

HOUSE+

Builder's Guide

Basement Remodeling

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Build a Risk-Free

Capturing this additional living space correctly and confidently

Finishing a basement can create extra living space with far less cost and complexity than an addition that expands the home's footprint. Perhaps for that reason alone, finishing a basement is a popular project for many homeowners. But a well-designed basement remodel is much more than an assembly of studs and drywall thrown up over a foundation wall, then trimmed and painted. Understanding and managing the risk of moisture and bulk water are imperative to developing a successful basement design, as is getting the insulation and air-sealing details right.

By assessing your site and basement accurately, and detailing your foundation floor and walls appropriately, not only can you improve the comfort, health, and efficiency of your home, but you can tackle

the fit and finish of your basement with complete confidence in its durability and longevity.

Economics of performance

As with all construction projects, risk and performance in a basement remodel exist on a sliding rule of cost. Minimizing risk, providing durability, and ensuring proper performance come with a price. But when is good enough really good enough? It is easy to think of a basement as "cheap" space, but if the remodel is not well planned, it could easily be an inexpensive project that leads to expensive problems down the road. Improper water management can lead to health and durability risks; improper thermal management can lead to

MANAGE RISK AND REAP THE REWARDS

Risk is related directly to the threat of water and moisture in the basement. The more water challenging the foundation, the higher the risk level.

Because no two basements are alike, each one demands its own method for keeping the space below grade dry and healthy. While finish and furniture



LOW This basement was a 1757-sq.-ft. remodel for clients looking for a family room, a fitness area, and a recreation area. The design is enhanced by a full-height walkout, which allows lots of daylight to enter the family room. This low-risk basement had an existing perimeter drain that emptied to daylight, but there was no evidence or history of water intrusion. The foundation wall was insulated with 2 in. of closed-cell foam, while the wood-framed walkout was insulated to R-19 with cellulose.



MODERATE This 1616-sq.-ft. basement remodel added a media room, a bar and recreation area, a fitness room with a flat-screen TV, and a large pantry at the bottom of the basement stairs for storing bulk items. The homeowners were looking for a casual environment for entertaining and a place for their three children to be with their friends.

Finished Basement

requires a careful approach to the site and foundation

BY STEVE BACZEK

comfort risks. When it comes to considering the budget for a basement remodel, it's helpful to follow the general guideline that as cost decreases, risk increases. The challenge is to find a suitable balance between cost and risk.

Rating the conditions

Because of the below-grade location of most basements, the existence of water is generally the measuring stick of risk. I typically rate existing foundations as having low, moderate, or high levels of risk. To me, low-risk foundations are not challenged at all by water infiltration. They are most often located in a high, well-drained area, and they have no evidence of water problems from the walls or the slab.

Remodels should still be detailed carefully, though, since dramatic weather-related water events could occur at any time. I have also seen basements compromised because site conditions changed naturally, or more frequently, because neighboring properties were developed.

A basement with a moderate risk level has seasonal challenges. In colder climates, water from the spring thaw can saturate the ground. In warmer climates, water might become a problem during the rainy season. Regardless of the source, a moderate-risk scenario has water issues for up to half of the year. If you've lived in the house for a period of time, you certainly know if and when water issues are a problem. If you're working on a home without historical context, look for evidence of bulk water in the basement in the form of stain-

selection can be inspired by other projects, it's important to design your finished basement around your specific needs and challenges. The approach to

low-, moderate-, and high-risk projects outlined here is not theoretical. It can be trusted in practice. Below are three of the author's designs, built by

