout joints.

Reducing the possibility of falls in a wet bathroom is important, and especially so on an accessibility remodel. These tiles have an R11 surface rating, which denotes a textured surface that enhances their slip resistance. I purchased them from the U.S. importer Avalon Flooring, in Manalapan Township, N.J.

With narrow grout lines, installation quality and joint alignment are of utmost importance, so you need a good tile setter. Avalon subcontracted the job to Pfaff Construction in Long Branch, N.J., which did a perfect job on the tile installation and alignment.

The floor perimeter is finished with 4-inch-high tiles cut from the 12-inch stock. Door sills are white marble and color-match the fixtures and shower base.

FINAL TOUCHES

The wall-hung vanities in the first- and second-floor hall baths create space underneath and were set onto two or three 1/4-inch-thick steel wall brackets from IronSupports.com.

The Silestone vanity tops were custom-made with a Duravit undermount sink. A standard vanity backsplash is 3/4 inch thick by 4 inches high, but I specified a height of 3 inches and a thickness of 1/2 inch. The backsplashes had to be custom-milled from standard stock and cost extra, but the result looks much better.

I sent drawings for shower glass enclosures to potential suppliers for three alternatives: full enclosure with a hinged door, full enclosure with a sliding door, and a splash panel with no door. I selected splash panels for the master bath and the wheelchair-accessible first-floor bath. They are easier to get in and out of and, for wheelchair access, the panel could be replaced with a curtain. The 78-inch-tall tempered low-iron clear glass is coated for easy cleaning.

For space heating, I replaced the two existing baseboard heaters with 3,100 Btu/h total rating with a single Haydon 1000 Supr-Heat with an output of 2,830 Btu/h. I used PEX-a (red) with an oxygen barrier, and SharkBite fittings for connections. The baseboards in the two other bathrooms were also replaced with shorter Haydon high-output units. All are installed above the 4-inch perimeter tile for easy floor cleaning.

I replaced the original exhaust fans with Panasonic Whisper DC fans, two of which have LED lights on a separate switch. The exist-



The narrow depth of the vanity in the second downstairs bath is just 20 inches, which made it possible to replace the 30-inch door with a wider, 34-inch model, in case wheelchair access is needed in the future (9).

ing metal ducts needed some adaptation to make the connection, which meant removing and replacing some drywall.

As for electrical, I replaced the recessed cans in the shower with surface-mounted LEDs from Progress Lighting that are rated for wet areas. The other can lights were retrofitted with Halo RL56 inserts with seals against the ceiling.

GFCI outlets were added below sinks and vanities for nightlights. Some wall switches had to be relocated for the wider doors and the wider primary-bath shower, and a switch above that shower's entry curb was sealed with a silicon bubble cover.

FINAL OUTCOMES

The new baths are easy to keep clean, thanks to the large tiles with narrow grout joints, wall-hung fixtures and vanities, and doorless showers. The overall look and feel is that of a modern spa.

I am extremely pleased with the high-quality products, suppliers, and installers. The custom-made cabinet and vanities were expertly installed. The inside of the room doors is covered with matching oak laminate.

Although this was my first time installing wall-hung fixtures, my experience was positive. Their advantages, including height adjustability and ease of cleaning, should make them standard for modern bathrooms, especially those designed for accessibility.

Ernest Mueller renovates homes in East Brunswick, N.J.

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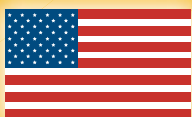
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BUILDING PERFORMANCE



Air-Sealing Wood-Frame Buildings Guidance on establishing an airtight layer on old houses from the exterior

BY TERRY NORDBYE

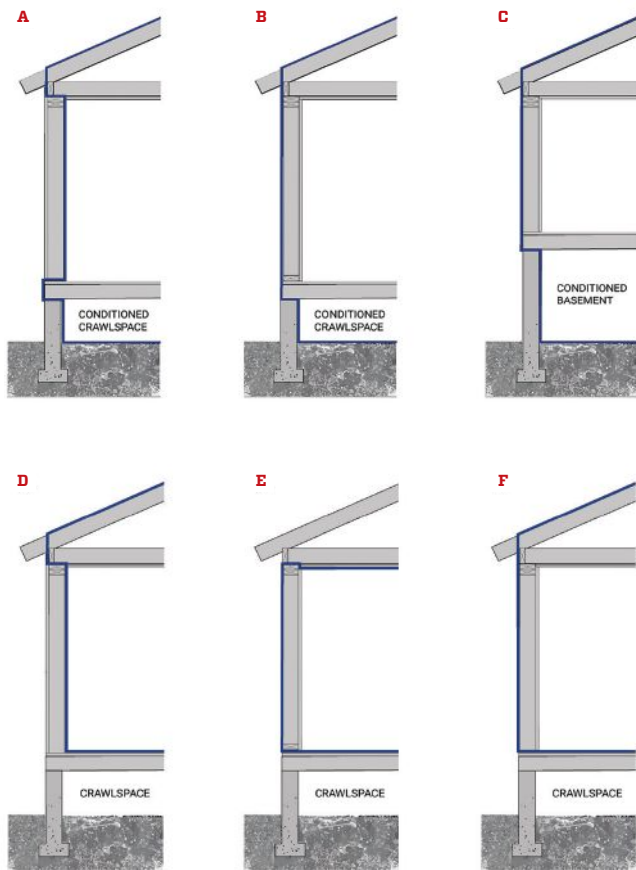
Editor's note: Terry Nordbye has been passionate about air-sealing houses since he completed an energy retrofit to Passive House standards in 2009. Over the last decade conducting air-sealing trainings for contractors in California, he recognized the need for a comprehensive air-sealing manual to help contractors identify the myriad pathways for air leaks through the hundreds of interfacing parts in the typical house. His answer, Air Sealing Wood Frame Buildings: When, Where, Why and How (available on Amazon this fall) covers almost every aspect of air-sealing new and old buildings. This important resource offers contractors a solid grounding for figuring out where to establish the airtight layer, even in existing buildings when conditions or the scope of work limit the ability to choose the "ideal" layer. In this article, we have adapted sections from the book that address the unique, and decidedly less-than-ideal, challenges of air-sealing older buildings built with lumber (board) sheathing when your only feasible option is to work from the exterior.

The continuous, unbroken skin or membrane around the entire building is called the "airtight layer" (ATL) or the "pressure boundary." The airtight layer is where air sealing should happen. If there is a hole or a gap—for example, a missing gasket under a bottom plate—in the airtight layer, air will pass through that gap and drift around the wall cavities and may then emerge through several outlets in the living room.

The outlets are secondary leaks. The gap under or at the outside face of the bottom plate is the primary leak. While sealing the outlets may be a good idea, it will do nothing to stop the primary leak, whereas sealing one primary can shut off five secondaries. If you can successfully air seal the full run and surface of the airtight layer, your air sealing is done. No other air sealing will be necessary.

This airtight layer simply establishes the environment (wild

side) on one side and the controlled indoor environment on the other. Tape, liquid elastomers, and fabric are the chief air sealing materials applied to the structural skin. The airtight layer, typically a fabric, can also be established somewhere between the structural skin and the interior finish wall (typically drywall), and it can have insulation on either side.



Six common ATL configurations. Above are six common configurations for an airtight layer (ATL) and a basement, crawlspace, or slab (slab configurations can be the same as **A**, **B**, or **C**). Any combination of these can be used. The blue line (ATL) must be continuous and unbroken around the entire building enclosure. Insulation can be applied on either or both sides of the ATL. In colder climates, insulation, usually in the form of continuous sheet material, is added to the exterior of the ATL.

SELECTING THE BEST SURFACE FOR THE ATL

To avoid problems, mostly with dry rot and mold, you need to study and understand the materials of the assembly and the climate in which you are building along with the possible uses of the building.

“The significant disadvantage of exterior air barriers is their inability to control the entry of air-transported moisture into cavities from the interior. Indoor moisture traveling out—chasing dryer exterior air.

“One big drawback with interior air barriers is the potential for moisture and mold on the backside of drywall in humid climates. In an air-conditioned house, the drywall will be cool in summer. Without an exterior air barrier, humid, outdoor air can get into a wall cavity, find that cool drywall, and get the drywall wet enough to damage it or grow mold.” —Allison Bailes of Energy Vanguard

Typically, the ATL on the exterior of the building works well in many climates and building uses. But in many renovation situations, such as a gut rehab of an old building when exterior renovation is not part of the scope of work, it makes sense to establish the ATL on the interior. And it’s especially challenging in older homes that predate the widespread use of plywood and OSB panels for sheathing and decking. Nevertheless, it is possible to improve airtightness.

MAKING THE EXTERIOR SURFACE THE ATL

There are several options for creating the ATL on the exterior of a building.

Plywood and OSB as the exterior ATL. Plywood entered the housing market in the 1930s. Its popularity grew slowly, but as plywood production went up, prices went down, and builders realized plywood was faster, stronger, and more economical. Oriented strand board (OSB), introduced in the 1970s, came in as an alternative to plywood. Using plywood- or OSB-wrapped buildings was the most significant leap in air sealing since the chinking of log cabins. And unfortunately, except for Passive House, that, for the most part, is where air sealing has stopped advancing.

Since most wood-frame buildings built after the 1960s are wrapped with plywood or OSB, those materials are the obvious choices for the primary airtight layer. Plywood and OSB provide a sturdy and thick continuous skin. Moreover, the surface is relatively easy to “read” for punctures. Any breaks or holes in the plywood/OSB should be sealed. There have been reports of OSB sheets leaking even though they appear undamaged, but this is an exception to the rule. Still, suppose you are going for a very

airtight assembly. In that case, you may consider using a good-quality five-ply plywood or applying an elastomeric coating or a self-adhesive fabric on the surface of the OSB.

Using tapes on plywood/OSB. There are numerous durable (long-lasting) tapes on the market that have super adhesion and flexibility. I call them “Super Tapes.” They will adhere to almost any kind of material, including plastic, glass, or concrete.



Super tapes. Both blue tapes are by Pro Klima. The green and white tapes are by Siga. The tape at bottom left is by Partel.

Lumber sheathing as the exterior ATL. Before the 1960s, solid wood planks with up to 1/4-inch gaps between the boards were commonly used to wrap a wood-frame building. By itself, lumber sheathing could not be the ATL. It relied on tar paper, wood siding, or stucco to be the primary exterior ATL. Except for stucco, most of these coverings were not airtight.



Lumber sheathing. Pictured is a single layer of 30 lb. tar paper torn off a diagonal lumber sheathing wall. Note the demo'd stucco at right. Any air that gets behind the stucco will quickly leak into and out of the wall assembly.

