

MAR/APR 2011



Home energy

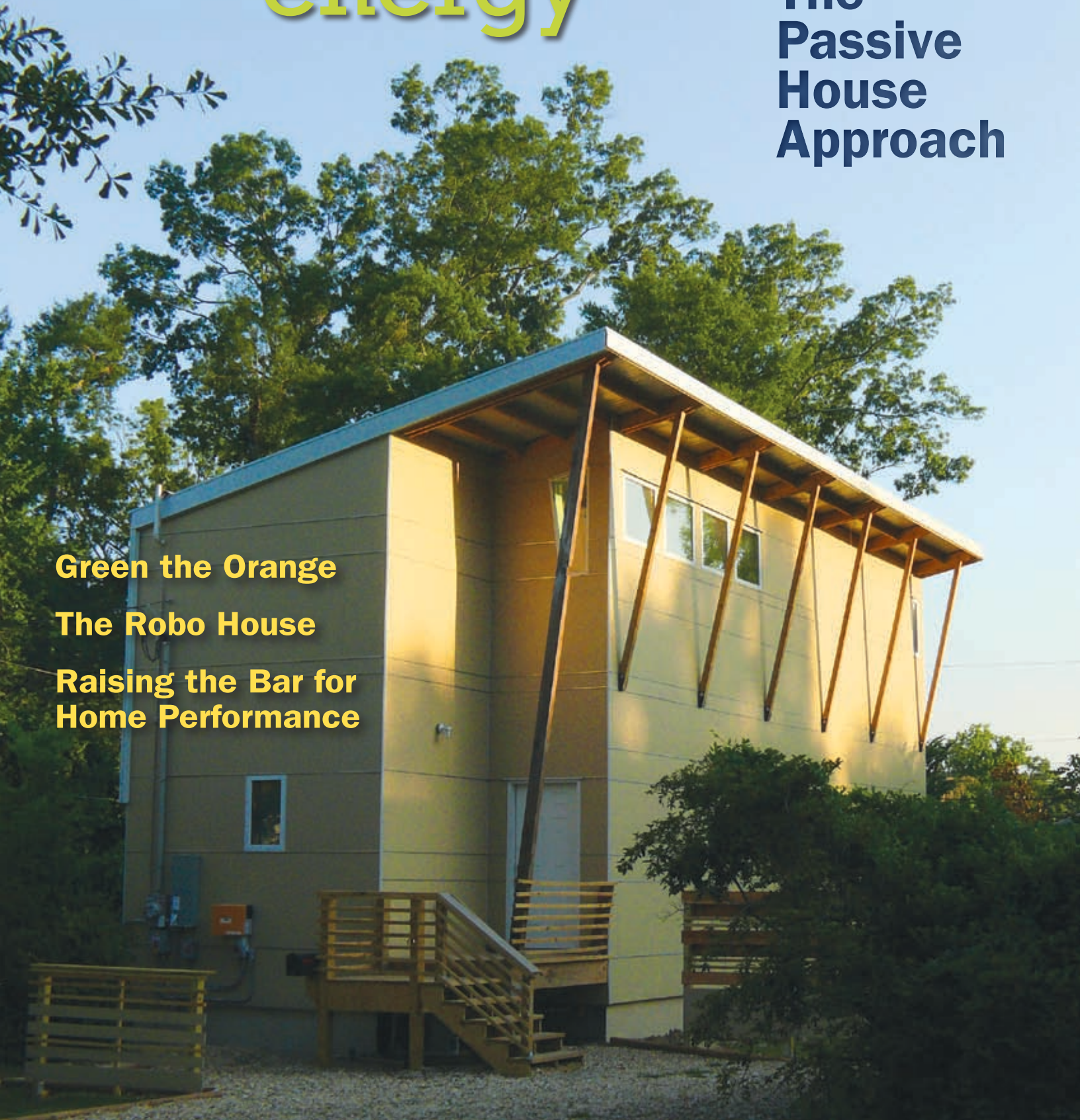
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The Passive House Approach

Green the Orange

The Robo House

**Raising the Bar for
Home Performance**



Raising the Bar for



HOME PERFORMANCE

BY JOHN TOOLEY

For the last 30 years, I have dedicated my life to working with the people who design, build, retrofit, and rehab buildings. Most of these people want to do high-quality work, and yet, year after year, we in the home performance industry find ourselves facing the same issues: poorly sealed, drafty homes; rooms that feel too hot or too cold because insulation or ductwork wasn't installed right; even fire hazards created by improper wiring. In fact, we find that when the average home performance contractor leaves a house, a full 25% of the home's problems have not been addressed.