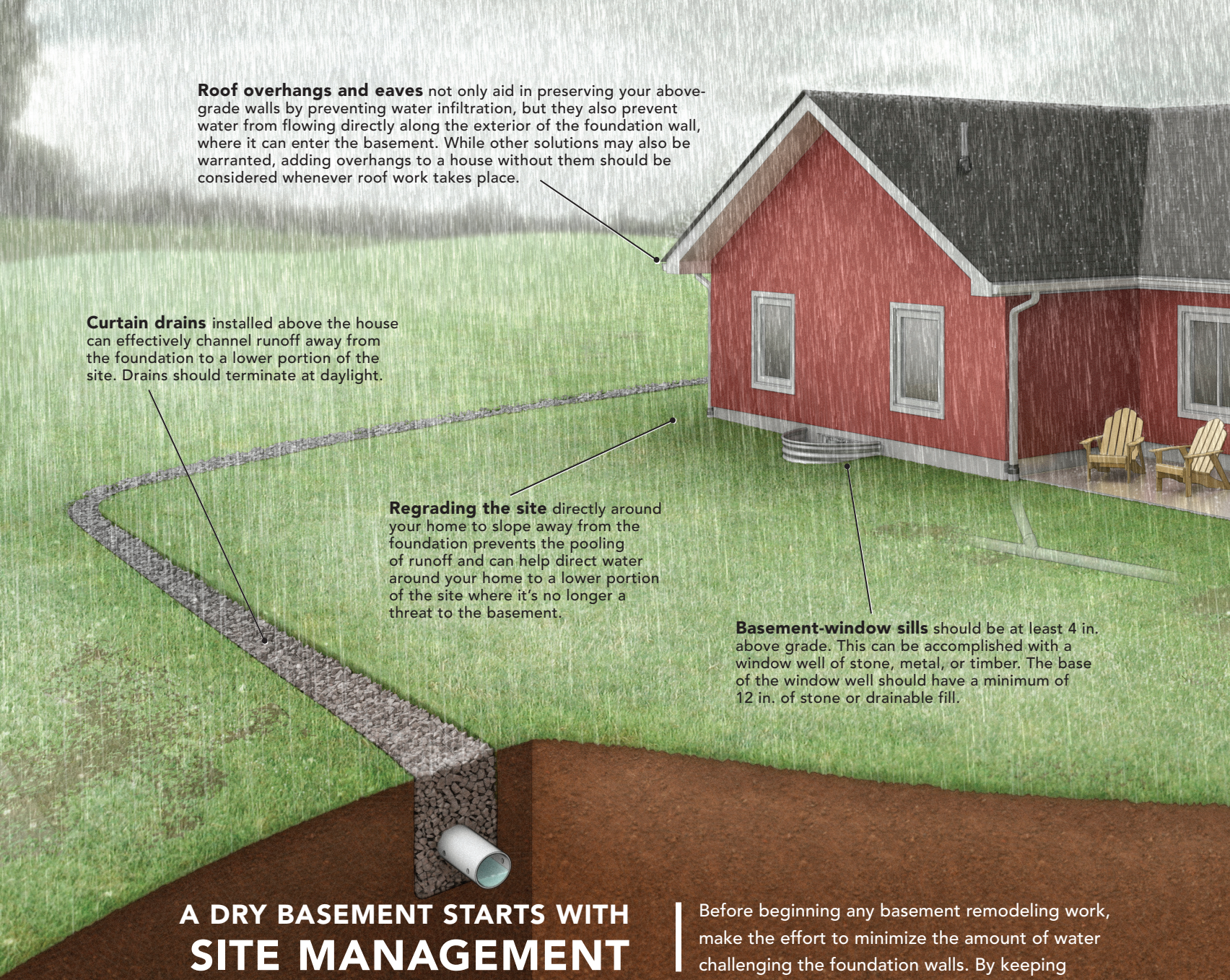
Two Storey Building of Bolton, Mass., that afforded his clients the additional living space they dreamed of while also offering them peace of mind.



The basement was at a moderate risk level and required a new perimeter-drain system. In this remodel, the foundation walls were insulated with 2 in. of polyisocyanurate. A 2x4 stud wall was then framed over the rigid foam and filled with R-15 unfaced batts. Finishes in this space are casual and comfortable, and they are easily replaced if needed.



HIGH This design called for a media area, a kitchenette, and a fitness area with a full bath. The remodel was considered high risk, as the space endured occasional water intrusion. To provide proper water management, a drainage curtain was placed on the interior face of the foundation from the mudsill to a new perimeter drain. The walls were insulated with 2 in. of closed-cell spray foam placed between the 2x4 stud wall and the foundation wall. An additional R-15 unfaced batt was placed in the wood-framed stud cavity.



Roof overhangs and eaves not only aid in preserving your above-grade walls by preventing water infiltration, but they also prevent water from flowing directly along the exterior of the foundation wall, where it can enter the basement. While other solutions may also be warranted, adding overhangs to a house without them should be considered whenever roof work takes place.

Curtain drains installed above the house can effectively channel runoff away from the foundation to a lower portion of the site. Drains should terminate at daylight.

Regrading the site directly around your home to slope away from the foundation prevents the pooling of runoff and can help direct water around your home to a lower portion of the site where it's no longer a threat to the basement.

Basement-window sills should be at least 4 in. above grade. This can be accomplished with a window well of stone, metal, or timber. The base of the window well should have a minimum of 12 in. of stone or drainable fill.

A DRY BASEMENT STARTS WITH SITE MANAGEMENT

Before beginning any basement remodeling work, make the effort to minimize the amount of water challenging the foundation walls. By keeping

ing on the slab and/or mineral streaks along the foundation walls. Your new neighbors might also be able to provide some insight into existing conditions, but keep in mind that every property is unique. Just because your neighbor's basement is dry doesn't mean yours is.