Stucco plaster as the exterior ATL. There are millions of stucco (plaster) wood-frame buildings and houses in the United States. They vary in how they are put together and present a variety of air sealing problems; therefore, they require a variety of solutions. Early stucco ran below the framed walls and was bonded to the foundation walls. If done properly, bonded stucco creates a relatively airtight plane along the stucco bottom. Tightly fitting stucco around door and window openings and other punctures in the stucco could yield a relatively airtight assembly.



Bonded stucco. Seen above is a 1949 house with three-coat, bonded stucco applied over lumber sheathing.

Early three-coat stucco coatings (cement, sand, and lime) have been used on stock houses and buildings since the early 1900s. They were mixed in the field, on site. Three-coat stucco is more vapor open and can dry out faster (which is good) than new formulas and mixes. In the mid-1970s, one-coat, premixed stucco came out in a bag. Over the years, different additives—fly ash, acrylic, fibers—were added to the sand, lime, and cement. One-coat stucco now dominates the stucco world.

The introduction of a drainage plane (a gap) behind the stucco and an added weep screed (drainage bottom) in the early 1980s allowed any possible water trapped behind the stucco to escape. The introduction of weep screeds introduced a new and massive primary air leak into our buildings. Since most wood-frame buildings have no gasket under the bottom plate of the framed wall, a weep screed within inches of the plates will allow air to flow in and out under the bottom plate. The weep screed is where air sealing efforts should be concentrated.

Air sealing bonded stucco—no weep screed. The house pictured below [see next page] was built in 1947.

Because the stucco is sealed (bonded) to the foundation or slab (no weep screed), and the stucco is sealed tight against the door

and window trim, it will be more airtight than stucco assemblies with weep screeds. Caulking or paint will keep the joints airtight. If stucco is below grade, dig down to where the stucco terminates on a concrete footing or slab. Make sure the bond is good. Break away loose bonds and repair. Not only can air get behind the stucco, but moisture (from soil) can also creep up the gap. Subterranean termites and bugs can also enter this gap.



A. In this assembly, stucco is applied over chicken wire. The wire is nailed over tar paper, which is nailed onto lumber sheathing. Stucco runs down past the framing and is bonded over the stem-wall footing. (The stem wall is part of a conditioned basement room.) The white arrow shows the surface of stucco bonded to the foundation.



B. Stucco is sealed tight against wood “stucco mold” and wood trim at all openings. Any failed caulking (caulk line indicated by black arrows) could allow water to reach the tar paper. Any weak spots in the tar paper would allow water to come in and cause rot.



C. This cutaway section shows hairline cracks (black arrows) in the stucco, leaving only the paint to make it watertight and airtight. Cracks such as these, over time, could transport water. Note the rotted wood (white arrow).

If possible, it may be a good idea to break away the stucco and finish the edge above grade.

SUMMARY:

AIR SEALING THE 1947 BONDED STUCCO HOUSE.

1. Leave stucco in place. Caulk seal around all stucco terminations, windows, doors, and so on.
2. Make sure the stucco is fully bonded to the concrete. If it is not, break off the loose stucco and, using a bonding cement or primer, patch in the broken areas.
3. Repair all cracks and paint stucco to cover hairline cracks.
4. Complete all other air sealing: floors, ceiling, attic, etc.

Air sealing bonded stucco on slab footing. The example below is from a 1972 commercial building. The stucco is bonded to the concrete above grade.



A. A mirror on the ground shows the weak bonding of the stucco to the concrete slab. Leaks will occur along this edge when the bonding layer breaks out.

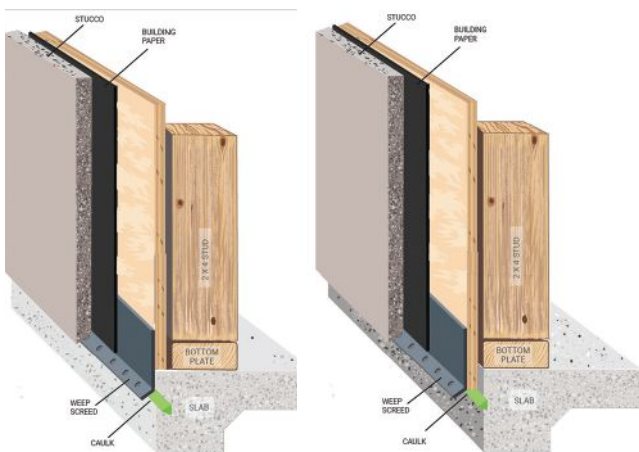


B. Remove loose mortar or stucco, scrub with a wire brush, then caulk joint. Use high-adhesion, highly elastic caulk.



There was no way to tell what the wall assembly was in this circa-1970 wood-frame office building. A mirror was laid on the ground under the stucco to view up into the screed. A folded dollar bill slips behind the screed, illustrating the ability of air to go behind the screed and enter the wall cavities. If the gap is wide enough, you could fill it with a backer rod or gun foam after cleaning it. This will do nothing to stop air from entering the screed holes, but you may get lucky and close off some of the flow of air that gets under the bottom plate.

Two possible weep screed configurations. After cleaning (with a wire brush) all the surfaces, seal with your best, highest quality elastomeric caulk. While this can shut off myriad direct leaks, air can still enter the weep holes and wash the surface of the tar paper and find ways into the wall cavity.



Shear wall plywood flush with face of concrete. Caulk between the weep screed and concrete (at left). Be sure caulk does not clog up the weep screed holes.

Plywood hanging over and past concrete face. Caulk the gap between the plywood and concrete (at right).

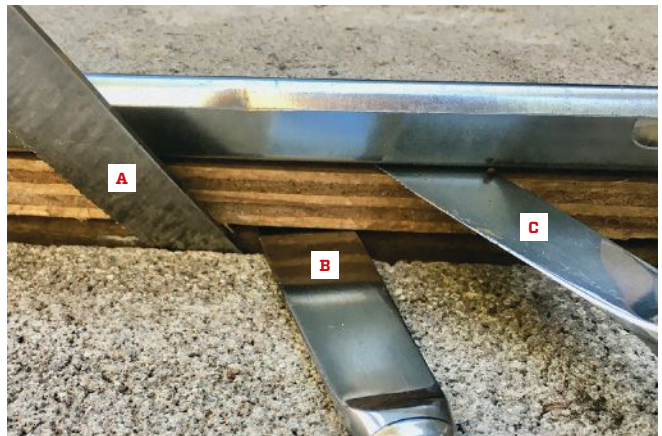
Stucco on shear wall hanging over concrete slab or footing.

Sometimes the shear wall is flush with the concrete. Sometimes it hangs over and below the edge. With no gasket under and at the edge of the bottom plate, there will be a massive opening that can create a hidden leak directly into the wall assembly.



Above is a grade-level view of plywood and stucco with weep screed overhanging a slab footing. Looks tight, right? Maybe not ...

... If you could put your ear on the ground and peer up, you would see the mystery gaps leading into unknown parts of the wall assembly.



Air pathways. This image illustrates (using butter knives) three ways air can enter the wall cavity.

A. Slipping under the gap between the bottom plate and the slab. This common gap, with no gasket under the bottom plate, will allow air to quickly enter the living space.

B. Slipping between the edge of the bottom plate and the back of the plywood. This gap allows air to easily enter and go up into the insulated wall cavity.

C. Slipping between the metal weep screed and the tar paper. This gap will allow air to run outside the plywood and find gaps or holes in the WRB.

The fix. This is how you would fix the multiple leaks through the bottom of a stucco wall:



1. Clean the concrete and any dirt accumulated in the gap.
2. Use one of two options below for sealing the air leaks:



Caulk. Caulk the gap between the concrete and the plywood with your best, high-quality caulk. Do not fill the weep holes.



Tape. Make sure the tape is rated to stick to concrete. Do not cover the weep holes.

Both tape and caulk must leave the weep holes open. This fix will still allow air to enter the weep holes and potentially leak behind the stucco wire and tar paper, but it will shut down the sizable leak pathway under the bottom plate.

Weep screed on the surface of a concrete footing. Below is an example of a weep screed circa 1998. This is a typical one-coat stucco assembly, found in newer buildings (1980 to present).



One-coat stucco was applied over wire (not visible) nailed on top of tar paper. Tar paper was stapled onto OSB or plywood, with a metal drain screed at the bottom. The weep screed is tight against the concrete. Other than caulking the screed where it touches the concrete, there is no

way to air seal this type of assembly unless you demo the entire bottom portion of stucco. Most of the outlets in this wall leaked air. Note: Tar paper behind stucco usually warps and crinkles. While this trait helps the drainage plane behind the stucco, it also provides a pathway for air (and termites) that get behind tar paper.

Air sealing stucco over framing—no shear wall. The figures below show an option for air sealing a stucco house built in 1978.



There was no shear wall in this assembly (above left). Stucco was troweled over wire and tar paper stapled onto framing. The stucco is broken away to reveal the many ways that air can enter the wall cavity (white arrows). This build-up cannot be sealed from the exterior. On the inside of the wall (above right), a steel strap easily slides behind the plate, past the weep screed to daylight. There was no way from the exterior to shut down the massive air leak, so the approach was to attempt to slow it down from the interior.



A 12-inch-wide run of drywall was removed from the interior of all the exterior walls to expose the massive gaps between the back of the bottom plate and the tar paper.



Thickened elastomer was sprayed on using a texture gun, then brushed to fill gaps up to 1/4 inch wide. While this will stop the big leaks between the tar paper and bottom plate, air can still leak between the stucco and

the tar paper and travel up until it finds a puncture in the tar paper or, more notably, at tar-paper seams. Make sure the tar paper is intact and the elastomer does not make contact with stucco, or it will block the flow of trapped water on the exterior surface of the tar paper. Note: Removing a smaller, 4 1/2-inch-wide section of drywall from the bottom of the wall would limit access to seal the gaps, but it would make for an easy repair using a 6-inch baseboard.

AIR SEALING STUCCO—GOING DEEPER

Removing all the stucco allows you to make the building airtight but is very expensive. Another option is to score and break off the stucco at 6 to 12 inches above the weep screed around the entire building. This may seem extreme and expensive, but if you leave the stucco as it is, you may never achieve any significant air leakage reduction in the building unless you choose to form the airtight layer on the interior. The gaps along the bottom perimeter of the building will be a substantial contributor to the stack effect during heating and cooling demands. The gaps will also be a runway for termites, powder post beetles, insects, moisture/vapor, and smoke, and will accelerate flame spread.

Demo the entire perimeter at the weep screed. While this may seem extreme and expensive, it will stop a significant amount of air from entering the entire perimeter of the building. It may be very cost-effective with large, multistory buildings or offices.



Score and break away the stucco about 10 inches up from the screed. Try to leave wire and tar paper intact. Remove the weep screed, lift the wire.



