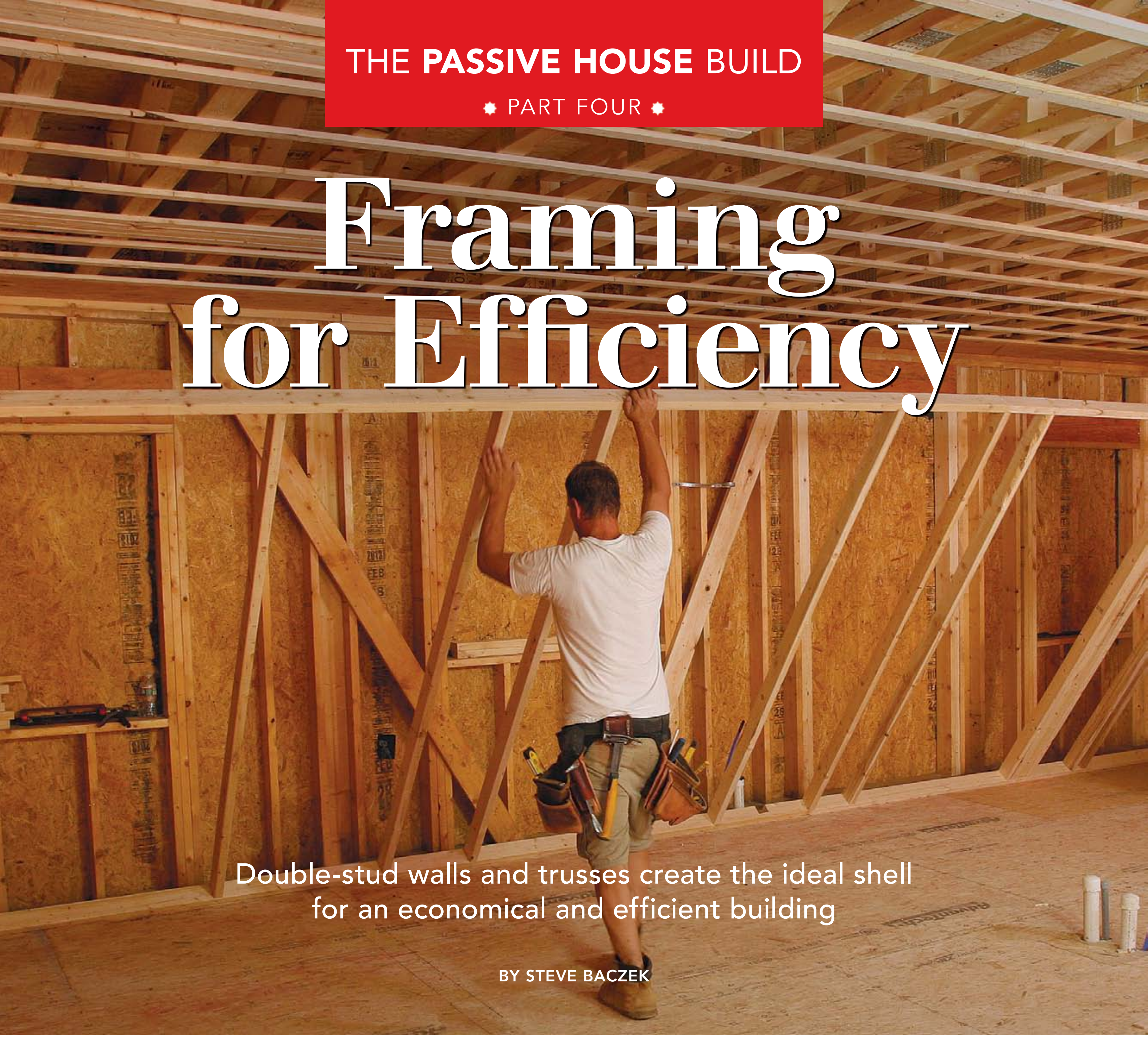


Framing for Efficiency

Double-stud walls and trusses create the ideal shell for an economical and efficient building

BY STEVE BACZEK

The frame of a Passive House may not be as exciting as the thick layers of insulation, the high-tech mechanical systems, or the triple-glazed windows, but it plays a very important supporting role—pun intended—in achieving success.