A high-risk basement faces water infiltration for more than six months of the year. Water might even be a daily challenge. High-risk basement remodels can be managed effectively, but demand a system of water management that requires a perpetual solution.

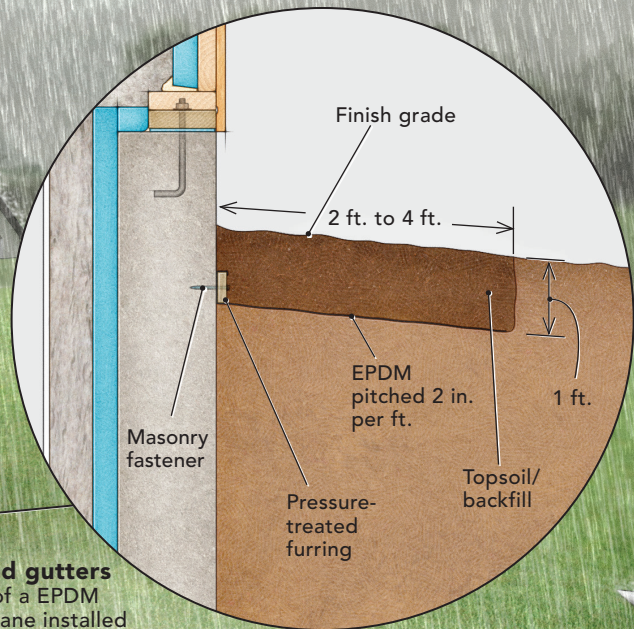
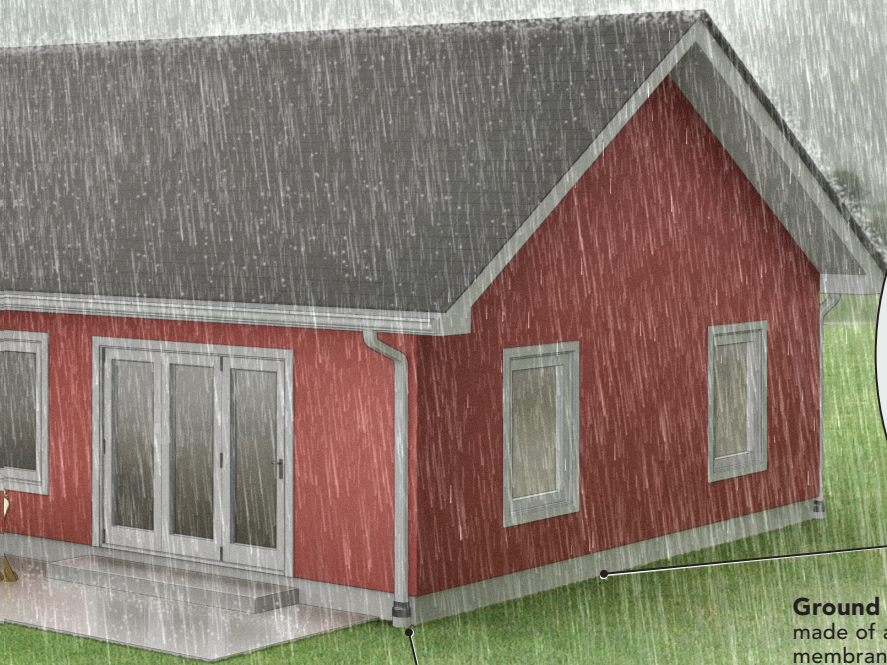
Site and foundation assessment

The initial steps in designing any finished basement are straightforward. First, if any water exists on the site, try to minimize the amount of water near the foundation as much as you can prior to beginning your work. The less water you have to deal with, the smaller the problem will be, and therefore, the smaller and less expensive the management system needs to be.

Once the site is analyzed and a plan for correction or improvement is developed, the foundation itself needs to be assessed. Different foundation types perform differently and can demand different approaches to management. Stone, brick, concrete block, and concrete all have specific characteristics that challenge a finished basement. Stone, brick, and concrete-block foundation walls are all mortared systems. The amount of mortar and the manner in which it was laid (neat and full vs. sloppy and spare) help determine the ability for water to penetrate the foundation wall. Because of their continuous casting, concrete walls offer a more formidable defense to the infiltration of groundwater. Make no mistake, though—if water exists, it will get in eventually.

Managing moisture

Moisture in its vapor form is usually not a cause for concern in a basement. It only becomes a problem when it is given the opportunity



Ground gutters made of a EPDM membrane installed below grade will keep water from migrating down the exterior face of the foundation wall. The membrane can be installed under perimeter planting beds, 12 in. to 16 in. below grade.