If the plywood is flush or overhangs the concrete, apply tape over the joint. This will stop any air from moving under the bottom plate, which constitutes the lion's share of stucco leaks.

To stop air from traveling behind and up the tar paper, tape the existing tar paper down over the first layer of tape or set the existing paper onto double-sided tape. (See photo, above right. Note: The tape in the image is no longer available. Use any of the “super tapes” shown on page 43.)

If the existing tar paper gets destroyed or is crumbly, you can slip new paper under and behind the old. Tape can be used in place



Caulk and tape options.

The overall goal is to “shingle” all the new materials and seal each layer with tape or caulk as it is being installed.

of caulk. Only use good-quality elastomeric caulk that you have tested for adhesion. Use only super tape for the tape option.



After demo of the stucco, you can slide a new strip of tar paper under the existing. If the shear wall extends below the screed, add new tar paper in a bed of caulk at the top.

A good stucco tradesperson can replaster and join the old with the new. (The new wire must overlap with the old wire to avoid hairline cracks.)

If there is a crawlspace or basement, you must seal the subfloor, blocking, and joists from inside the building. This combination of air sealing will ensure you have air sealed all but one potential leak problem—the air running up the outer surface of the tar paper and leaking in or out through the seams of the tar paper covering the plywood. This step will work only if the stucco is backed by plywood or OSB—not lumber sheathing.



New construction. In this photo, stucco screed, tar paper, and wire were applied over a completed airtight layer, so there was no need for further air sealing. Flashing was added to cover up the visible tape.

Exterior insulation and finish systems (EIFS). In the 1960s, an exterior insulation finish system (EIFS) entered the United States from Europe. A thin “stucco coating” (synthetic material) is laid over EPS sheet foam. While the stucco coating is airtight, there is no way of telling how leaky the assembly is behind it.

There is a drainage plane behind the EPS with a drip cap at the bottom, much like a weep screed. Leakage could occur there as it does with all other stuccos at the weep screed and at the junctures of other materials. If the assembly is not airtight behind the sheet foam, there is not much you can do to shut down leaks other than caulk all the open visible junctures of the EIFS.



EIFS in Detail

1. Stone fascia
2. Elastomer stucco coating
3. EPS sheet foam
4. Drip cap

BRICK VENEER OVER FRAMING

Many wood-frame buildings are wrapped with brick or stone. The brick is primarily the weather barrier. Code specifies a gap between brick and a wood-framed shear wall but, typically, there isn't one on older homes. This gap serves as a drainage plane for bulk water as well as a drying vent for the framed portion of the wall. The roof and floor assembly are the same as on any other standard wood-frame building, and the house can have a full or partial basement. Air-sealing protocol follows the procedures outlined elsewhere in the book; however, the brick wrap prevents access to the exterior. Air sealing the brick-facing walls must be done from the inside.



Most brick veneer has a 1- to 2-inch gap between the brick and the framed wall. There is no effective way to seal brick veneer from the exterior.

WOOD SIDING AS EXTERIOR AIRTIGHT LAYER

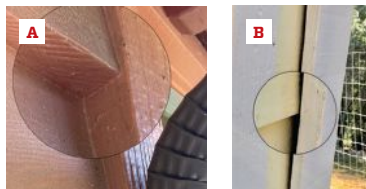
If your goal is less than four or five air changes per hour, you must remove solid wood siding, or you could move the ATL to the interior walls. If there is no tar paper behind the siding, you should remove all the siding and install some kind of weather-resistant barrier. This would be a good opportunity to establish a new airtight layer on the exterior.

Removing original siding. Using a blower door, the 90-year-old house shown below tested in at 15 air changes per hour. Upon completion, it achieved just under one air change per hour. All the work was done outside the conditioned space, including the attic, sidewalls, and crawlspace.



- A. The original shiplap siding was taken off (see lead photo, page 41). There was no building paper or sheathing under the siding.
- B. New OSB shear wall was gasket-sealed by setting the OSB into a wet bed of gun foam; alternatively, you can let the foam set up for five to 10 minutes before installing the OSB.
- C. The wet foam bed is oozing out of the seams. This same concept of gasket-sealing can be done with caulk or foam gaskets between the shear wall and the framing surface.
- D. Old wire and plumbing lines were cleaned up. Main lines were stubbed out below the floor joists to be finished after the OSB was installed.
- E. The OSB was sealed using tape and gun foam.

Leaving the original siding on. Suppose you are not removing the exterior siding and have no access to the interior wall. In this case, you can significantly reduce the leakage in a house with a can of foam (for big gaps), some backer rod, and a case of good caulking. You do, however, run the risk of trapping moisture behind the paint, which can “throw” the paint off the wood.



- A. Trim laid over boards will easily allow air and bugs into wall cavities.
- B. Caulk every open joint and seam.

Terry Nordbye is a building contractor in Point Reyes Station, Calif.

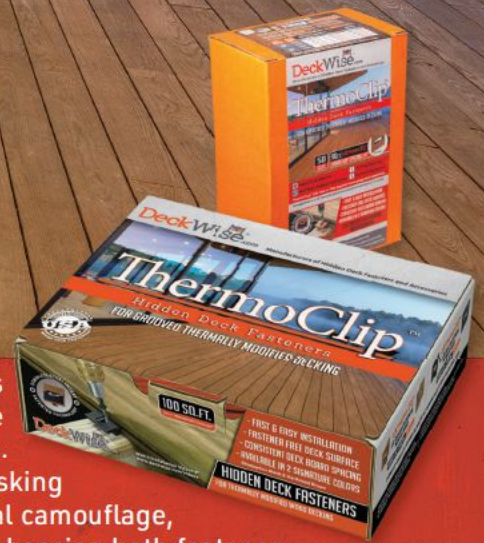
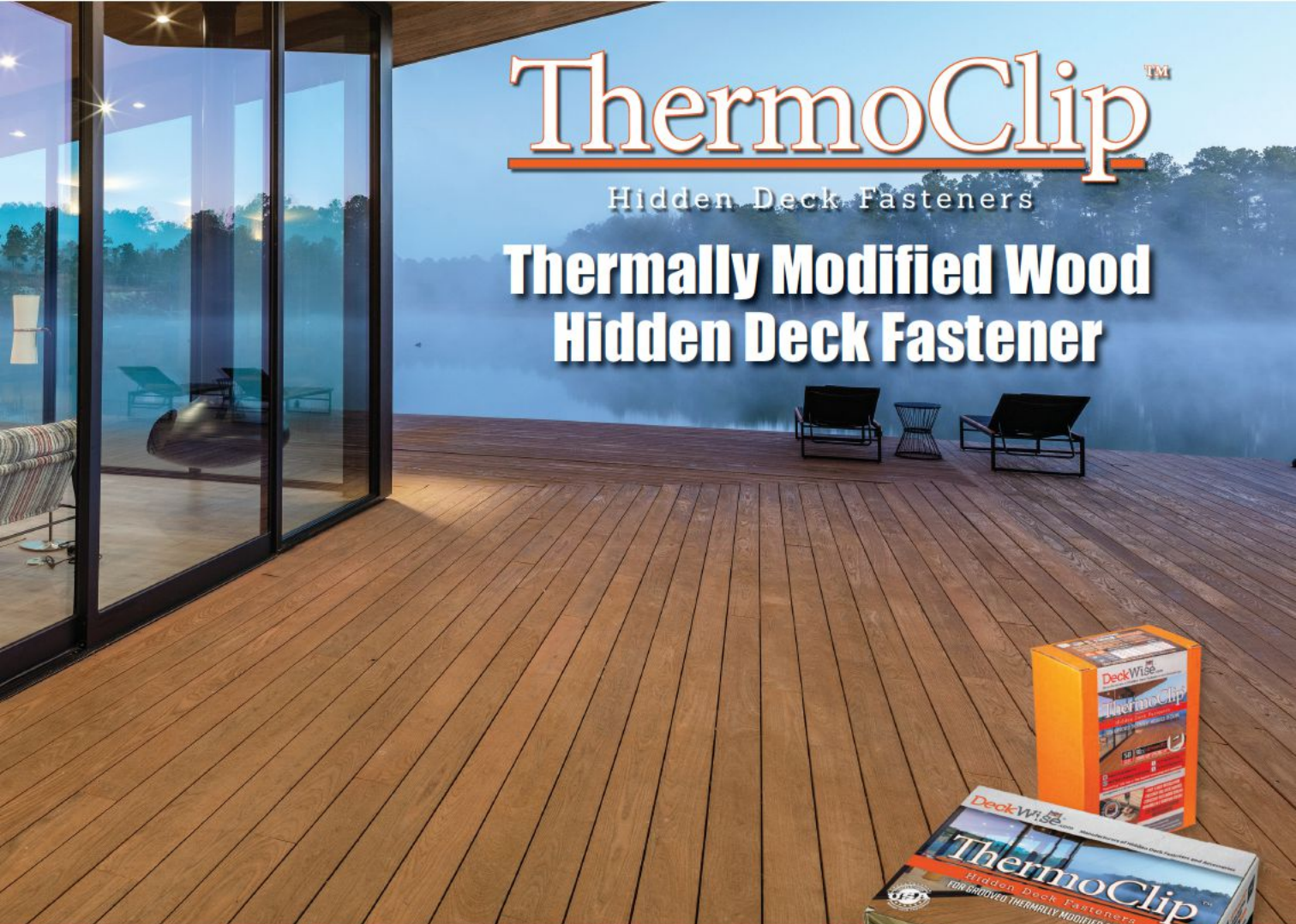


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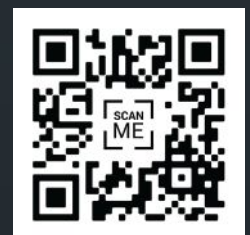
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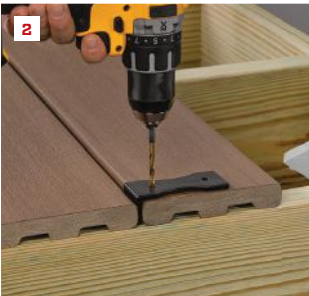
1

1. Composite Board and Batten

Fabricated with a glass-reinforced polymer and graphite-infused polystyrene, Ascend 12-inch board-and-batten composite cladding from Alside features a 10-inch-wide board and integral 2-inch batten, a $\frac{3}{4}$ -inch panel projection, and either a wood-grain or matte texture. According to the manufacturer, the lightweight cladding requires no special tools or skills for installation, doesn't need to be painted and resists high winds, moisture, and impact damage. The profile is available in 20 colors. alside.com

