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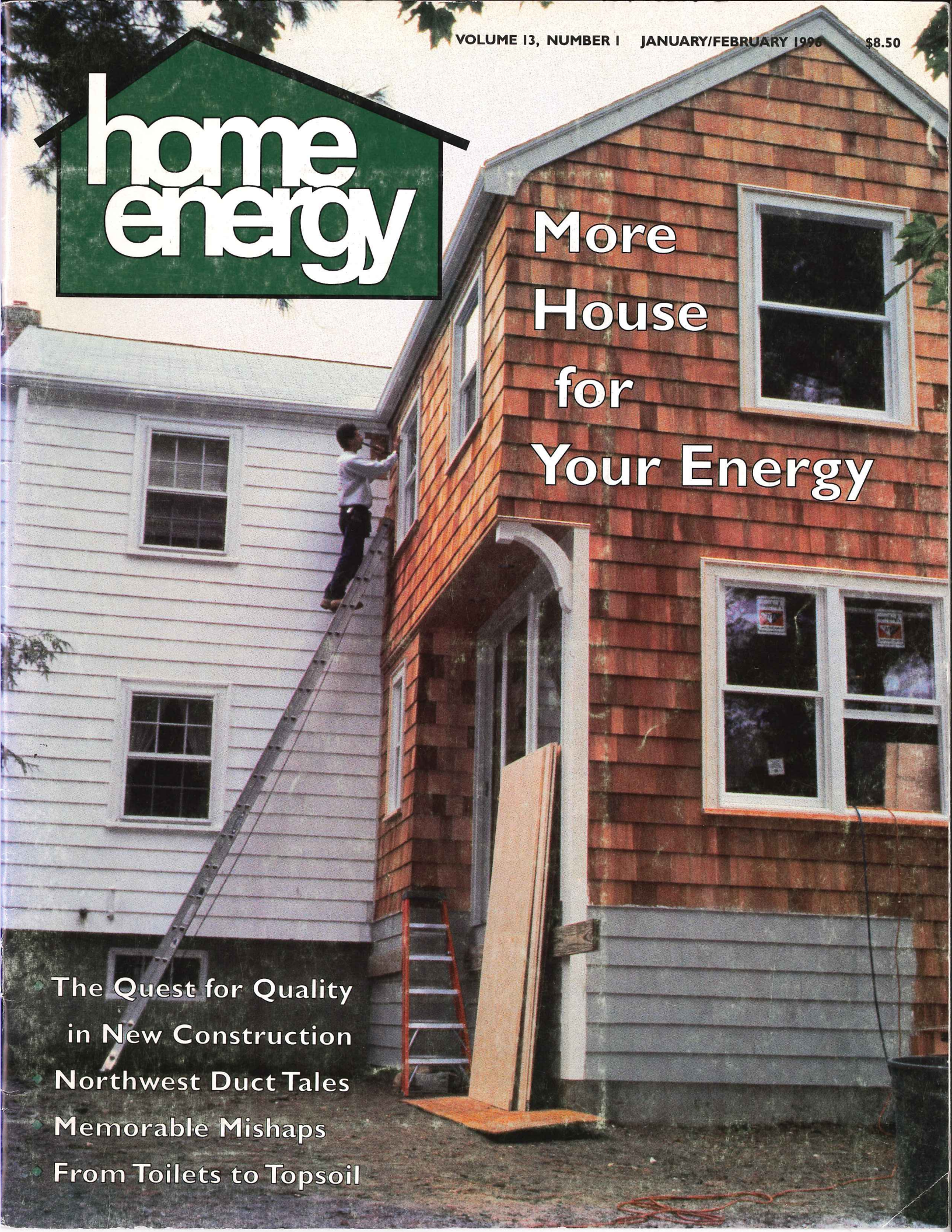
home energy