Gutters and downspouts are critical in channeling rainwater and snowmelt from the roof away from the house. However, a downspout that terminates too closely to the house can saturate the ground next to the foundation. Downspouts should ultimately terminate to daylight at a lower portion of the site.



storm water, snowmelt, and runoff away from your home, you decrease the risk level of the basement renovation, which can help reduce the cost and

complexity of the remodeling work. Here are the primary things to keep in mind as you create a strategy for keeping water away from the foundation.

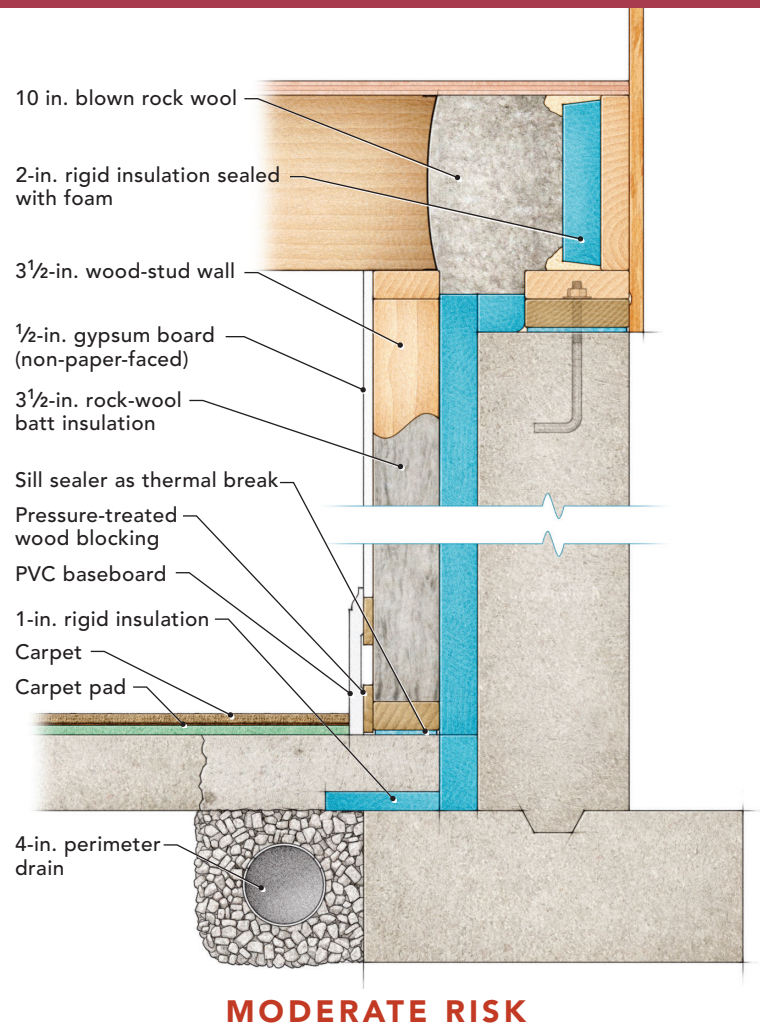
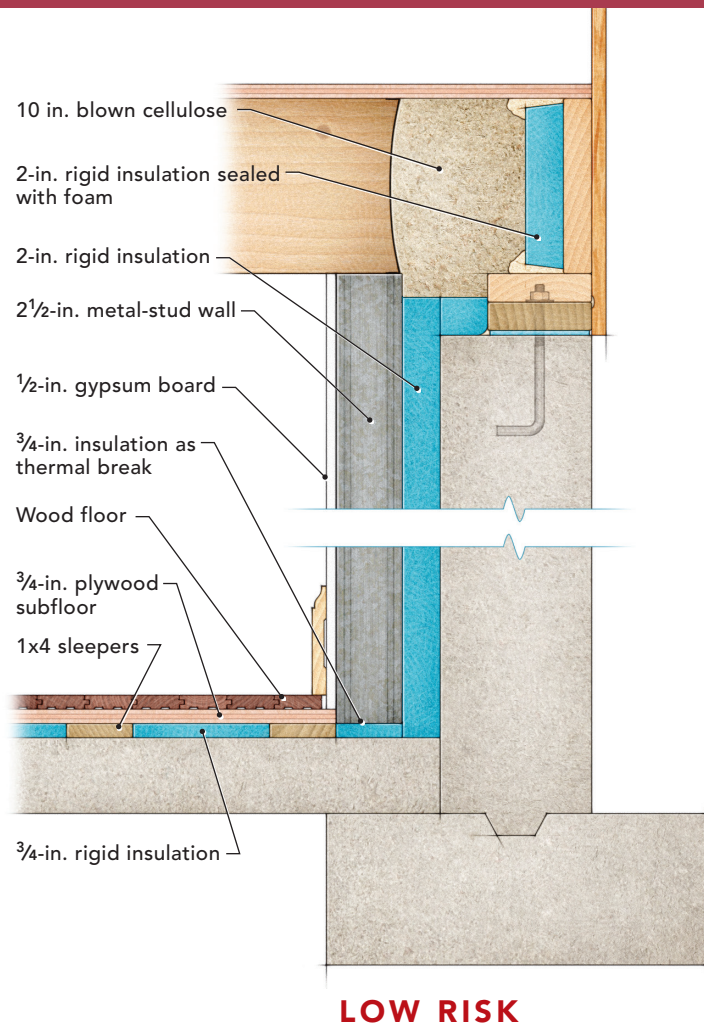
to cool and compress to its saturation limit and condense on cool surfaces. For this reason, controlling surface temperatures in the basement is critical. For example, I recommend thermally breaking the framed walls from the concrete slab with a piece of rigid insulation under the bottom plate. This prevents vapor from permeating through the slab and condensing on the cool wood framing, where it could conceivably cause rot and mold growth.