2. Hand-Guided Fastener

FastenMaster's Cortex collated hidden fasteners are now available with a hand guide for scalloped TimberTech boards. The guide helps installers align the fasteners through the thickest portions of the scalloped boards for maximum engagement and strength. Plugs are made from the same composite material as the boards, in matching colors and textures. Collated strips of plugs for 100 linear feet of decking cost \$110. fastenmaster.com



2

3



3. Precise Overhead Lighting System

Whisper Multiples overhead lighting from Creative Systems Lighting features unobtrusive, small apertures that the manufacturer says provide soft and glare-free illumination for either general or accent lighting. Each $\frac{3}{4}$ -inch round head delivers up to 816 lumens; housing options include two, three, or four independently adjustable light modules, with or without round trim. A serviceable integral driver and easily removable light modules simplify installation. csslighting.com



4

4. Wood-Look Exterior Metal Profiles

Drexel Metals has introduced a new Timber Series of five soffit and wall panel finishes that sport a wood-grain pattern. Shades in the timber aesthetic range from browns to gray and soft white in a four-coat, polymer-resin-based (PVDF) finish. The Timber Series is offered in a variety of substrates and coil widths up to 48 inches, in 24-gauge steel and 0.032-inch aluminum. Additional gauges are available with extended lead times and minimum quantities. drexmet.com



5. Waterproof Wall Panel Molding

EnduraFlood has enhanced its waterproof drywall systems with additional design options, including a prefabricated Picture Frame Molding kit that can be applied to the company's EnduBoard to create the look of panel molding. All EnduraFlood components are made from waterproof and mold-resistant materials, including PVC, galvanized steel, and proprietary plastic materials. A small kit, with pieces and glue to make two 15-by-18-inch picture-frame moldings, costs \$29.50; a large kit that makes one 18-by-36-inch picture frame costs \$25.75. endurflood.com



6. Comprehensive Fall Protection

Each Eveook Nonpenetrating Fall Protection System from Ballantyne Gear is engineered to protect up to eight users on sloped roofs. The system can be installed in less than 15 minutes and the anchorage connectors set in place without putting holes in the roof. Users can install fall protection before getting on the roof, and a horizontal anchor line with adjustable lifelines can be used to avoid swing falls and keep workers in travel restraint. The full system, which includes two body harnesses, two nonpenetrating connectors, and more than 25 other components, costs \$5,860. ballantynegear.com



7. CLT Barrier Coat

KP-14 Vapor Permeable Barriercoat from the Sansin Corp. is designed to be used in conjunction with KP-12W Undercoat to protect horizontal surfaces of engineered wood like cross-laminated timber (CLT) from moisture absorption during construction. Waterborne, low in VOCs, and UV-resistant, KP-14 can be applied by spray, roller, or brush to clean, even surfaces after they've been coated with KP-12W. KP-14 is not intended to be a decorative finish. sansin.com



8. Weatherproofing Flashing Tape

FrogTape Pro Grade Flashing Tape can help create weatherproof seals around windows, doors, and other building openings in both residential and commercial applications. The tape combines the manufacturer's acrylic adhesive with a conformable film backing that bends around edges, corners, and other building transitions. Engineered using Shurtape's UV curing technology, the tape does not contain VOCs and won't react with caulks and sealants. A 3 3/4-inch-by-75-foot roll is available for \$35. frogtape.com

9. Innovative HVAC Solution

Navien's NPF Hydro-furnaces employ the same technology that's behind the manufacturer's tankless water heaters, combi-boilers, and boilers in an HVAC setting. Unlike traditional forced-air systems, the NPF Hydro-furnace heats water by burning the gas in a sealed stainless steel combustion heat exchanger isolated from the airstream. Heated water is then pumped through a hydronic heat exchanger that transfers the heat into the air. A variable-capacity blower and modulating combustion system allows the NPF to operate from 15% to 100% capacity for both natural gas and propane applications. navieninc.com



10. High-Capacity Hold-Down

The HD22 Hold-Down from QuickTie resists uplift forces due to wind and overturning of shear walls. With a 22-kip load capacity and a screw application that eliminates through-bolts, the HD22 is well-suited for doorway and corner applications, QuickTie says. Additionally, the pointed base ensures proper offset from the bottom of the adjacent stud. Other applications include purlin-to-purlin and concrete or masonry walls to decking or flooring attachments. quicktieproducts.com

11. Solutions for Expansive Soil

VoidForm works with builders to select the right void forms for soil conditions and potential vertical rise. System components include void forms, cover boards, vapor barriers, and backfill retainers. In areas with expansive soils, void forms made from paper-based cartons in the SureVoid line provide temporary support during concrete placement. These void forms degrade over time, leaving space between soil and concrete, according to the manufacturer. voidform.com



12. Outdoor TV-Lift Cabinets

Cabinet Tronix says its outdoor TV-lift cabinets are weathertight and resistant to temperature extremes, moisture, mildew, rot, and insects. Units are mounted on heavy-duty, stainless steel swivel casters and come preinstalled with a telescoping TV-lift system activated by a single click. A variety of styles, sizes, colors, and materials—including stucco, porcelain tiles, concrete, and ipe—are available. Premium options include integrated bars, refrigerators, lights, and serving spaces. cabinet-tronix.com



Cabinet Plumbing Jig

BY CHRIS LAND

As a cabinet maker and installation company, we use many different tools in pursuit of our goal to provide speed, efficiency, and precision to every job we work on. We've found that True Position Tools is a company dedicated to producing tools that will elevate your workflow game. It already makes the industry-leading cabinet-hardware installation jig, so when I heard about the release of its Cabinet Plumbing Jig, I could not wait to get my hands on one.

Upon receiving the jig, I was impressed by its zippered and padded bag with hold-down straps that secure it during transport. It also came with a full-color, step-by-step instruction booklet. It's an indication of the quality of a tool when a company puts this kind of effort into creating a storage bag and ensuring you use the tool correctly.

Before using the jig, we first mark a level line on the wall at the sink cabinet's height and lay out its centerline. We then line up the jig's center mark with the centerline on the wall and place two fasteners on either side of the line to hold the top bar of the jig level and steady. Next, we line up the jig's arms (it has three) above each of the plumbing pipes coming out of the wall and tighten the arms using the jig's stainless-steel knobs.

The next step is to mark a centerline on the back of the sink cabinet and line it up with the jig's center mark, using the stops to

keep it in place. Then we trace along the red marking edge of the V-shaped fixed head at the end of each arm to create marks for lining up the edges of a hole saw. It is that simple to mark precise plumbing locations on the back of the cabinet with this jig.

The saying "Time is money" is so true in the trades. While there are many different ways to mark plumbing on a cabinet, one of my preferred methods is to use a torpedo level and mark lines that represent the top and sides of all the pipes. I then measure the location of these lines based upon the level line and center point created in the layout process. Over the past three months, this process averaged 10 minutes for a set of three pipes. When we used this new jig, that task took only two minutes. Not only does the jig increase speed, but it also improves accuracy.

Kitchen sink cabinets also often have an outlet for under-the-cabinet electrical needs, like a garbage disposal. The Cabinet Plumbing Jig comes with a swivel head to mark the location of electrical boxes.

True Position Tools has done its homework in creating this jig. If you mark one or two cabinets a year, this tool may not be for you. If you are marking cabinets professionally on a daily basis, however, this tool is a must for your bag of "tricks of the trade." It costs \$300 at truepositiontools.com.

Chris Land is the owner of Cutting Edge Woodcraft in Greenback, Tenn.



With the Cabinet Plumbing Jig leveled and centered on the cabinet layout, a worker aligns the arms with the pipes (1). After tightening the arms in place, he moves the jig to the back of the cabinet to mark out the pipe locations (2). The jig comes with a padded, zippered storage bag (3).

Photos: Chris Land

Weigh In!

Want to test a new tool or share a tool-related testimonial, gripe, or technique? Contact us at jlctools@zondahome.com.

DeWalt Cyclone Dust Separator

BY NATHAN RINNE

Dust collection has become integral to my setup, whether I'm on site or in my shop; in fact, I've come to dread working without it. While I hook up large tools to a shop collector, I run hand tools like a track saw and sanders through portable extractors. Their filters clog quickly and are costly to replace, though, so I started connecting an in-line cyclone separator to the extractor. The separator collects most of the dust before it ever reaches the extractor, not only keeping the filters running clean but also eliminating the need to empty filter bags multiple times a day. I own three cyclone dust separators—a Festool CT-VA 20, an Oneida Dust Deputy, and a DeWalt DXVCS002—and I've found the DeWalt to be the superior choice.

The more bends, sharp turns, and restrictions in a dust collection system, the greater the loss of suction. The Festool separator has too many of the above, with two 90-degree bends in the included hose alone. Inside the unit is a compact version of cyclone technology that is restricted in piping size and doesn't allow for the volume of airflow needed.

DeWalt took a different approach, using the same tried-and-true cyclone design that's the basis for most industrial collectors. The loss of suction in this type of design, if any, isn't noticeable, as it allows maximum airflow. DeWalt claims that its cyclone separator captures 99.5% of dust, and while I don't have a way to scientifically measure that, I am 99% sure it captures more than my Festool and

certainly more than enough to meet my needs. With the DeWalt at about a third of the price of the Festool and having better performance, it's a clear choice between the two.

I also prefer the DeWalt over Oneida's Dust Deputy, for several reasons, not least of which is ease of assembly: A handful of screws and the DeWalt was ready to go out of the box, wheels and all. In comparison, the Dust Deputy comes in pieces and takes time to set up. The other big reason I prefer the DeWalt over the Dust Deputy is the quality of the build. The Dust Deputy has a 5-gallon bucket and lid attached to a cyclone, whereas the DeWalt has a 6-gallon poly shop-vacuum base with nice, locking latches and a thicker wall. I typically use a 250-cfm Bosch extractor in my shop, which, when I turn it on, will regularly flex the sides of the Oneida bucket and nearly collapse it if I put my hand over the hose. Not so with the DeWalt, which remains rigid without losing its shape or succumbing to the pressure. And it beats the price of the Dust Deputy by about \$8.

I always appreciate getting more for less and recommend DeWalt's cyclone dust separator over both Oneida's Dust Deputy and Festool's CT-VA 20. Price: \$135. dewalt.com

Contributing editor Nathan Rinne owns Rinne Trimcraft in Missouri. He specializes in on-site carpentry and ornamental built-ins. Follow him on Instagram at @rinne-trimcraft and on Facebook at facebook.com/rinnetrimcraft.



The DeWalt DXVCS002 cyclone separator moves with the work, thanks to its casters and stable base (1). Compared with the author's Oneida and Festool units, the DeWalt has a larger capacity without adding too much footprint and has better stability and mobility (2).