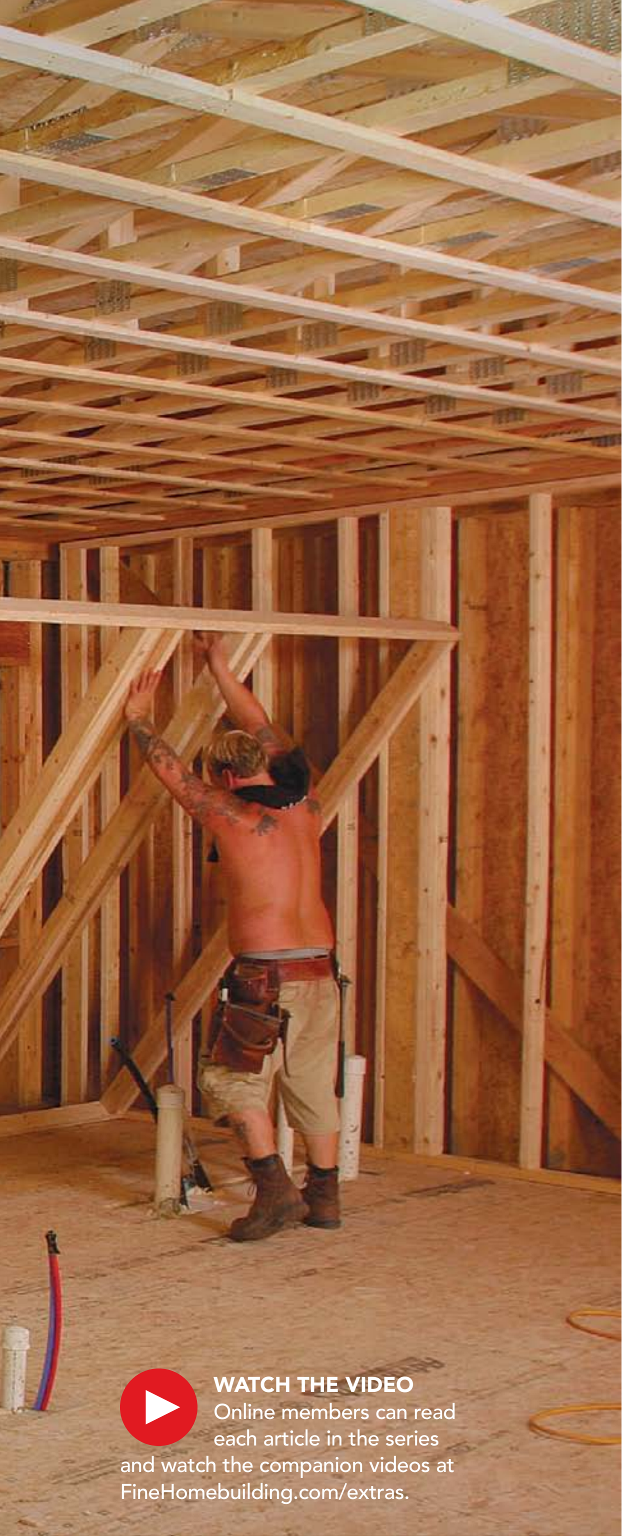
I chose every component of the framing package in this house with care, and for a specific reason. The exterior sheathing provides airtightness, the double-stud walls and raised-heel roof trusses are a cost-effective means of supporting or containing above-average levels of insulation, and the floor trusses easily span the open floor plan and provide plenty of room for the many ducts necessary for the ventilation system and supporting mechanicals.