More House for Your Energy

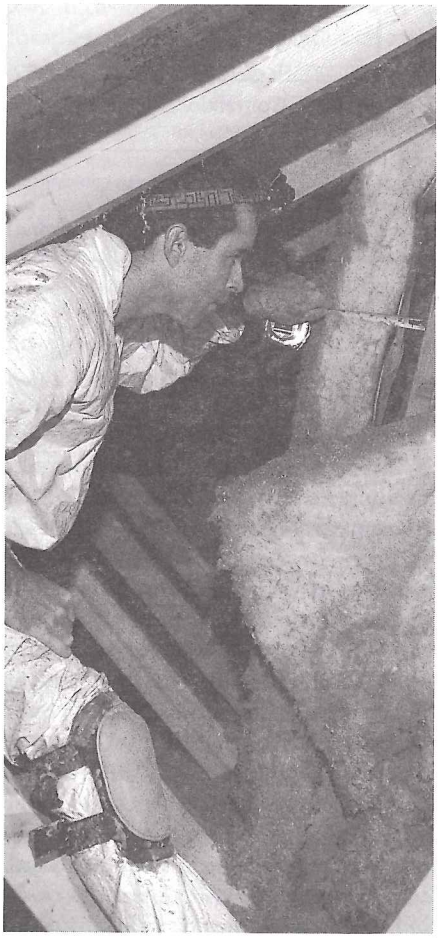
- The Quest for Quality in New Construction
- Northwest Duct Tales
- Memorable Mishaps
- From Toilets to Topsoil

Creating Quality in New Construction:

A Practitioner's Perspective

by Michael Uniacke

Twenty-five years after the first energy crisis, most newly constructed homes still lack the most basic energy conservation details.



RANDY SWEDLUND

A visit to homes under construction will reveal that builders are rarely utilizing the most basic energy-efficient building and design principles. Construction supervision on a custom or tract subdivision is an appearance- and schedule-driven process, and details such as the quality of the trim work, gypsum board finish, paint, cabinets, and final cleanup most often indicate a quality job to both the construction supervisor and the consumer.

The housing industry needs to redefine a quality job to include a high quality insulation system, airtight ducts, energy-efficient framing, and simple solar control strategies—benefits that the home buyer doesn't "see" until the utility bills come in.

Elements of Quality Construction

Quality work on the job site starts with a clearly written set of specifications from the builder that includes framing and insulation details, standards for airtightness of distribution systems, and glazing selection. Although this does not guarantee that quality work will be done, it at least points the crews in the right direction. Detailed specifications also create accountability and provide an even playing field during the bidding process.

The general contractor also needs to give subcontractors clear information well before the job begins. For instance, a framer needs to know details during the bidding, not during wall erection. When clear construction details and expectations are coupled with informed supervision, many energy-efficient elements can be incorporated into the building process at little or no additional expense and only minor disruption of the construction process. Other energy-efficient practices and materials do cost builders more, but also provide large paybacks in reduced energy bills and increased comfort.

Framing

Some carpenters are still framing buildings with conventional channels at exterior corners and at the intersection of interior and exterior walls. There are framing techniques that reduce the amount of lumber used in a house and permit insulators to do a better job. Twenty-four-inch on-center framing, three-stud corners, two-stud corners with drywall clips, ladder-back blocking, and insulated headers are a few approaches that can save money and significantly increase the effectiveness of the insulation system (see Figure 1).

Airtight Ductwork

In the last 150 new homes I inspected, all of the duct systems leaked, and about one in four had catastrophic duct leakage. One local builder who specified an airtight duct system, but didn't test it, received a complaint from the homeowner about high utility bills. The builder then tested the ducts and found major return leaks in the crawlspace. The lesson the builder learned was that if he doesn't test, he may not be getting what he pays for from the contractor.