Some builders try to control vapor by applying vapor barriers between the slab and finish flooring or between the foundation walls and the finished space. In some cases, this approach might be successful, but I tend to stay away from barrier systems in favor of management systems. I typically allow the vapor to migrate into the basement and then manage the level of moisture in the basement air with my mechanicals. A heat-pump water heater, for instance, provides partial dehumidification of the air as it heats the domestic water supply. This appliance, though, needs its own drain line for condensate.

When it comes to managing bulk water infiltrating the basement, the strategy is straightforward. The objective is to manage, collect, and discard water from the basement. Depending on the level of risk and the amount of water infiltration, an appropriate drainage plane must be employed to manage this water. With a moderate level of risk where water moves through the wall by capillarity or saturation, the drainage plane could be as simple as a layer of rigid insulation applied to the foundation wall and its seams taped. At a higher level of risk, where bulk water comes through the wall, a drainage curtain or drainage mat would be needed. A drainage curtain needs to be linked physically to a subslab perimeter-drain system in cases where a footing drain isn't already in place. This is the "collect" part of the strategy. After the infiltrated water is collected, it is directed to a sump pump for discharge. (For more on sump pumps, see "What's the Difference?") If the exterior grade allows, however, the perimeter drain can be directed to daylight at some point on the property. By virtue

BALANCE RISK WITH THE RIGHT DESIGN

There are two simple rules when it comes to designing a finished basement. First, water is never stopped, halted, or detained; it is managed. Second, Mother Nature and Father Physics are formidable opponents, with a very long history of success. Believing that we can win against their natural forces



of its subslab position, the perimeter drain handles any groundwater challenging the slab from below.