Two walls, two air barriers

The chief function of the double-stud walls is to hold insulation. Measuring 14 in. from the interior face of the 2x4 inner wall to the exterior face of the 2x6 outer wall, the wall assembly provides a 5-in. thermal break between halves.

In addition to the taped sheathing seams and the picture-frame-style application of Tremco acoustical sealant, the wall is redundantly air-sealed with a 4-in.-thick coat of closed-cell foam sprayed against the inside face of the sheathing. The remainder of the cavity is filled with 10 in. of dry, dense-

Drawing: John Hartman



WATCH THE VIDEO
Online members can read each article in the series and watch the companion videos at FineHomebuilding.com/extras.

packed cellulose, bringing the wall assembly to an overall thermal resistance of about R-52.

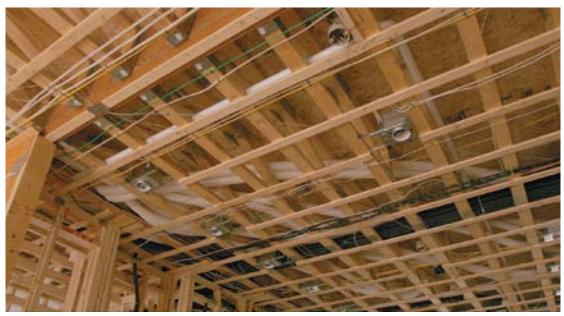
Some energy-conscious builders and architects might wonder why anybody would design a building that represents the height of energy efficiency, and specify walls with 2x6 studs spaced 16 in. on center and structural headers over every window—details that fly in the face of advanced-framing techniques.

Given that these walls are thermally broken by the cavity between the inner and

MULTIPURPOSE COMPONENTS

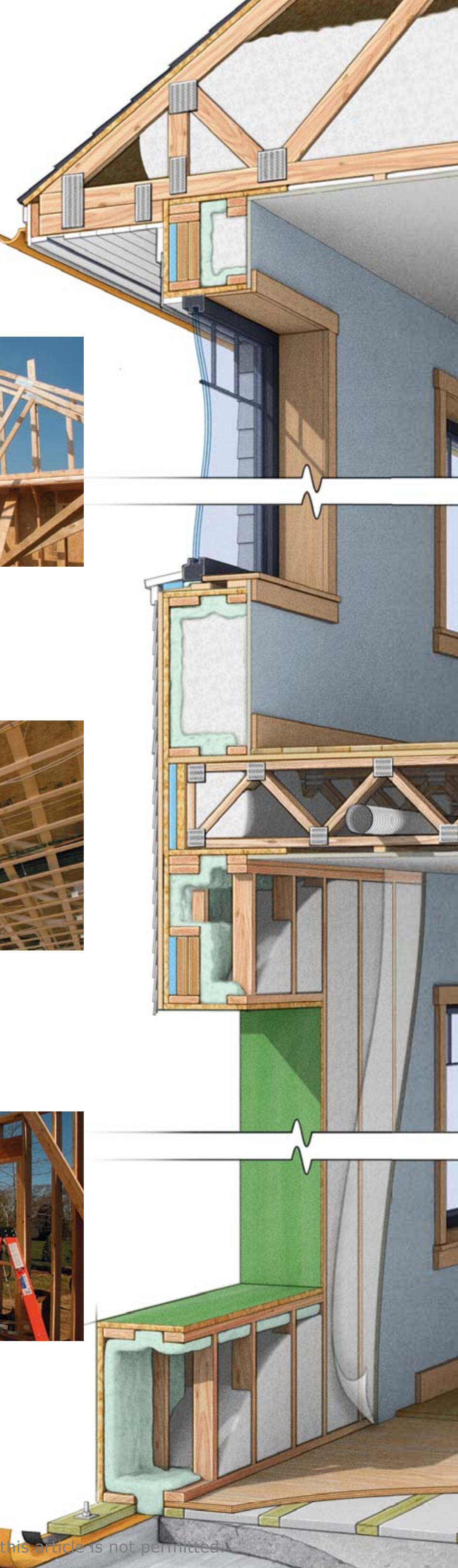
Because the attic won't be used for anything but insulation, raised-heel ROOF TRUSSES ▼ were a quick and cost-efficient means of putting a lid on this house and of providing a way to hang and finish the ceiling air barrier before partition walls went in.