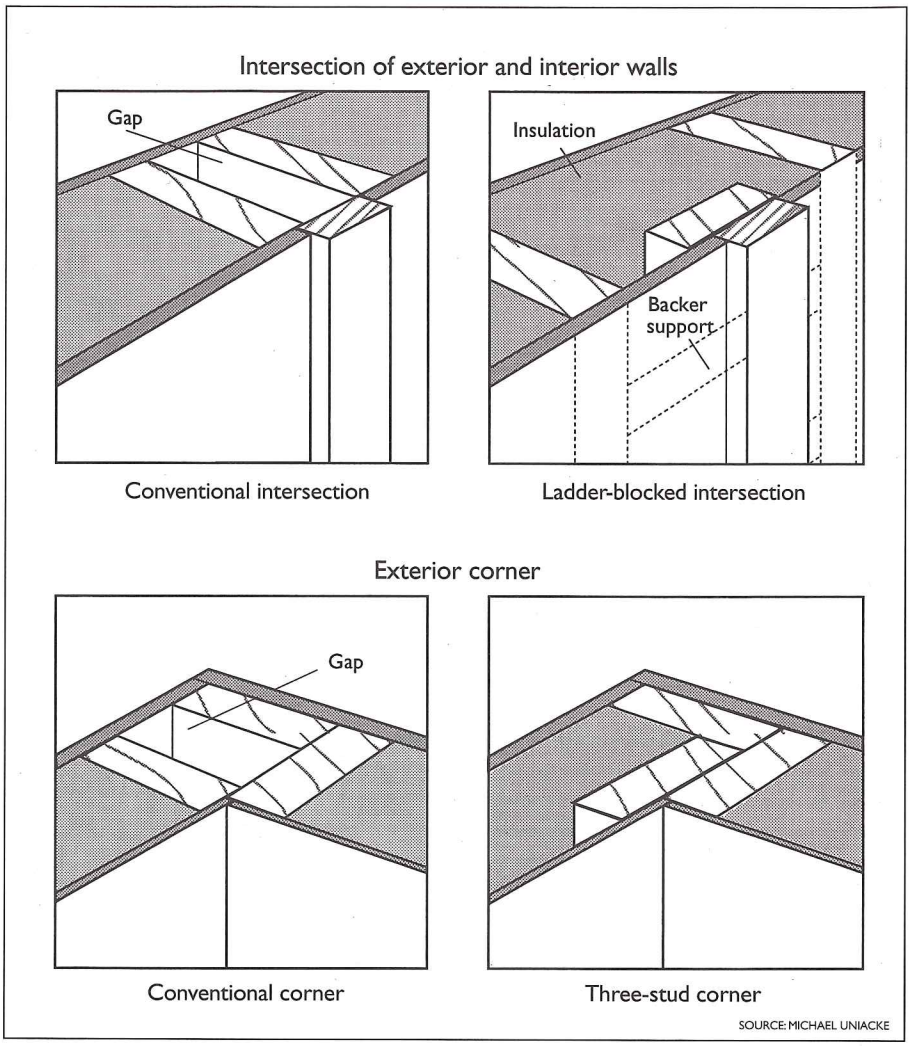


Figure 1. Many contractors still use conventional construction procedures to provide nailing surfaces for drywall at intersections. These methods create gaps that cannot be insulated (see figures to left). The figures to the right illustrate ways to avoid such gaps and allow complete insulation.

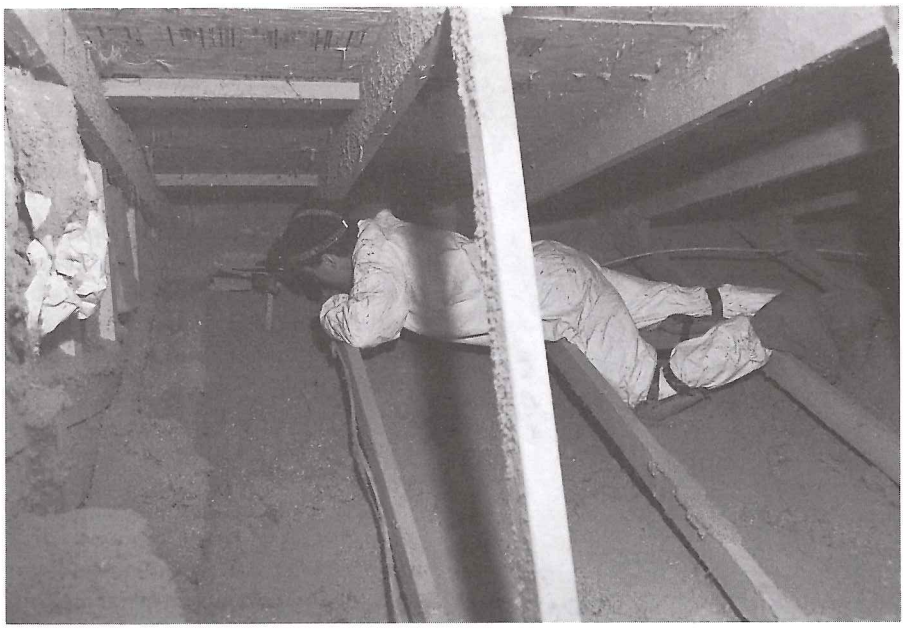
The HVAC contractor is responsible for the airtightness of the entire air distribution system. This includes framed cavities, such as platform return plenums and panned joists. A duct airtightness test can often be performed prior to installing gypsum board. This allows the installer to seal any discovered leaks. A test just before occupancy will not allow as much sealing, but can help to maintain quality control.