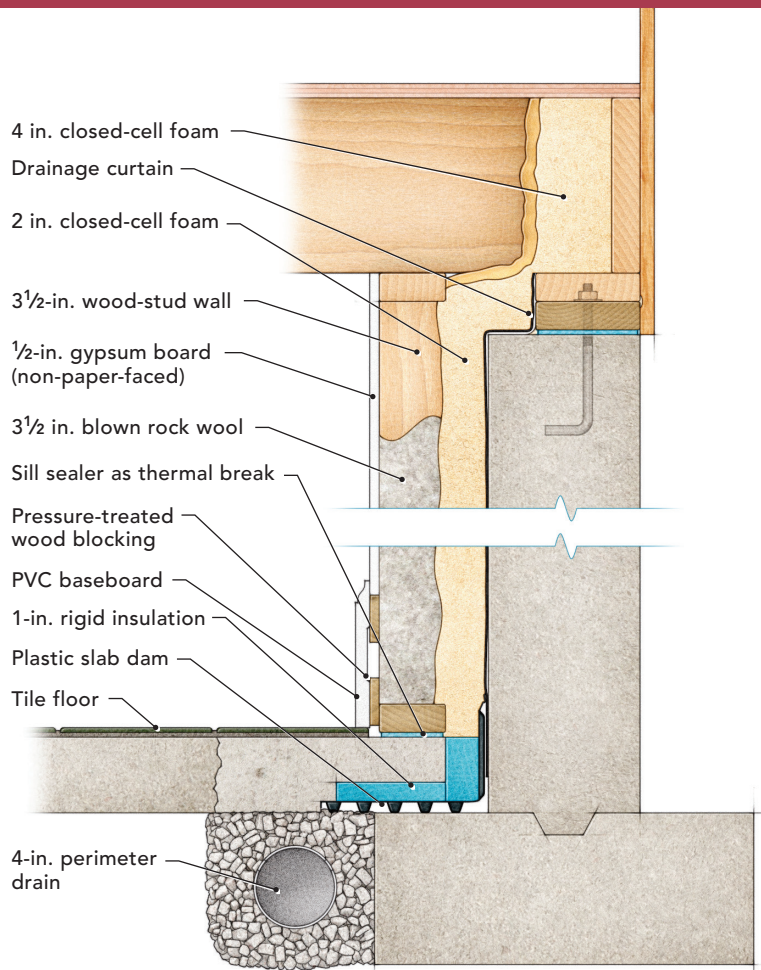
Insulation and air-sealing

In most unfinished basements, moisture issues cause few problems because a leaky above-grade envelope allows the moisture to dry. In many homes, though, attempts have been made to separate the basement from the conditioned living space above with batt insulation installed in the first-floor joist bays. These attempts usually fail, since air movement between the floors goes unchecked. In addition, as the lowest point in the house, the basement is subject to the highest negative pressure (air infiltration) due to the stack effect. Whether the basement is insulated or not, the mechanical system located there is unavoidably tasked with conditioning the basement. In many cases, adding a proper thermal barrier in the basement allows the mechanical system to work less and still be able to provide the required heating or cooling of the insulated basement.

When it comes to insulating the basement, there are code-minimum R-values that vary based on where the home is located. My approach is to provide an R-value that is proportional to my thermal goals above grade. I typically strive for a basement-wall R-value that is at least half of my above-grade wall-insulation value. My target slab R-value is typically at least half of my basement-wall R-value. At a minimum, these numbers usually work out to an R-10 slab and an R-20 foundation.

Rigid insulation, spray foam, blown insulation, and batt insulation all have their place in certain basements. I typically consider batt or blown insulation to be an additional level of insulation rather than my primary insulating method. I refrain from putting any of them directly against the foundation wall for a couple of reasons. First, they allow air movement between the foundation and the wall assembly, making it more difficult to control the surface temperature of the framing and drywall. Second, water permeating the foundation can easily move through the insulation and damage the framing and drywall.

is simply a fantasy. Water management that aligns with their rules is the path to ultimate success. The following examples illustrate adherence to these rules and insight into the proper approach to waterproofing, insulating, and finishing foundations that vary in risk level.



HIGH RISK

I like to control the surface temperature of the foundation wall with rigid foam or spray foam. After one of them has been installed, I determine the risk of adding batt or blown insulation. I tend to avoid batt or blown insulation in high-risk basements, and I use it sparingly or as bulk-fill insulation in lower-risk basements.

In terms of air leakage, the concrete walls and slab do a fine job of providing air-barrier continuity along their surfaces. With a stone, brick, or concrete-block foundation, the air barrier becomes more of a challenge. In these cases, I tend to use a drainage curtain, rigid insulation with sealed joints, or spray foam as the primary air barrier linking the slab to the mudsill.

Fit and finish

When it comes to finish materials in the basement, I have heard hundreds of opinions on which ones to use, where to use them, and why. I rely on my initial risk assessment to guide me in material selection with my clients, but I try to accommodate their wishes. In most

Code considerations

Many code requirements for basements apply directly to occupant health and safety. Here are a few worth investigating before moving forward in any basement design.



- Ceiling height or beam height is always a challenge in basements, especially in older homes. According to IRC R304.3, minimum ceiling height of a habitable space is 7 ft.
- Egress demands increase dramatically when the basement remodel includes adding bedrooms. Refer to IRC 310.1.
- Proper alarms for smoke, fire, and carbon monoxide should be installed and maintained in accordance with IRC R314 and R315.
- Sealed-combustion mechanical equipment that separates the combustion air within the device from the basement air is required in some jurisdictions and is a good idea in all of them.
- Natural ventilation is a calculated requirement in many jurisdictions. Start by researching section R303 in the IRC.
- Radon testing and mitigation are required in some jurisdictions. Radon can become a problem as a basement gets tighter.

cases, the installation methods of the selected materials are of prime importance, not the materials themselves. For example, if drywall is to be used in a moderate- or high-risk basement, then I will install a tall (8-in. or 10-in.) synthetic baseboard and hold the bottom edge of the drywall just under the top of the baseboard, which I will fasten to blocking. If the basement incurs a flood, the drywall is likely not to be part of the resulting problem. If a client desires carpet in a low-risk basement, I probably won't have a problem with installing it wall-to-wall. In basements of moderate and high risk, a better option is either an engineered-wood floor or a tile floor with large area rugs. Area rugs are easy to remove, clean, and reuse if they are part of a flood.

In summary, my approach is pretty simple: As risk increases, materials used in a finish basement should be less permanent or more resistant to moisture and water. □

Steve Baczek is an architect in Redding, Mass. Photos by David Fell, except where noted.