Why are we falling short? And how can we do better?

I believe the problem is the lack of industry-wide standards on how to retrofit homes. This will come as a surprise to some; after all, for more than three decades the home performance industry has been passing best practices to ensure that jobs get done correctly. But these best practices, while helpful, are as varied as recipes for baking bread—a situation that leads to widely inconsistent outcomes.

Another problem is that on most jobs, quality doesn't get checked until the after the work has been completed. But while a blower door is an indispensable tool, you should have a detailed air-sealing process that guarantees an agreed-upon result. The same goes for every other phase of the job—if you follow a standardized process, the quality control and assurance inspections should yield no surprises. It reminds me of something my father often said when I was young: “Do it right the first time.”

To help contractors do things right the first time, Advanced Energy Corporation, with funding from DOE and BPI, plus contributions from Conservation Services Group, Masco's Well Home and over 140 participating subject matter experts, has been co-

ordinating the development of standardized work specifications (SWS) for residential energy retrofits—specs that ensure that tasks get done exactly the same way every time, no matter who is doing them. We have recruited the top experts in each phase of the retrofit process—attic air sealing, insulation, heating and cooling, ventilation, and so on—to help develop these specifications. (For a sample set of SWS, see “Single-Family Homes.”)

SWS are not specs that describe the standardized process mentioned above; instead, they are a framework that lets a contractor or program administrator develop that process. The SWS for which we have coordinated the development are broad enough to allow each company or program to use its own work methods, yet specific enough to ensure that the same result is achieved no matter who does it.

Our ultimate goal is to help develop a base set of SWS that can be adopted by weatherization agencies, utilities, and contractors nationwide to serve as bedrock for building retrofit programs. We're confident that the SWS will be an important step toward raising the quality bar in the retrofit industry.

Creating the Specifications

SWS are different from the scopes of work you would expect to get with a set of house plans. A set of SWS defines the performance requirements for high-quality energy efficiency retrofit work and the minimum conditions necessary to meet those requirements. It eliminates opinions and sets clear expectations.

To create SWS that consistently accomplish these goals, we followed a standardized development process. In effect, we have a standard spec to create these standard specs.

For instance, each set of SWS must address specific needs, must define the tasks that will be done to meet those needs, and

must include a measurable outcome. Take the example of air sealing a chase (see “Air Sealing a Chase,” pp. 54–55).

As the example illustrates, the outcome must be one of performance—in this case, the requirement for zero air leakage. Other examples of performance outcomes might be that insulation shall be in contact with the air barrier, or that a crawl space vapor retarder shall cover 100% of the ground area, or that a bath fan shall exhaust a minimum of 50 CFM₅₀.

Though SWS are performance based rather than prescriptive, there are places where a particular material, tool, or trade is essential to achieve the specified outcome. Examples are the need for a licensed HVAC contractor to do a furnace tune-up, or the requirement that a caulk meet the requirements of ASTM C834-10. These details must be included in the spec.

Outcomes must also meet what we call SAFE criteria. That is, they must be Specific, Assessable, Feasible, and Effective. We define these terms as follows:

SPECIFIC. An outcome must be clear, concise, and written in a way that leaves nothing to guesswork. Requiring “substantially airtight” ducts is too vague. It’s better to say that duct systems “will not leak where air sealed,” or better yet, that they “will not leak more than a specific leakage at 25 Pa.”

ASSESSABLE. There must be an objective way to measure or evaluate whether an outcome has been met. For instance, infrared camera technology can determine whether a home was properly insulated, while pressure diagnostics, blower doors, and Duct Blasters can measure airtightness.

FEASIBLE. The outcome must be achievable by any trained crew on any jobsite. Much of the work of retrofitting a home is done in tight, hot, and wet places such as attics and crawl spaces, so it’s not feasible to expect duct leakage to meet the same requirements in every location and for every type of duct system.

EFFECTIVE. All solutions must be capable of producing an intended result. That’s why, for instance, you would require that attic air sealing be done prior to insulating. Without proper air sealing, even perfectly installed insulation can’t effectively reduce heat flow.