The INTERIOR FRAME ◄ provided the typical mounting surface for fixtures and finishes, but it also served as a barrier to contain the cavity insulation before the final wallboard was installed.



Open-web FLOOR TRUSSES ▲ offer long spans and the ability to run mechanicals between the first and second floors—a saving grace in a house where the attic is off-limits and there is no basement.

The OUTSIDE FRAME ▲ supports most of the floor load and all of the roof load. It also holds part of the primary air barrier, and with the help of diagonal bracing, provides the necessary windshear resistance for this coastal site.



outer stud walls, the only advantage to framing with studs set on 24-in. centers would be a small cost savings in lumber. But on this house, which is located in a coastal high-wind zone, that small savings would have been offset by the additional structural measures required of a wall 24 in. on center.

For the headers, all of which are thermally broken with a piece of 2-in.-thick rigid foam, I have found that consistency pays even if it results in a minor energy penalty. I try to minimize decisions for the builder to increase the likelihood that the things I need to be done right will be done right. Also, for what it's worth, the high-performance triple-glazed windows necessary in a Passive House are two to three times the weight of a typical double-glazed window, so a robust window frame is a good thing.

At the top of each wall, bridging the gap between the interior and exterior stud walls, is a rip of ¾-in. plywood, which has a couple of duties. First, it caps and isolates the cavity space of the double-stud wall. Second, it overhangs the interior wall plate, providing a means to connect the interior ceiling to the wall assembly, maintaining the continuity of the air barrier. A third function is one I hadn't planned for but that the builders found very useful: a walking surface. By attaching bracing below the plywood flange, the builders were able to walk the walls easily while installing the floor and roof trusses.

Strong, wide-open floor framing

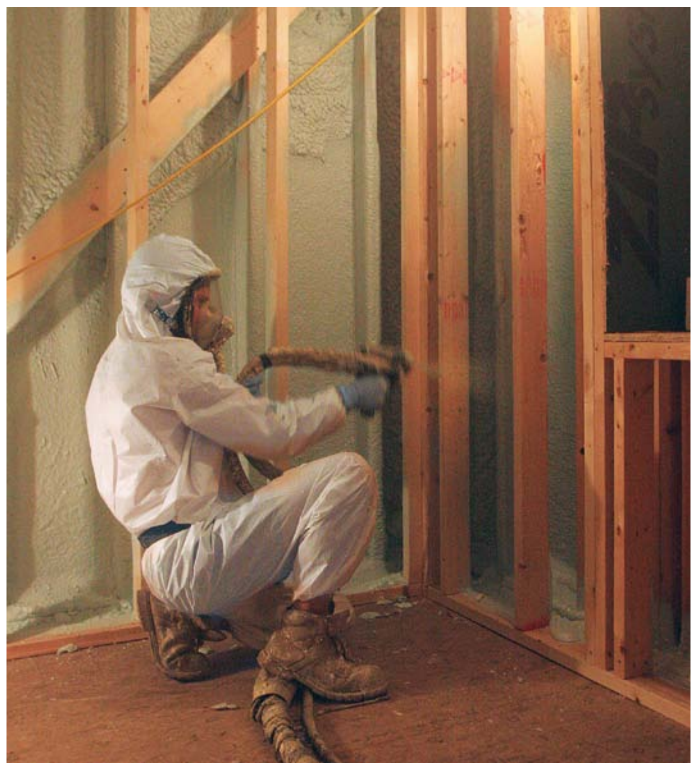
One of my goals in designing a successful Passive House is to get as much of the structural load from the floors and roof as possible to the outside of the house. This allows me to keep an open floor plan, which is helpful in moving conditioned air around the house. To achieve this open floor plan, I needed