Colliflower Cube for Kapex Zero-Clearance Fence

BY TOMMIE MULLANEY

When it comes to making precise cuts, a Festool Kapex KS 120 REB sliding compound miter saw does a fantastic job, but there is always room for improvement. One of my biggest complaints has been its fence, which has a very large throat that can allow the blade to fling offcuts across the room. These small pieces of wood shrapnel can be a danger to the saw, the user, and anyone standing nearby. The standard approach to combating this problem is to fit the saw with a sacrificial fence, but when you do that, you lose some depth of cut, which can be frustrating.

Jack Colliflower, a woodworker and owner/designer of Colliflower, in Cheney, Wash., has fixed both problems in one swift step with the Cube for Kapex Zero-Clearance Fence. This accessory consists of a black powder-coated fence base milled from 6061 aluminum that completely replaces the original Kapex fence base while still employing the existing mounting holes and bolts on the Kapex.

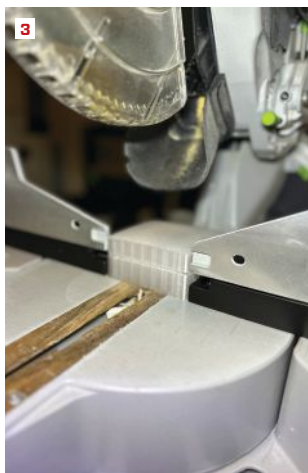
At the heart of the Colliflower system is the Cube, a 3 1/2-inch-by-3 1/2-inch by 2-inch-high clear PETG (thermoplastic polyester) block that occupies the once-empty space between the auxiliary fences. This block is slotted around all four sides to fit snugly within

the Colliflower replacement fence base and becomes its own sacrificial fence without sacrificing depth of cut or dust-collection capability. With the Cube in place, safety and accuracy are enhanced, and tear-out on the back of the cut is eliminated, regardless of the angle of cut.

Since the Cube is symmetrical, you can rotate it to use all four sides when making sacrificial cuts, extending its life. To replace it, you can buy new PETG cubes from Colliflower for about \$20 each, but it's easy to make your own cubes with offcuts from a 4x4. It's possible to make custom cubes taller than the PETG cubes, but you'll get better dust collection by limiting the height to about 2 inches.

The price for the U.S.-made Colliflower Cube for Kapex system—which includes the replacement fence base and a PETG cube—is \$170, which is well worth the increased safety and accuracy the system brings to the Kapex. colliflower-zci.com

Tommie Mullaney owns Black Label Carpentry in Naples, Fla. You can visit his website at blacklabelcarpentry.com or follow him on Instagram at [@BlackLabelCarpentryCo](https://www.instagram.com/BlackLabelCarpentryCo).



Comprising a black, powder-coated aluminum fence base and a plastic block, the Colliflower Cube system marries easily to a Festool Kapex saw using the saw's existing bolts and holes (1, 2). The Cube fits the fence's throat completely to prevent fly-aways and reduce material tear-out but doesn't impede dust collection or limit depth of cut (3). Adjustment bolts ensure that the Cube remains aligned with the front of the fence (4).

Photos: Tommie Mullaney

Powerful Cordless Arc Welder

BY JAKE LEWANDOWSKI

Not long ago, we landed a project reinforcing steel trusses in a multiuse mid-rise to accommodate a large number of new solar panels. As in many of our projects, there were a ton of hurdles.

Our first challenge was getting the leads from the welding truck up to the center of the building on the third floor. We had to hump 300 feet of welding leads up there and, from this work area, run the leads to a window and lower them down to a roof deck, then run them off the side of the roof deck down to the welding truck. This was planned.

What wasn't expected was the mystery tenant who parked in the spot provided by the owner. Unable to park the F-450 welding truck where we planned, we had to park in an alley. I also was not expecting the noise and diesel-exhaust complaints about the welder running. All of this was accompanied by incessant honking as vehicles struggled to drive around the welding rig (although we did expect this, as it's common when working in the hustle and bustle of Chicago). It's projects like this that pushed me to consider other solutions, and I landed on the ESAB Renegade Volt ES 200i, which proved to be a game changer for us.

It's no wonder *Popular Mechanics* gave the Renegade a well-deserved "best tools of 2024" award. It's the first welder to use interchangeable batteries. It comes with four DeWalt 20-volt, 12-Ah

batteries, a 230-volt plug along with an adapter for a 120-volt plug, and some nice, 10-foot leads. It can be used for TIG and stick welding; however, if you do plan on TIG welding, you will need to purchase the torch, foot pedal, and gas cylinder.

You can run the Renegade on battery-only power, or you can plug it into a 230-volt or regular 120-volt receptacle to run off AC power. Or you can plug the unit into a 120-volt outlet to run in a hybrid mode of 120-volt and battery power that ESAB calls AMP+. Doing structural work on battery-only power, we mainly run 7018 rod—both $3/32$ - and $1/8$ -inch ESAB rods—and so far the welder has run these flawlessly. Weighing in at under 60 pounds, the unit is easy to load on and off the truck and move around a jobsite. The power cord and leads wrap around the main handle at the top of the welder, and the shoulder strap cinches down the cords.

Its ability to be moved so easily around a job, its versatility in how it's powered, and its virtually maintenance-free unit compared with a small, engine-driven unit all make the ESAB Renegade a go-to welder for us on all types of jobs. It sells online for around \$4,000. For more information, go to esab.com.

Jake Lewandowski is a construction manager with Chicago-based Great Lakes Builders.



The ESAB Renegade Volt ES 200i comes with four 20-volt, 12-Ah DeWalt batteries. It can also plug into a 230- or 120-volt outlet or run in a battery-plus-120-volt power mode (1, 2).



Photos: Jake Lewandowski

BY MARC FORGET



Treasures Found

Taking apart an old home, I always feel like I'm connecting with the trades who came before me. Past practices and skills are frozen in time, and I imagine what the carpenters were like—not just how they created the house I am in. I think, too, of the work I have done and wonder whether it will lead the next carpenter to ask the same questions.

Sometimes during a renovation, I find artifacts hiding in walls or floors. What we would recycle today or haul away in trash bags was often buried in the yard or stuffed into gaps of the house; these items give another glimpse into what went on at the time of its construction. The empty whiskey bottle my partner found in a joist cavity reminded me of the older gentlemen I first worked with: Sitting at break, they would relate that, in their time, alcohol was cheaper than aspirin or ibuprofen. In a house built after the Second World War, I found a photo of a man in uniform slipped behind old baseboard I was removing; was it the original homeowner? I never found out but left the photo behind the new baseboard months later. That same post-war bungalow gave up stacks of magazines and newspapers that had been used to layer the ceiling as an air barrier of sorts. Most were too fragile to keep, but the ads and articles from 1946 and '47 made for some good lunchtime conversations.

Often, I find tools on these jobs. An old chisel that was driven into the side of a stud and then covered is now a friend's pouch chisel. A framing square that was oddly wedged into a rafter surprised me while I was cutting into sheathing boards. I could never figure out how that happened, but most of the time, the reason is obvious: A worker laid a tool down or dropped it into a framing cavity and

never recovered it—some things never change. One day, my framing hammer will be found in the blown insulation of that attic.

I haven't ever found anything that would be considered valuable. I did find a stack of money once, slipped into a traveler's check pouch that made its way under an old oil tank. The bills were from the early 1950s from French Indochina, Hong Kong, Australia, and the like, tracing a tour from Iran through southeast Asia. In all the colors of the rainbow, some bills came from countries that have since changed names and sovereignty. But simply being old doesn't make something worth much, I found out. Worn from use and age (time under the oil tank didn't help either), they went to a collector in exchange for a few modern bills long spent. The stories and questions that they brought up offered much more value.

I have kept a few found items over the years. Among those is a group of ink wells (1) that I found during an excavation for an addition. I've been told that when the ink was used up, they were just thrown away—like pens today—and a new bottle purchased. Medicine and all manner of tonics were sold in glass bottles of various colors and shapes; some of the ones I have list ingredients that would make the FDA cringe (2). I also have some bottles and cans that may have been workers' or homeowners' (3). The beer in the Labatt 50 bottle should probably not be consumed now.

These items—and others lost or discarded during the construction of what were once new homes—now live on shelves in my bar, with renewed purpose as enticement to conversation.

Marc Forget is an associate editor at JLC.

Photos by Marc Forget

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Preventing Early Deck Framing Failures

by Frank Woeste

Collapsing decks—sometimes involving serious and even fatal injuries—continue to grab the headlines. NADRA (the North American Deck and Railing Association; nadra.org) estimates that nearly half of the more than 60 million residential and commercial decks in the U.S. are past their useful life.

Sometimes, the structural connections—think bolts, lag screws, engineered structural screws, ordinary decking screws, concrete anchors, joist hangers, and other structural connector hardware—are deficient due to a design defect or corrosion (rust), which alone can cause a deck element to fail without warning. But decayed framing system components, such as joists, beams, posts, footings, stairways, guard systems and handrails, decking, and treads, can alone cause or contribute to a collapse event. Of course, decayed wood coupled with a deficient connection can jointly cause a collapse event.

I believe that contractors can do more to extend the life of the framing on a new deck, avoiding costly repairs or deck replacement costs and—more importantly—preventing an unexpected early framing decay collapse event. My recommendation is to flash the tops of all joists, beams, and stair stringers to provide preservative-treated wood additional protection, and make sure that the framing can dry out.

Life Expectancy of Deck Framing

Prior to 2004, residential deck framing in my region was constructed with southern pine (SP) lumber and preservative-pressure-treated (PPT) with chromated-copper-arsenate (CCA) at the AWP (American Wood Protection Association) Use Category UC4A level, known as “Ground Contact.”

Because of its cellular structure, southern pine is a preferred species for the PPT process, and CCA was a proven effective preservative treatment for solid-sawn wood products. The expected life span of an elevated deck built with 2x8 or 2x10 SP joists and nail-laminated beams CCA-treated to AWP UC4A requirements was typically two to three decades.

When manufacturers voluntarily discontinued producing chromated arsenicals for residential use in December 2003 and started treating lumber with alternative preservatives, they also reduced retention levels for lumber widely available to contractors and homeowners from “Ground Contact, UC4A” to “Above Ground,” labeled AWP UC3B. As a result, UC4A treated lumber largely disappeared from the marketplace, except as a special-order item (see “Treated Wood Industry Looks to Toughen



Preservative treatment lumber tag on one end gives the size of the 2x12, along with the AWP UC4A level that indicates it is suitable for “Ground Contact.”

Standards,” *JLC* Feb/15). Unfortunately, by the end of the next decade, deck builders and others began to report unexpected deck framing decay, sometimes after only about 10 years of service.

By 2016, the AWP responded to the early decay issue by adding a footnote to the AWP Standard U1, Table 2-1 Service Conditions for Use Category Designations: “Joists and beams shall be treated to requirements for UC4A when they are difficult to maintain, repair or replace and are critical to the performance and safety of the entire system/construction.”