The North Carolina Alternative Energy Corporation has developed a standard target for duct leakage in new construction. The limit is determined in cubic feet per minute at 25 Pascals test pressure (CFM_{25}). It can be calculated for each house by multiplying the livable floor area by 3%. For example, a 2,000 ft^2 home should have no more than 60 CFM_{25} of leakage in the air distribution system (2,000 x .03 = 60).

Telling someone to seal up a duct system is entirely different from training them to do the job correctly and following up with a test. HVAC contractors need numbers generated by a blower door or duct tester that give them feedback on how well they are doing.

Insulation

Insulation needs to be treated like an essential house system, not just a necessary evil. Tremendous gains can be made by simply achieving the R-values specified on the plans. Insulation crews need to understand that there is a large energy penalty when they leave low



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Thorough inspections are vital for quality control. Here the author crawls over a joist to measure the depth of blown-in insulation.

spots or gaps that allow air to flow freely around the insulation.

It's easy for insulation crews to cut corners if their work is never checked. The builder should require a certificate of coverage from the insulation contractor and inspect each insulation job to ensure that the insulation crew took all of the following steps:

- Use sprayed-in insulation (wet-spray cellulose, blown-in fiberglass blankets, or a sprayed-in foam) instead of batts in exterior walls.
- In the bathroom, insulate behind fiberglass tub enclosures when these are installed against exterior walls.
- Insulate dropped ceilings over closets or bathrooms.
- In homes with vaulted ceilings, insulate kneewalls.
- Insulate the attic access hatch if it is in conditioned space.
- Insulate the rim joists in two-story homes.
- Bring insulation into contact with the subfloor in crawlspaces.
- Use correctly sized wire batt hangers for engineered wood I joists.

When insulation is not thoroughly inspected by the builder, insulation contractors do not get feedback on their work and quality often suffers. Other trades—for instance, wiring, plumbing, or roof sheathing contractors—are usually held to a higher standard of accountability. Thus, the actual effective R-value of installed insulation may be well below the value specified on the plans.

A thorough inspection involves a complete visual examination of all attic spaces, walls, and crawlspaces. Inspectors must climb into the attic and through the crawlspace. Simply lifting the access hatch and peering into the attic does not constitute an inspection. The harder it is to inspect a space, the greater the likelihood of insulation problems.

Basic Air Sealing

Air sealing efforts should focus on getting the big leaks and controlling pressure differences in the house (see "Air Sealing in Occupied Homes," *HE* Nov/Dec '95, p. 33). Pressure differences can occur due to duct leaks and an inadequate number of returns. Sealing the ducts and air handler, providing enough returns or pressure relief (transfer grilles) for closed-off rooms, and correctly sizing the ducts will help keep the house operating at a neutral pressure (see "Duct Improvement in the Northwest," p. 21).

A blower door test provides vital information to both the general contractor and the technicians doing the air sealing work. The test does not take long to perform, and the feedback that the test provides to workers is invaluable. Simple air sealing techniques, coupled with insulation that assists in air sealing, should easily reduce leakage in a new house to less than 3 air changes per hour at 50 Pascals (ACH_{50}).

Effective air sealing will only occur on a widespread basis if the process is simplified. Subcontractors make money by doing the same thing day in and day out. Every time a step is added to the process there is a greater risk that something will be missed.

The construction process can be simplified by using materials with inherent quality control, such as cellulose, blown-in fiberglass blankets or sprayed-in foam insulation. The performance of fiberglass batts depends too much on the quality of the installation. Batts can be installed in such a way that their rated R-value is compromised by as much as 30%–60%.

Wet-spray cellulose, spray foam, or alternate wall systems combine air sealing with insulation. These systems should be coupled with sill sealing and applying an expansive foam around windows and plumbing and electrical penetrations in top plates (see "Urethane Foams and Air Leakage Control," *HE* July/Aug '95, p. 25).

If lights are to be recessed, insulation contact airtight (ICAT) recessed cans help to maintain an airtight shell and should be used. Insulation can be safely blown over these recessed cans.

Sealed combustion appliances eliminate the possibility of backdrafting, regardless of pressure imbalances in the house. Thus they provide inherent safety for the occupants.