The Stay-Dry, No-Mold Finished Basement

Rigid-foam insulation
is the key to a
comfortable living space

BY ANDY ENGEL

Finished-basement projects usually begin with visions of a game room for the kids or of a secluded spot for Dad to watch Sunday football games with his cronies. Just about as frequently, these projects end badly with black spots of mold, crumbling drywall, and a smell reminiscent of a dungeon. What goes wrong? In most cases, water becomes trapped behind a wood wall or floor and nurtures a bloom of rot.

However, it probably isn't a flood that causes the problem. Yes, bulk water, the kind that flows across the floor, needs to be eliminated before an attempt is made to finish a basement. (Some common measures include exterior waterproofing, functioning gutters, and/or an internal drain system.) But even if your basement looks dry, you easily can have problems when you enclose the concrete with a framed wall. The real villain here is water vapor, the invisible moisture that keeps concrete damp and makes cold-water pipes drip with condensation in the summer. This water is always present. To reduce mold

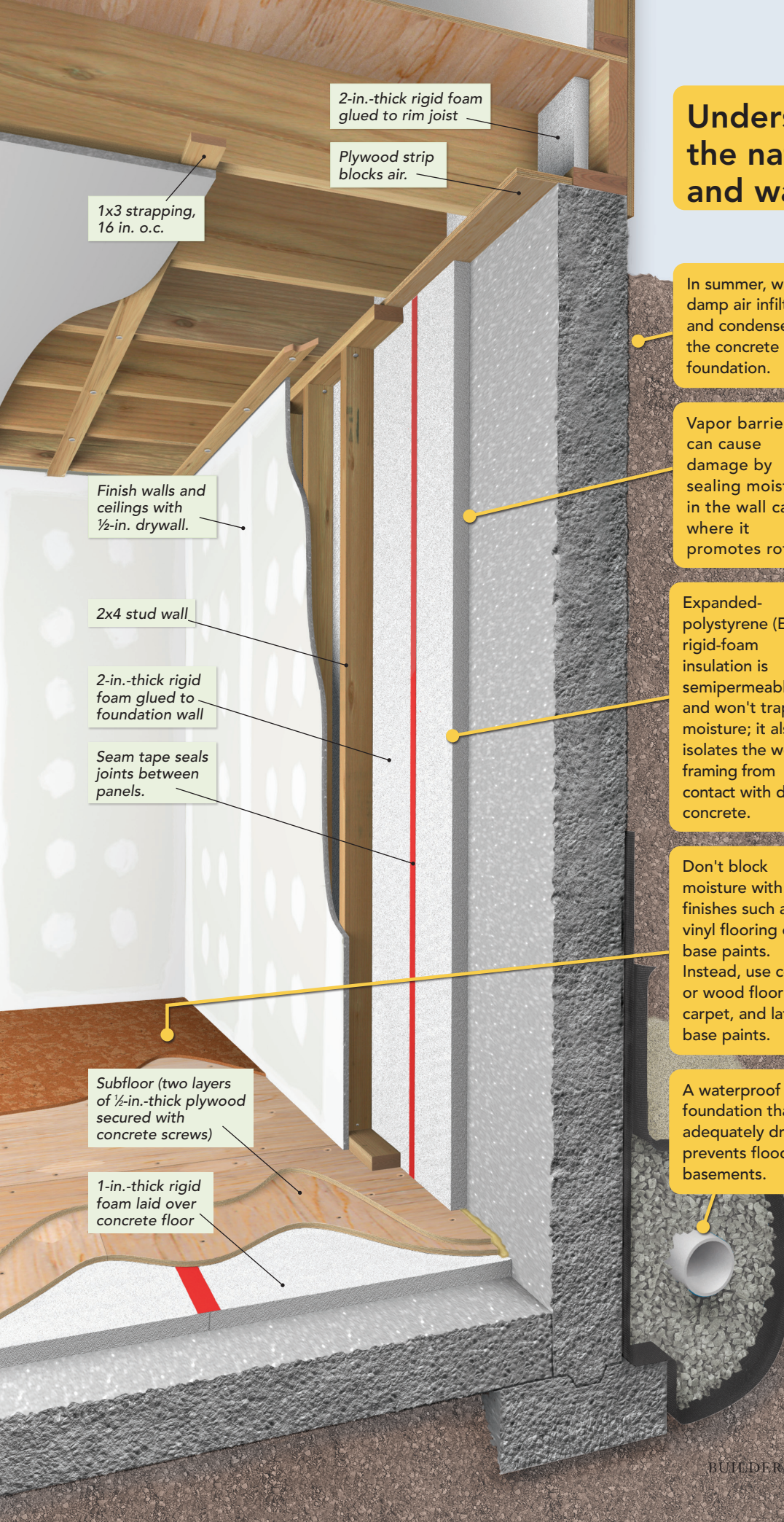


Before



After

A rec room that will last. Built with conventional wall framing, a plywood subfloor, and rigid-foam insulation, this basement remodel doesn't trap moisture that can cause problems later. (By the way, the stair railing isn't finished.)