Joists and beams used to construct a residential deck are indeed “difficult to maintain, repair or replace” and, when elevated, are “critical to the performance and safety of the entire system/construction.” The AWP recommendation led to UC4A treated lumber becoming more commonly available, particularly in the wider dimensions typically used for framing decks. Being that AWP U1 is a referenced standard in the IRC, contractors are well-advised to make sure they are indeed using PT lumber rated for ground contact (UC4A) for elevated deck joists and beams. In addition, deck contractors should save all treatment end-tags and give them to the homeowner for demonstrating that AWP UC4A treated lumber was used and to save in case of a warranty claim.

The Need for Flashing

Even with UC4A treated lumber, the service-life of deck framing may be less than desired due to numerous factors, such as species of lumber, effectiveness of the preservative, climate, and treatment variables that can affect the quality of the treated materials. For example, the preservatives used during the treatment process are waterborne, so if the wood cells are already full or partially full of water because the lumber to be treated

STRUCTURE

hasn't been well-dried, the cells will absorb very little treatment solution. In addition, the heartwood at the center of a log is difficult to treat, even if well dried.

While preservative treating plants generally subscribe to a third-party quality control (QC) inspection service that visits plants on a schedule, only a sample of lumber is tested per AWPAs testing standards. As such, it is unlikely that the individual pieces of preservative-treated lumber delivered to your jobsite for a specific deck project would have been tested for chemical penetration and retention. In addition to the efficacy of the chemical treatment used, both penetration and retention of the chemical in each piece of lumber are critical to the in-service performance of the lumber. Due to the natural variability of moisture content (at the time of the pressure-treating process) and other treatment variables for each piece of lumber, it's likely that some pieces and batches of treated lumber may not perform in-service as expected.

According to Jim Mailey, a former training specialist (now retired) with Simpson Strong-Tie and author of NADRA's "Decks Done Right" education programs, "There are numerous stories from deck builders that the framing is lasting 7 to 10 years before significant decay has shown up that can be seen without doing the pick test (which can detect early decay before it becomes visually evident)." Based on a concern for occupant safety as well as deck replacement costs, I believe that measures to enhance the protection of framing lumber without increasing the potential for fastener and connector corrosion caused by higher preservative retention levels are warranted.

Extending the Deck Service-Life

Flashing all joists, built-up beams, and stair stringers while providing free or unobstructed ventilation below is a simple way to address this uncertainty and extend the service-



Central Virginia deck after 10 years in service. The bulk of decay damage is where the top edges of joists are in contact with the decking. Such water-trapping joints accumulate water by gravity and capillary action and are slow to dry after a rainstorm since the top edge of the joist is not exposed to natural ventilation.



Constructed in coastal New Jersey, a deck joist in-service about 10 years was preservative treated to the "Above Ground" AWPAs U1 Use Category.



Advanced decay of joists and beam treated to "Above Ground" based on an available treatment tag. The tag did not indicate an AWPAs Use Category System.

life of deck framing to as much as 25 years. A self-adhering, self-sealing flashing (not all peel-and-stick membranes are self-sealing) or a self-sealing coating that has been tested to meet the standards of AAMA 711 should be used over the tops of joists to prevent the entry of water around the decking screws or other fasteners used to install the decking. The expected service-life of the flashing is also important as the tops of all joists between deck boards will have some UV exposure, and the outside top edge of band joists and beams may have maximum UV exposure most of the day.

Built-up beams are especially vulnerable to water collecting in the gaps between members, which can be avoided by flashing the top of the beams. At least one manufacturer, PWT, which offers a preservative-treated LVL, has a requirement to flash all framing. Flashing for 2-by joists should be a minimum of 2 1/2 inches wide to ensure good coverage. Built-up nail-laminated beams (two, three, and four plies) should be flashed with a single width that is adequately sized to cover the entire assembly.

Deck ledger. Of course, the single most important structural element to flash on a deck frame is the deck-ledger-to-house-band connection. While an in-depth discussion of this critical detail is beyond the scope of this article, guidance



The PWT preservative-treated LVL framing has been flashed for additional protection.



This UC4A-treated 6x6 southern pine post has been repaired using UC4B-treated 2x6 cleats and 1/4-inch-by-3-inch structural fasteners. Note that the cleats (as well as the concrete, not shown) have been sloped to shed water.



Cutting a stringer creates “end grain” at each stair tread and riser. End grain absorbs water up to 100 times faster than the sides of the lumber do. As such, cut edges of the 2x12 preservative-treated southern pine stringers are flashed.

on how to flash a deck ledger properly can be found in Figure 14 in the American Wood Council’s *DCA6 Prescriptive Residential Wood Deck Construction Guide*, as well as in Mike Guertin’s three-part series “Installing a Deck Ledger” (*PDB* Jul/19).

Posts. When deck structural support posts are embedded in the ground, AWPAs recommends UC4B material, commonly known as “Ground Contact Heavy Duty.” About four decades ago, leading post-frame building companies switched to UC4B after experiencing early decay failures.

For UC4A or UC4B structural deck posts attached to a concrete slab or pier, a post-base connector that separates the post end-grain at least one inch from the concrete or standing water should be used. UC4B may not be available in retail outlets and require a special order. Note that with UC4B lumber, stainless steel hardware is recommended to avoid premature corrosion.

These recommendations are in addition to IRC requirements, which call for field-cut ends, notches, and drilled holes in preservative-treated wood to be treated in the field in accordance with AWPAs M4. According to the *Forest Products Laboratory Handbook*, sealing all end-grain surfaces to prevent liquid water from entering the wood “is probably the single most valuable improvement that can be made in standard construction practice to improve the performance of wood exposed to water. The end grain is so important because liquid water can enter wood through the end grain so quickly—100 times faster than from the sides is not unusual.”

Flash and ventilate. Even when the tops of all joists and beam framing lumber are flashed, the installation of an under-decking water-management system that prevents the open, “natural ventilation” of the framing up to the flashed top edges will likely be counter-productive to preventing the decay potential of the framing lumber. For homeowners who seek a protected space under a deck, “above the joist systems” are available that prevent the framing system from being exposed to rain and snow water while not obstructing the natural ventilation of the joist framing below flashing. Wood structures that are protected by cover from the weather and well-ventilated are known to maintain a moisture content (MC) well below what’s required for fungal decay. ❖

Frank Woeste is professor emeritus at Virginia Tech and a wood construction consultant.



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A Durable Wood Railing

This classic porch railing should last for decades, thanks to clever water-shedding details and careful finishing

by Emanuel Silva

Front porches are an important architectural element on the older housing stock where I work just north of Boston, and I've restored a lot of them over the years. Most of the time, the restoration doesn't have to be historically accurate, but I like to try to match the porch's basic style and materials while fixing its problems and bringing it up to code, and I like to incorporate details that will help the porch last a long time. In this article, I'll describe the details that I used to build a durable, traditional-looking wood railing.

Materials

Earlier in the project, I had reframed the porch featured in this article and replaced the original fir flooring with a type of mahogany called red balau. To match the decking, I selected straight

6-foot and 8-foot lengths of s4s 2x4 red balau at my lumberyard to use for the top and bottom rails. This lumber, which currently costs about \$6.35 per lineal foot for 2x4 stock, is comparable to ipe in terms of durability.

I planned to paint the balusters to match the trim on the house and chose to use clear red cedar rather than fir. Both hold paint well, and the cost is similar (about \$4.60 for a 1³/₈-inch-by-1³/₈-inch-by-36-inch red cedar baluster at my lumberyard, a bit more expensive than fir), but the railing detail I planned to use involved nailing and screwing into the ends of the balusters, which would probably split a fir baluster without a lot of careful predrilling. It's much easier to drive a nail or screw into the end grain of a red cedar baluster.

I opted to fasten the tops and bottoms

of the balusters to PVC nailers, creating railing sections that would in turn be fastened with screws to the top and bottom rails to complete the balustrade.

On-Site Millwork

I don't have the luxury of a dedicated shop, so I choose tools and equipment that let me set up a portable shop in my clients' driveways or garages. In addition to the worktables that I've described in previous *JLC* articles (see "The Best Site-Built Worktable?" Jan/Feb 2024), one of my most valuable pieces of equipment is a 10x10 pop-up tent, which provides welcome shade when the weather is hot and protection for me and my tools in all but the heaviest downpours. I use it almost daily, so it has earned a permanent place in my box truck.

Rails. I started by ripping a pair of kerfs

A Durable Wood Railing



Figure 1. The author ripped a pair of kerfs in the undersides of the 2x4 red balau mahogany rails (A), routed notches in their sides, and then beveled the tops to shed water (C). Prior to finishing, he then sanded them with 100-grit paper (D).

about $\frac{1}{4}$ inch deep and $\frac{1}{2}$ inch in from each edge along the underside of my rail stock. Then I used a router with a cove bit to make $\frac{3}{8}$ -inch-wide by $\frac{1}{4}$ -inch-deep notches along each side of the rails to break the surface tension of rainwater flowing off the rail and allow it to drip off. Mostly, the notches serve as shadow lines in the rails, but on the stair handrail—which has a similar profile but is ripped to $2\frac{1}{4}$ inches wide—the notches improve graspability, which my building inspector appreciates.

Along the tops of the rails, I ripped shallow, 5-degree bevels, first with one rail edge facing down and then with the other rail edge facing down, centering the V-profile that the bevel cuts made. This railing profile is similar to one that most lumberyards in my area have been stocking for years, typically in fir, and is intended to shed water away from the top of the rail (**Figure 1**).

On the bottom rails, I cut steeper, 15-degree bevels, setting my fence so that the cuts would leave a flat area along the center of the rail for the baluster nailer.

After milling the rails, I sanded them with 100-grit paper to remove the kerf marks and the waxy coating that this lumber seems to have and open up the grain. Then, to all edges of the rails, I rolled on two coats of Penofin penetrating oil finish for hardwoods in a transparent natural tone, the same finish

used on the decking. One of the keys to a long-lasting porch is to prefinish all the components prior to assembling and installing them. Before applying any finishes, I like to cover my worktables with plastic to keep them clean.

Balusters. Before cutting any more stock, I made a pair of mock-ups for the porch railings—one for the bottom rail and one for the top rail—to make sure everything would fit properly and look right. I wanted the total rail height to equal 36 inches, with a $2\frac{3}{4}$ -inch gap between the bottom rail and the decking.

I cut one end of all the balusters to a 12-degree angle, orienting them so that any curved ones would face in the same direction and front to back. Then I set up a stop block before cutting the other end of the balusters, to ensure that they all would be the same length. The 12-degree angle at both the tops and the bottoms of the balusters allows water to drain quickly out of the assembly and away from the porch and prevents water from pooling around the baluster's end grain.