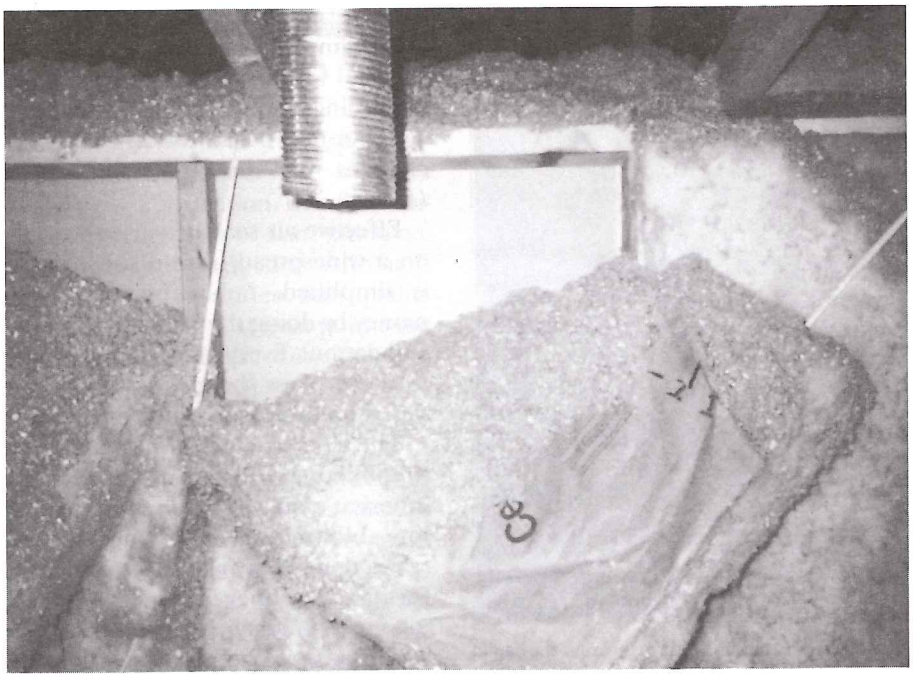
By specifying materials like these, the builder can be more certain that the result will be a quality job.

Ventilation

Mechanical ventilation is necessary if the new house is to be healthy and comfortable. In mild climates, a simple, quiet, and effective bathroom fan can cost as little as $90. In more severe climates, heat and energy recovery ventilation systems should be used.

Solar Control

Solar control strategies should be utilized in the design process. Air conditioning loads can be reduced dra-



MICHAEL UNIACKE

This poorly installed fiberglass batt hangs off the kneewall above a dropped ceiling. The metal pipe visible toward the top of the photo is a vent that was never actually connected to the bathroom fan it was intended for.

matically if solar gain is kept out of the house through building design and shading strategies, including overhangs, shade screens, trees, and low-e windows with low shading coefficients.

If a contractor performs a heating and cooling load analysis on a house using the Air Conditioning Contractors of America's (ACCA) Manual J, the importance of controlling solar gain becomes very obvious. The rate of summer heat gain through an R-19 wall in Prescott, Arizona, is 0.9 Btuh/ft^2, but it is 72 Btuh/ft^2 for east- and west-facing glazing. This means that 80 times more energy flows through a ft^2 of glazing than through a ft^2 of insulated wall area.

In climates with more heating load than cooling load, suntempering (increasing south-facing glazing up to 7% of the floor area) is a wonderful strategy to produce a more comfortable and energy-efficient home. A designer simply has to know how to orient the house correctly.

Properly Sized Equipment

Most air conditioners are oversized. A properly sized air conditioning system can help offset the cost of duct sealing and duct airtightness tests. Not only does oversized equipment hide problems with the building shell and ducts, but it is also less efficient due to short cycling. The HVAC contractor should perform a Manual J thermal analysis and use Manual D to size the ductwork (see "Bigger Is Not Better—Sizing Air Conditioners Properly," *HE* May/June '95, p. 19).

How Can We Make Quality Happen?

Improving the quality and efficiency of new construction requires the cooperation of all of the people involved in the process of building and buying a home. The elements and value of energy efficiency need to be understood by architects, builders, contractors, subcontractors, and consumers. A comprehensive effort at technology transfer is needed to build an effective information loop for all of these participants. This effort should focus on getting the basics right in all new building stock, not on expensive and complex methods to build superefficient houses.

The way to accomplish this is through high-quality training and education. Technology transfer needs to reach architects, builders, contractors, home buyers, and realtors.