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Topic: Combustion Appliances
Subtopic: Vented Gas Appliances

2.8 Detail Name: Combustion Air for Atmospherically Vented Appliances

Desired Outcome:

- Sufficient air provided in the Combustion Appliance Zone (CAZ)

Row	Title	Specification(s)	Objective(s)
2.8.1	CAZ pressure testing	The Building Performance Institute (BPI) protocol or equivalent for CAZ combustion safety testing will be administered ²⁶	Ensure appliance is drafting properly
2.8.2	Required combustion air ²⁷	Volume of air required for complete combustion of the fuel and air mixture will be calculated in cubic feet per minute (CFM) according to ANSI and NFPA guidelines	Determine if existing conditions meet the combustion air calculation
2.8.3	Additional combustion air (if action is required)	Additional combustion air will be provided according to ANSI and NFPA guidelines	Ensure adequate combustion air for operation of the appliance
2.8.4	Occupant health	Carbon monoxide (CO) monitors will be provided in all houses with non-sealed direct vent appliances. Ambient CO will be maintained at or less than acceptable levels after work is complete ²⁸	Ensure occupant health and safety

SINGLE-FAMILY HOMES

The illustration shows the typical format that Advanced Energy is using for the SWS it is developing for single-family homes. The project includes close to 200 such specs, distributed over eight broad areas. Those areas are

- combustion appliances,
- ventilation,
- air sealing,
- heating and cooling,
- insulation,
- exterior walls,
- crawlspaces and basements, and
- baseload management.

Each of the 200 or so individual specs will stand on its own, so contractors and program managers can incorporate the relevant ones into their own manuals and write the needed training and reference materials.

For example, a utility that’s designing an audit and tune-up program for baseload management might need the SWS on cleaning and tuning existing refrigerators and freezers, but not the one on refrigerator and freezer replacement. A weatherization company would need all of the insulating and air sealing specs, as well as those dealing with combustion safety,

so it could make sure that its retrofit measures didn’t cause backdrafting; however, it would probably not need the specs for replacing gas boilers or designing duct systems.

We are much further down the quality road than I ever thought possible. There remains much to be done. We must remember that a set of documents alone cannot cause a company to conform to requirements. We at Advanced Energy have found that consideration must also be given to processes, prevention, resources, and behaviors. System thinking is essential to getting the right work done right.

On the Jobsite

Creating SWS is just the first step in raising the quality bar; a bigger job is getting them into the workplace and helping workers to use them effectively. Aids to making this happen include job instruction breakdowns (JIBs), on-site technical tips, and Process Improvement Verification (PIV) forms. JIBs are notes for a crew leader or instructor to use when teaching workers how to use an SWS. Technical tips are critical details that are kept on the work site as a reference guide. PIV forms are checklists that help team leaders ensure that work is being done to spec.

Because an SWS lets contractors achieve an outcome using the particular techniques that work in their market and for their work crews, these supplemental materials need to be developed by or for individual companies or programs. (Advanced Energy is able to develop all of these materials.)

The Bottom Line

Companies that successfully implement SWS will enjoy faster production, better quality, and a safer, more predictable work environment. It will be easier for them to figure out

1 - ATTIC CRITICAL DETAIL : AIR SEALING A CHASE

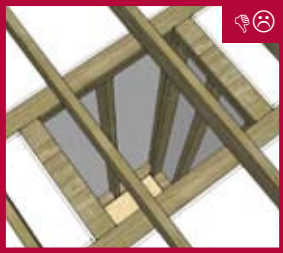

Advanced ENERGY

EXISTING HOME TECH TIPS

(HARD BARRIER)

DESIRED OUTCOME(S)

1. Air does not enter or exit the house through the chase.
2. Eliminate bending, sagging or movement.
3. Eliminate cracking of ceiling materials or nail pops.
4. Adhesion of sealants to all surfaces to be air sealed in order to stop the passage of air.

EFFECTS ON THE HOUSE

Openings to the attic allow heat, cold and moisture movement to/from the attic and house and may result in decreased durability.

EFFECTS ON THE OCCUPANTS

Intrusion of unhealthy air from unconditioned areas, reduced comfort, possible back drafts containing poisonous fumes and higher utility bills.

SAFETY

- Before entering attic or cutting, put on all personal protection equipment. *This is to reduce the amount of dust particles you breathe, protect your eyes and hands.*

JOB PREP

- Measure size and cut [air barrier material](#) larger than opening in all directions. *If [air barrier material](#) bends, sags, or moves when in place, a [support material](#) must be used.*
- If needed, cut [support material](#). *[Support material](#) must not sag or bend when fastened.*
- Fasten any [support material](#) in place.