To enhance drainage, I also cut $\frac{1}{4}$ -inch-wide by $\frac{1}{4}$ -inch-deep slots in the ends of the balusters. To safely make the slots, I screwed a pair of baluster offcuts to a scrap 1-by with a gap between them sized to snugly hold a baluster in place. The slots are wider than a saw kerf, so I had to make two



Figure 2. The author applied the penetrating oil finish with a roller, wiped it down after about 20 minutes, then allowed the finish to dry overnight before repeating the process (A). The author made mock-ups of the bottom rail (B) and top rail (C) details to determine the length of the balusters (D). A stop block guarantees uniform baluster lengths (E). Here is the simple jig the author made to safely cut the notches in the ends of the balusters (F).

passes through the table saw to add up to the 1/4-inch-wide slot (Figure 2).

I primed the balusters on all four sides and on the ends with Zinsser Bin shellac-based primer, rolling the primer on three sides and placing the balusters on a ladder to let them dry before flipping

them over and coating the fourth side. Then I rolled on two coats of Benjamin Moore Regal Select in a low-lustre finish to match the trim color on the house. Not everyone likes to prime and paint balusters before assembling a railing, but I find that it's easier this way and—

more importantly—is the best way to seal up those end cuts.

Nailers. To make the nailers that hold the balusters in place, I ripped some 1-by PVC stock to 1 5/8 inches wide, so that there would be about a 1/8-inch reveal between the edges of the

A Durable Wood Railing



Figure 3. Coating end grain with primer and paint prior to assembly helps prevent the wood balusters from wicking up moisture (A). Here, the author is ripping a 12-degree bevel on one of the PVC nailers (B). After marking the layout from the centers of the upper and lower nailers (C), the author first tacked the balusters to the nailers with 18-gauge nails (D), then strengthened the connection with pairs of 1 1/2-inch trim screws (E).

nailers and the balusters. I also needed to match the angle that I had cut on the ends of the balusters, so I then set up my saw to rip a 12-degree bevel on the PVC nailers (**Figure 3**).

As anyone who has worked with PVC knows, the dust sticks to everything. Setting up dust collection can help, but when I work outside, I don't always have a shop vacuum with me, and it's usually just as easy to sweep up everything afterward rather than fuss with hoses. But one thing I've found is that—dust collection or not—PVC dust needs to be blown off occasionally so that it doesn't build up and solidify around the saw arbor. The problem seems to be worse in cordless tools, as I've found that a corded saw doesn't build up as much of the static charge that attracts the dust in the first place.

Assembly. I used a cedar clapboard as a story pole to accurately measure the rail sections. It's important to get a snug fit, and a clapboard is light and easy to hold while I'm working solo and recording measurements.

After cutting the nailers to length, I set each pair up on my worktable to lay out the balusters, starting from the center and working toward the ends with a spacer block to mark the baluster locations so that there would be a 3-inch-wide gap between balusters (by code, the space between balusters must be less than 4 inches). Having a long, flat surface at a comfortable height to work on made layout and guardrail assembly easy.

To secure the balusters to the nailers, I tacked them in place with 1 1/2-inch-long 18-gauge galvanized nails driven

through the nailers and into the balusters, one pair at the top and one pair at the bottom of each baluster. Then I drove two coated U2 1 1/2-inch trim screws through the nailers and into each end of the balusters. Here is where my choice of red cedar vs. fir balusters paid off, as I'm sure that driving so many fasteners into the end grain of fir balusters would have resulted in a lot of splitting and cracked pieces.

Installation

Instead of using mounting blocks to fasten the rails to the walls, I wanted to fasten the ends of the rails through the cedar clapboard siding and directly to the framing. To do this, I had to do a little "surgery" to open up the wall and install blocking, because I was unsure about the condition of the sheathing



Figure 4. Where upper rails are fastened to the house, the author removed siding and cut back drainage mat, WRB, and board sheathing to install blocking (A). He reinstalled the siding and used a multi-tool to cut pockets for the rails (B), leaving a small gap below for drainage (later, he sealed the tops of the rails to the siding with sealant). The stair railing has similar details, but the nailers aren't beveled, and the rail width is 2 $\frac{5}{8}$ inches for graspability; the ends of the rails and nailers are notched for drainage (D). The author fastened the baluster assemblies to the rails with trim screws driven through oversized pilot holes, which he later capped with Starborn PVC trim plugs (E).

and wall framing in the mounting locations (**Figure 4**).

After installing the blocking, I closed up the opening and reinstalled the siding. Then I used a multi-tool to cut out the opening in the siding after marking the rail profile.

I knew that the PVC columns had been accurately installed and everything was square where the rails are fastened to the columns, but that isn't always the case. To help support the railing, I screwed mahogany blocks to the underside of the bottom rails before installing them.

I used pocket screws to join the rails to the walls and the columns. While Kreg makes exterior pocket screws, the ones that I had weren't long enough to penetrate through the wall sheathing into the blocking or through the PVC column wraps into the PT posts. So I substituted 3 $\frac{1}{8}$ -inch-long U2 Universal construction #25 torque head screws, which have a similar head.

After installing the rails, I added the rail sections to the assembly, using 1 $\frac{1}{4}$ -inch-long U2 trim screws to fasten the nailers to the mahogany rails. First, though, I predrilled shallow oversized

$\frac{1}{4}$ -inch-diameter holes in the nailers spaced every other baluster apart. These holes are sized to fit Starborn Pro Plug system trim plugs, which I use to fill the holes. I trim the plugs flush with a sharp razor blade, so that they don't need to be sanded afterward.

To finish up, I masked off the railings and brushed on a touch-up coat of paint onto the nailers to erase layout marks. ❖

Emanuel Silva, a JLC contributing editor, owns Silva Lightning Builders in North Andover, Mass. He can be reached at silva.lightningbuilders@gmail.com.

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An Economical Cable Rail

RailFx's Express Mount is a smart, affordable, fast-to-install cable railing for wood decks

by Mark Clement

PHOTOS BY MARK CLEMENT

Many of my deck-building colleagues on social media, and perhaps many *PDB* readers as well, proudly claim that they've graduated their business above the lowly pressure-treated (PT) wood deck. I get it. Wood is hardly perfect. But for my market and customer base, were I to make the same leap to building with only composite materials, the amount of work I'd have to say "No" to would cut my annual revenue by half or more. Besides, I like building PT decks: I serve clients who are easy to deal with and who pay on time, I make the same profit margins I do with composite decks, and I get to do carpentry I enjoy, too. What's not to like?

Here on the East Coast, I work with PT southern pine. It is as inexpensive as

it is durable, which are the first things that draw my customers to it. Coming in a close second is that PT wood decking remains cooler in the summer than composite decking.

Where PT decks fall short, however, is their typical rail systems with 4x4 posts, 2x4 or 2x6 rails, and 2x2 balusters. They're no picnic to install, they're bulky enough to effectively act as a solid barrier between the deck and the yard, and they're ghastly to maintain. All my customers want alternatives, of which cable railing is usually the first ask—and, at somewhere around a \$10,000 line item, it's also usually the first upgrade that is cut from the budget.

Now, though, I have a new option to offer to customers: RailFx's Express Mount

Bracket System, the cable railing used on the project shown in this article. It's designed for wood decks and is a bridge between the nosebleed prices for standard cable railing systems and more modest wood-deck budgets. At about \$3,500 (my cost, no markup) for a 16x20 deck with three-tread stairs, it's around double the cost of the powder-coated aluminum balusters I often use but still one-third the cost of a full-fledged cable rail system—and I don't have to drill a million dead-on-accurate holes in 4x4s. The secret to the sauce is the system's surface-mounted brackets.

A Different Approach

With most cable railing systems, posts are drilled to accept cable, whether they are

An Economical Cable Rail



Figure 1. To extend the life of the railing fasteners, the author fastens the top rail to the guard posts from below (A). Between each guard post, he installs a 2x4 subrail (B) to lock the posts firmly in position. This is required to resist the tension the cables transfer to the posts. To streamline the install, he places bar clamps to hold the supplied drilling template to the posts with the bars facing away (C) from where he needs to work with the template (D).

wood posts drilled on site or metal posts drilled in the factory. On one end, the cable is slotted into a toothed fitting; on the other end, the cable is mounted with a turnbuckle-type of hardware. Rail-Fx also makes that kind of hardware, but the Express Mount brackets install to the exterior face of the guard posts for the cable to run through instead of drilled holes. Easy on the eyes from the yard and invisible from the deck, they're a low-risk, high-reward install.

Layout. Express Mount brackets require 4-foot post spacing; for greater spans, the system requires a cable brace centered between posts. Because the configuration will affect budget and process, that's a decision that needs to be made in your permit application and materials order. On this deck, 4-foot post spacing worked fine with a single corner post in each corner.

Takeoff. The lumber order differs a little when Express Mount is used, too. Because the tensioning force of the cable fittings is massive, a 2x4 needs to be placed between the posts, under the typical 2x6 cap. No bottom rail is needed. (I also like this look and, to add shadow lines, I may install the 2x4s on other deck rails that don't require them.) In this case, I installed the 2x6 cap first, toe-screwing up through the post. I then used it as a stop to install the 2x4 underneath it (**Figure 1**).

Installation

Bracket installation is guided by a drilling template. I prepped the template for a 36-inch guardrail by cutting 8 inches off the end using a miter saw. Plastic doesn't act like wood and tends to jump when being cut, so make sure that it's secure and held tight to the saw fence. Be mindful that the template now has a top and bottom, and you'll need to register the top to the underside of the 2x4 post spacer every time.

End-post brackets. Mark the center of the post, 1³/₄ inches. Then, opposite

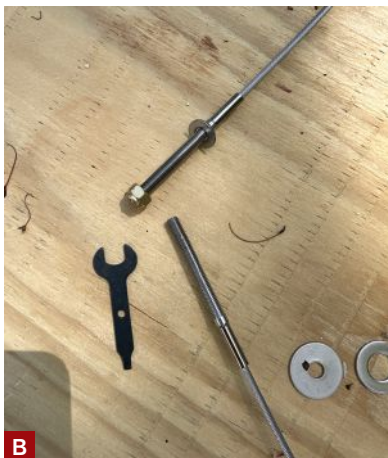


Figure 2. Following the template layout, the brackets are secured to the end posts with two screws per bracket. Next, a “threaded stud spacer” is inserted into each bracket (A). On a worktable, the author assembles a washer and nut on the threaded end of a cable (B). This assembly is fed through the “threaded stud spacer” (C). A flared, unidirectional “pull lock” (D) is then fit onto each cable and pushed into the bracket (E).

the cable run direction, mark a 1/2-inch offset from the centerline (2 1/4 inches total). Clamp the supplied drilling template here. The instructions show C-clamps, but I have bar clamps. It didn't take long to figure out the bar end of the clamp should face the deck, not my face.