Colleges and Universities

Universities and community colleges should teach building science courses, particularly for students who are entering the building fields. Some universities are already doing this. For instance, within Portland State University's mechanical engineering department students can choose an emphasis on building science. These students take courses in HVAC design, commercial and residential building analysis, and fundamentals of building science. The courses bring students out in the field to apply what they learn in lectures to actual buildings.

Community colleges are another important setting for teaching students about energy use in buildings. Many students go to community colleges for two years to become technicians in the building and HVAC trades. Lane Community College in Eugene, Oregon, offers courses in building technology, which incorporate hands-on training in diagnostic tools and skills.

Programs like these are still much too rare, even though there is clearly a great need for them. They should be encouraged and funded at other schools.

Utilities

Utilities have been in the energy efficiency business for many years and can play an important role in increasing efficiency in new construction. The problem with many utilities' traditional approach is that the battle is often waged in offices and not in the field.

Many utilities depend too much upon prescriptive programs, demonstration houses, and thermal analyses. Reality is what happens in the field, not in a software run; the job site and a computer simulation should never be confused.

Some utility rebate programs encourage investment in high-efficiency equipment as a stand-alone program, without any performance testing on the air distribution system. This is a prime example of the failure of technology transfer. It leads the homeowner to think that the equipment is all there is to it, and forces contractors to compete on that level. But if the ducts are very leaky, an investment in an air conditioner with a high Seasonal Energy Efficiency Ratio (SEER) or a furnace with a high Annual Fuel Utilization Efficiency (AFUE) will produce minimal savings.

Recently, one utility spent $800,000 on a demonstration house, filled with expensive state-of-the-art technology. That budget could pay for a lot of training for builders, HVAC contractors, architects, realtors, and homeowners. Utilities should make training programs, like the Energy Crafted Home program in New England, a larger part of their conservation efforts in residential new construction.

Learn from the Pros

Builders and subcontractors need high-quality building science training. Contractors should be trained in both the practices and the principles, so they can use this information in the field to make decisions concerning construction details and to supervise subcontractors.

We don't need to reinvent the wheel. We should learn from programs that work. The Florida Solar Energy Center and the North Carolina Alternative Energy Corporation's Duct Doctoring classes have excellent programs that deal with the contractors' reality. The Washington State Energy Office has also done some remarkable work with building codes and training programs. The City of Austin's Green Builder program is another extremely effective program.

The most successful training programs make a strong connection to the job site. The more time spent teaching professionals to think independently, the greater the likelihood of success. Recently at a construction site, I pressurized a duct system with a Duct Blaster and then filled it with smoke from a theatrical machine. Seeing the smoke blow through the cracks and leaks in a supposedly airtight duct system created a paradigm shift—the duct installation crew suddenly understood what the builder was after.

Trainers must understand the design and construction process, and they must also empathize with their audience. Trainers should subject their own work to performance tests. If a training is successful, the participants should change their practices in the field.

Marketing

Consumers will pay for superior systems only if they can see the benefits. Marketing training helps builders to feel confident that they will get a return on their investment in quality.

More progressive builders already incorporate insulation inspections, leakage standards and testing for duct systems, air sealing, efficient framing details, and controlled ventilation—and then capitalize on the fact that their competitors are deficient in these areas.

For marketing to work, potential home buyers need to be educated about the benefits of high quality efficient construction. Government, utilities, nonprofit organizations, and industry groups can all help to educate consumers.

Builders also have a role in educating consumers. Some builders hold workshops for people who are planning to have a home built, to inform them about what makes a quality job. A customer who is educated about energy, health, and safety issues will be the best customer for a quality builder. This customer will understand that a lower bid offered by a competitor is for a different job.

Quality HVAC contractors are also beginning to hold workshops for their clients—the builders. It is vital that participants in different parts of the building process educate one another about the definition of quality work.

MICHAEL UNIACKE

Two obvious energy-wasting problems are evident with this new duct: a disconnection and poor insulation.

Technology Transfer Is the Key

The bottom line is that the people who really need the information about quality building are often not getting it. Quality will be built consistently into homes only when we acknowledge the difficulties and obstacles in the construction process and begin to show more empathy with the mainstream builder. The building science community should be championing products that are easy to install and inherently efficient. The real challenge is not to squeeze more efficiency out of an energy-efficient home, but to transfer our current understanding of home performance to the mainstream building community.

Michael Uniacke is the owner of Residential Energy Consulting in Prescott, Arizona, which specializes in educating builders, architects, HVAC contractors, and consumers on quality construction.