The construction sequence is guided by

PHASE 1 Primary air barrier

The primary air barrier in this house is formed by the slab, the exterior sheathing, and the plastered ceilings below each roofline. Backed up with a thick, continuous bead of Tremco acoustical sealant at all seam edges, the 7⁄16-in.-thick Zip System OSB was chosen because of its butyl-based seam-sealing tape, which partners with the water- and air-resistive barrier that's bonded to the exterior side of each sheet. The rough openings at windows and doors are left uncut so that the builders can test the airtightness of the shell before moving to the next step of the process.

TEST RESULT
83
cfm50



PHASE 2 Secondary air barrier

A 4-in.-thick coat of closed-cell polyurethane-foam insulation is sprayed on the inner face of the wall sheathing. Running continuously from the subslab insulation to the top plates, the foam performs a couple of functions. First, it acts as a secondary air barrier should there be any air leakage through the sheathing seams or the acoustical sealant. Second, with an insulation value of roughly R-27, it ensures that the inner surface of the sheathing remains above the dewpoint, eliminating the risk of condensation in the extrathick wall assembly.

TEST RESULT
46
cfm50

engineered floor joists, which can span longer distances than dimensional lumber.

Although it's largely heated by the sun in the winter, a Passive House still relies on mechanical systems. In addition to the standard plumbing and electrical, this house has lots of ductwork for ventilation. Without a basement or conditioned attic, just about everything has to run through the floor joists that support the second level.

This combined need for a long span and room for lots of mechanicals made open-web floor trusses an easy choice. They are cost-effective and sturdy, and they eliminate concerns about the placement of penetrations or the need for mechanical chases.

This attic is for insulation

Because the attic will hold 24 in. of loose-fill cellulose, I didn't even attempt to provide storage or living space up there. Forfeiting any claim to the attic made roof trusses an easy choice compared to a traditional stick-built roof, and allowed me to get the house dried in and prepped for the uppermost portion of the primary air barrier: the ceilings.

To ensure that this ceiling air barrier—a layer of veneer-plastered blueboard—would be continuous, the plaster installers hung and finished the ceiling before any interior partition walls were framed. That approach not only eliminated the hundreds of linear feet of joints between top plates and ceiling joists—all of which are weak points in an air barrier—but it made the hanger's job easier because full sheets of blueboard could be used. □

Steve Baczek is an architect in Reading, Mass. Construction by Dunhill Builders, Osterville, Mass (dunhillbuilders.com). Photos by Justin Fink.

blower-door tests

177 cfm50

The airtightness requirement for Passive House certification is less than or equal to 0.6 air changes per hour at –50 Pa (ACH50). This number can also be expressed as 177 cubic feet per minute at –50 Pa (cfm50). I prefer to use the cfm figures because the larger number makes any changes in performance easier to track.

PHASE 3 Windows and doors

Even a house with the best windows and doors in the world, installed perfectly, is leakier than a house without any openings. For that reason, once the sheathing has been cut away at rough openings and the windows and doors are in place, the air-leakage numbers will creep up slightly. Also, because most penetrations should have been made at this point, this test result should be a fairly accurate prediction of the final result once the house is complete.

TEST RESULT **106 cfm50**

PHASE 4 Insulation and mechanicals

With the more-delicate control functions handled as close to the outside face of the building as possible, the space between the outer and inner stud walls and the space in the attic offer an opportunity for more-cost-effective insulation to provide the bulk of the thermal resistance. Cellulose insulation is packed into the walls to a density of 3.6 lb. per sq. ft., adding R-37 to the overall thermal resistance of the wall assembly. In the attic, loose-fill cellulose is piled to a depth of 24 in., providing an R-92 insulated lid above the ceiling air barrier of the house. At this stage, minor leakage typically stems from final work on mechanical rough-ins and other last-minute tweaks.

TEST RESULT **110 cfm50**