DO NOT USE NAILS

MATERIALS

Air Barrier

Support Material

Fasteners

Sealants

TOOLS

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ATTIC AIR SEALING (HARD BARRIER): CRITICAL DETAILS

	IMPROVE
✓	✗

SELF-CHECK	1	All CHASES have been properly capped and air sealed. Air does not enter or exit the house through the chase. Air barrier does not bend, sag, or move.		
	2	All DROPPED CEILINGS have been properly capped and air sealed. Air does not enter or exit the house through the dropped ceiling. Air barrier does not bend, sag, or move.		
	3	All open SOFFITS, FURRED-DOWNS & BULKHEADS have been properly capped and air sealed. Air does not enter or exit the house through the soffit, furred-down, or bulkhead. Air barrier does not bend, sag, or move.		
	4	All OPEN STAIRWELLS have been properly capped and air sealed. Air does not enter or exit the house through the open stairwell. Air barrier does not bend, sag, or move.		
	5	All OPEN WALL CAVITIES have been properly capped and air sealed. Air does not enter or exit the house through the open wall cavity. Air barrier does not bend, sag, or move.		
	6	All OPEN FLOOR SYSTEMS have been properly blocked and air sealed. Air does not enter or exit the house through the open floor system. Air barrier does not bend, sag, or move.		
	7	All WALL TOP PLATE CRACKS, HOLES & PENETRATIONS have been properly air sealed.		
	8	All ADJACENT FRAMING CRACKS, HOLES & PENETRATIONS have been properly air sealed.		
	9	All PLUMBING, WIRING, NON-COMBUSTION & DUCTING PENETRATIONS have been properly air sealed.		
	10	All ATTIC ACCESS HATCHED & DOORS have been properly air sealed and weather-stripped. Air does not enter or exit the house through the attic access hatches and doors.		
	11	All INTERIOR FINISH PENETRATIONS have been properly air sealed.		
	12	All PENETRATIONS THROUGH FIRE RATED FLOORS & WALLS have been properly air sealed.		
	13	All FLUES, COMBUSTION VENTS & CHIMNEYS have been properly capped with metal flashing and air sealed with a fire safe air barrier.		

Certified Installer Signature _____ Date _____
print name signature

Crew Leader _____ Date _____

The sub-contractor who signs and completes this form is doing so to the best of his/her knowledge and should not be held legally responsible for work completed by other organizations. The intent of this form is to ensure job sites are ready prior to beginning work.

what they're doing right and to identify ways to do things better, more efficiently, and at less cost. If something does go wrong, having standard practices will make it easier to determine what happened and to make sure it doesn't happen again.

Of course SWS aren't a silver bullet. The companies that are most successful at implementing them will be those whose owners and managers have a solid grounding in building science—the relationship between air, heat, moisture, and energy flows—and who understand how a building's various interdependent systems and occupants interact. They will also have a company culture that values continual improvement.

For such companies, SWS will let them spend less time and energy putting out fires, so they can focus their attention on doing better work and improving quality for our industry as a whole.

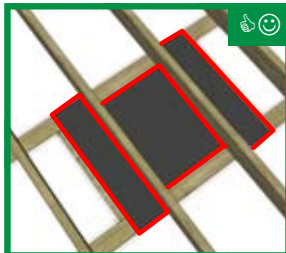
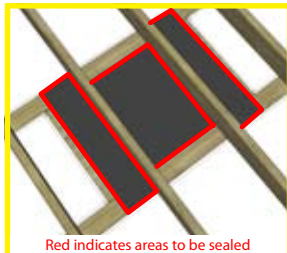
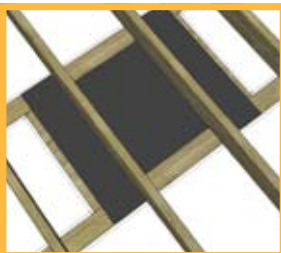
John Tooley is a senior building science consultant with Advanced Energy in Raleigh, North Carolina.

In short, this monumental work could not have been accomplished without the partnerships of government and industry, the dedication of the experts across the nation and the professional management of the National Renewable Energy Laboratory. I can't express the depth of my gratitude but do want to say thanks to all!

1 - ATTIC CRITICAL DETAIL : AIR SEALING A CHASE

EXISTING HOME TECH TIPS

(HARD BARRIER)



AIR BARRIER

- Install [air barrier material](#).
- Fasten [air barrier material](#) if needed.

DO NOT USE NAILS

AIR SEALING

- Air seal **ALL** edges and penetrations of the [air barrier material](#). Assure 100% of the edge and all penetrations are air sealed with [sealants](#).

FINAL PRODUCT

>> For more information:

To learn more about Advanced Energy, go to www.advancedenergy.org. The SWS should be ready for distribution in early 2011 from the National Renewable Energy Laboratory. To learn more, go to www.nrel.gov.