Code language says that railing infill may not allow a 4-inch sphere to pass through it. That applies to cable railing but, because properly installed cable can deflect, the RailFx drilling template provides tighter spacing at 3 1/8-inch centers.

Intermediate and corner post brackets. For intermediate posts, you'd think that you would align the drilling

template flush to the edge of the post. In reality, however—and I don't know why—when the template is correctly placed so the brackets are centered on the post, the template's outside edge runs 1/4 inch past the edge of the post.

The corner brackets require a particular fastening sequence. Place a bracket using the template as a guide, then snug up a screw but don't set it until after you have set the screw on the other side. The brackets are durable, but make sure not to overdrive the screws.

I also noticed a difference between using a cordless drill and a cordless impact driver. The drill set softly but with enough force to crush some wood fiber

on the 4-by posts. Everything threaded through, but another 1/16 inch or so and I would have been backing out a lot of screws. The impact driver was easier to goose in just right.

Inside corner posts. The installation instructions have a provision for inside corners for deck rails that have them. Each side of an inside corner post is treated as an end post, and the drilling template needs to be offset down 1/8 inch on one side so the cables can pass by each other.

Setting Cable

If there was ever a project that called for setting up a large worktable, this is it.

An Economical Cable Rail

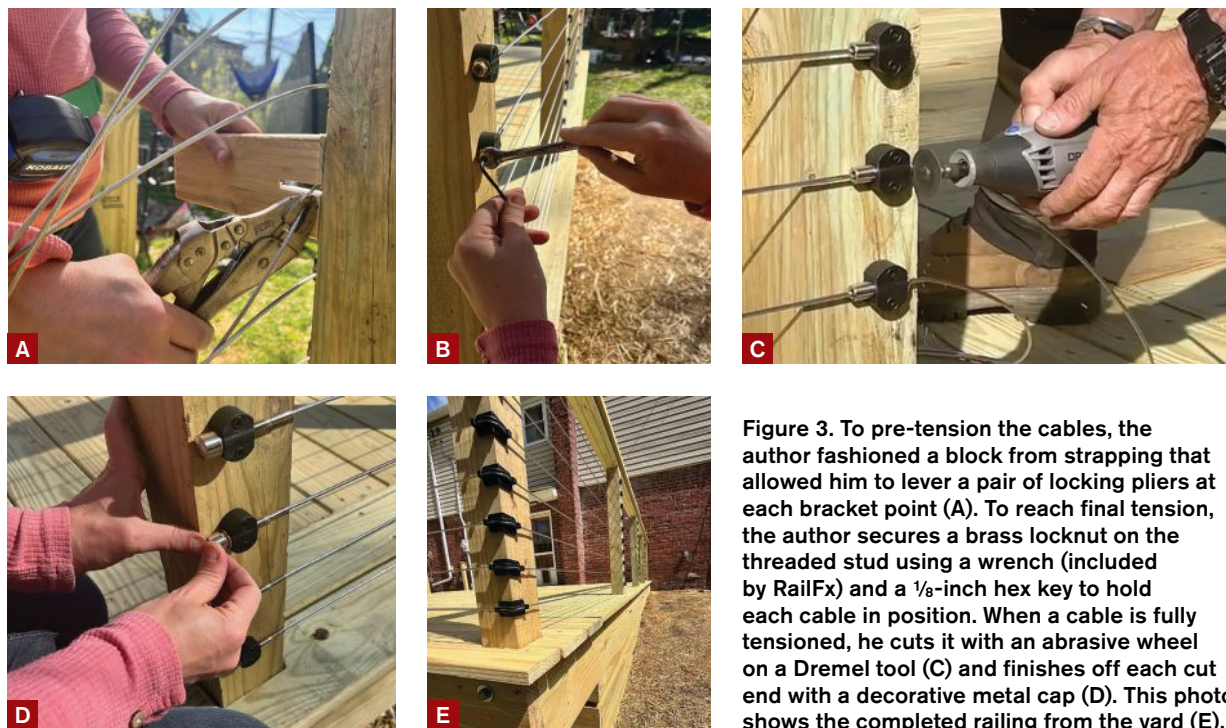


Figure 3. To pre-tension the cables, the author fashioned a block from strapping that allowed him to lever a pair of locking pliers at each bracket point (A). To reach final tension, the author secures a brass locknut on the threaded stud using a wrench (included by RailFx) and a 1/8-inch hex key to hold each cable in position. When a cable is fully tensioned, he cuts it with an abrasive wheel on a Dremel tool (C) and finishes off each cut end with a decorative metal cap (D). This photo shows the completed railing from the yard (E).

Once the cable, cable parts, and hardware come out of the boxes and bags, there are suddenly a hundred pieces, parts, nuts and washers, and other spare parts. My guess is that the same hardware bags are packed in with all the RailFx models, so there are mystery washers and parts not needed for Express Mount installation. All these pieces need to be organized in the same place. Two sawhorses, three 2x4 struts, and a sheet of 5/8-inch plywood do the trick for me. Call it a really big stand-up desk.

To set a cable, the threaded stud spacer first needs to be inserted into the post bracket (**Figure 2**). Next, at the table, we install a washer and nut on the threaded end of the cable. This assembly is then fed through the stud spacer in each intermediate bracket.

At outside corners, pull the cable all the way through one side of the corner fitting, then horseshoe it into the other side of the fitting. The cable will have twisted as it has been passed through the

various fittings. While the last gesture of snaking it through the corner post is kind of a snap fit, make sure the cable has very little play and is untwisted before doing so, or you risk putting a kink in the cable. We didn't kink any cables, but I can see a newbie yanking the stuff—like cranking all the stretch out of a nylon line with a trucker's hitch—and things going sideways fast. You can't just run out to the lumberyard and get another piece of cable, so it pays to be mindful of what you're doing.

At the end of the run, you'll have excess cable. Sleeve the pull-lock fitting on to it. This is unidirectional, so make sure the flared end is toward the end of the cable. The fitting is similar to a zip tie: Once it's in, it's in. And while that's a little all-or-nothing, if something does go wrong—for example, we had a strand of cable unspool a little that we needed to get past—the kit includes a tool that disengages the teeth such that the fitting can slide freely along the cable.

Then it's a matter of hand-snugging the cable and fitting.

Pre-tension cable. RailFx sells a product for pre-tensioning cable, but one didn't come with my order. Making a tool out of a piece of strapping (or furring strips, something I usually have on hand for making jigs, braces, and other assemblies) was easy. Give the cable ends a quick crank to snug them up (**Figure 3**).

Tension the cable. RailFx calls for 225 pounds of tension and, while there are tension testers out there, I'm happy with about 1/4-inch deflection—tight but not too tight. RailFx also calls out a tensioning sequence, starting with the center cable, then moving up one, then down one until all cables are snugged up. We found that we still had to tune individual cables to make all the cables the same tension. If you're installing the cable in cold weather, it might be worth putting a line item in the scope of work to return when temperatures warm up to readjust the cables, which, technically,



Figure 4. For stair rails, the bracket must be positioned on the post at the same angle as the railing. To accomplish this, the author cut a block at this angle, which he used to sight the angle of the bracket (A). Each angled stair-rail cable passes under the corresponding level cable on the deck (B).

will elongate when it gets hot. It might also be worth mentioning to customers that this condition is possible, and that there's nothing wrong with the system. It might not happen, but if it does, you're covered.

Cut the cable. My kit shipped with what appears to be an abrasive grinder wheel and mandrel-like thing for use with a cordless drill. I couldn't get it to work. I'm sure it's my fault—one of those glitches between the instructions and real life, but no matter; I already had a Dremel rotary tool with an abrasive wheel out anyway, and it works great for zapping the cable ends. I don't wear safety glasses all day, but for a task like this, I always wear them. That thing is spinning a billion rpm, and it doesn't

have a guard to catch a fleck of abrasive moving at light speed toward your face.

Also, read your item list when you're ordering materials. If you plan to install more than one of these systems, keep track of the template, because it costs \$40 to \$55, depending on where you shop.

Finally, pop on the caps.

Stairs

As all instructions are wont to do, they tell you what to do but often leave out how to do it. For our stair configuration, the end post of the horizontal run was also the end post for the angled run down the stairs, and it took some head scratching to figure out how the cables crossed. Simply, the cable through the

angled Express Mount Brackets passes under the cable in the level brackets (**Figure 4**).

As for matching the stair angle, our solution was to cut a small guide block at the angle of the stair and match it up to the orientation of the disc on the post. We had to set the top bracket using a tape measure but were able to use the drilling template for the remainder. The rest of the installation sequence is the same as for level parts. Make sure to place the bottom bracket-set the same distance from the top rail as the top bracket-set so everything is parallel. ❖

Mark Clement is a deck builder and remodeling in Ambler, Pa., and author of The Carpenter's Notebook. @myfixituplife

A Better Top-Rail Corner



Miters for rail caps look great when first cut. The problem, however, is that despite how tight the miter is, wet wood—especially pressure-treated southern pine—changes shape as it dries. Typically, the toe (the long point of the miter) moves toward the other long point, while the heel (the short point) recedes, opening a gap. It takes a couple of weeks, but the result is inevitable. To avoid this unfortunate result, I've landed on what I call a "stepped joint" for my top caps. Essentially, the stepped pattern is a series of butt joints. The wood still moves, but it all moves at the same rate, so the gaps are consistent and don't look like a mistake. —M.C.

DAY'S END

Focus on good design and clever construction



This ipe deck won first place in the “Wood Deck Under 25K” category in the North American Deck and Railing Association’s 2023 deck competition.

From Afterthought to Backyard Focus

by Brendan Casey

Our client in Maryland had an old, decrepit deck that needed—at minimum—rejuvenation. Upon inspection, it was deemed beyond repair. Deciding to proceed with a full replacement, the client was vehemently opposed to composite decking and adamant about using ipe.

We wanted to use only full-length boards, eliminating unsightly and po-

tentially hazardous butt joints, so we opted for a herringbone pattern with an outward spray that gives a visual illusion of a larger deck. We then dressed the deck up with a soft curve on the front.

The client opted for white rails to contrast with the dark, oiled wood. Large, 6x6 rail post covers enhance the appeal of the cocktail rail while black round

balusters open the westward view of adjacent farm fields and beautiful sunsets.

We used ProWood critical structure treated lumber to create a substructure having a longevity commensurate with the Brazilian walnut decking. ❖

Brendan Casey is the owner of Casey Deck and Fence in Frederick, Md.

PHOTOS BY BRENDAN CASEY AND ROBB BLANTON