2-in.-thick rigid foam glued to rim joist

Plywood strip blocks air.

1x3 strapping, 16 in. o.c.

Finish walls and ceilings with 1/2-in. drywall.

2x4 stud wall

2-in.-thick rigid foam glued to foundation wall

Seam tape seals joints between panels.

Subfloor (two layers of 1/2-in.-thick plywood secured with concrete screws)

1-in.-thick rigid foam laid over concrete floor

Understanding the nature of basements and water

In summer, warm, damp air infiltrates and condenses on the concrete foundation.

Vapor barriers can cause damage by sealing moisture in the wall cavity, where it promotes rot.

Expanded-polystyrene (EPS) rigid-foam insulation is semipermeable and won't trap moisture; it also isolates the wood framing from contact with damp concrete.

Don't block moisture with finishes such as vinyl flooring or oil-base paints. Instead, use cork or wood flooring, carpet, and latex-base paints.

A waterproof foundation that's adequately drained prevents flooded basements.

Moisture moves from wet to dry and from warm to cool. In the summer, damp soils and warm air outside make the moisture drive mostly inward. Humid outside air enters the basement and condenses on anything below its dew point: cold-water pipes, concrete walls, and floors. In particular, carpeted concrete floors can be a problem because they easily can become wet enough to support mold and dust mites.

Most basements dry out only in the winter when interior heat sucks the available moisture out of the basement and drives some moisture outward through the exposed portion of the foundation. There's also some drive-out through the foundation itself because the basement is warmer than the surrounding soil. The trouble is that the soil tends to be wet, and so has a limited capacity for drying.

There's a significant energy cost in moving this water through the foundation. The traditional response has been to frame walls next to the foundation, fill them with fiberglass, and seal them with a plastic vapor barrier. But a basement vapor barrier can trap moisture and promote rot. Basement floors built with a similar system fare no better.



PLYWOOD SUBFLOOR IS SUPPORTED AND

Use rigid foam instead of wood for sleepers

To isolate the wood from moisture in the concrete, full sheets of EPS are laid on the concrete floor. Seam tape and expanding foam seal the seams against the infiltration of moist air.

growth, water's contact with cellulose (paper, wood, etc.) has to be limited, and the water has to be allowed to escape.

Through research published by Building Science Corporation, I've found that rigid-foam insulation both thermally protects the basement and breaks the contact between framing and concrete. To avoid trapping moisture, I never install a vapor barrier. Instead, I use materials and finishes that allow moisture to diffuse. You can get rid of this diffused water by installing a dehumidifier or by extending the air-conditioning ductwork into the basement. I'm no expert in this area, so let an HVAC contractor figure out the specifics.

Isolate and insulate the concrete

I use 2-in.-thick expanded-polystyrene foam (EPS, or styrofoam) on the walls and 1-in.-thick EPS below the plywood subfloor. This rigid-foam insulation is sufficient to make a noticeable temperature difference in the basement without crowding in the walls or the ceiling height. EPS is cheap, effective, and vapor permeable. Believe it or not, it also has the compressive strength to support a two-layer plywood subfloor without the use of sleepers.

After insulating the rim joist,



INSULATED WITH RIGID FOAM



Two layers of plywood go down with screws

After drilling and counter-sinking pilot holes (1, 2), the author attaches the first layer of 1/2-in.-thick plywood with 2 1/2-in.-long concrete screws (3). To allow for expansion, 1/8-in. gaps are left between each sheet and around the room's perimeter. Laid at right angles to the first layer, a second layer of plywood is fastened with 1 1/2-in. drywall screws and spans the joints between sheets to make a stronger floor. (4).



1



2



3



4

I cover the floor with a layer of 1-in.-thick EPS. On top of this, I lay the subfloor, then build a regular stud wall against the foam on the walls.

Keeping wood from contacting concrete is critical. Fail here, and you're inviting water in through capillary action. You could use pressure-treated plywood and framing lumber, but I think that's false security and an unnecessary expense. If you've got enough moisture in the wall or the floor to cause rot, then you've also got the right conditions for mold growth, something that pressure-treated lumber won't prevent.

It's also possible to skip the stud wall and to screw furring strips to the concrete through the foam, but I don't like that approach for two reasons. First, I haven't seen many basement walls that are as plumb or as straight as I can build a stud wall. Unless you want to spend days playing with shims, the furring strips will mimic the defects of the foundation. Second, furring strips don't have the depth that allows easy installation of electrical boxes.

Andy Engel was a builder and Fine Homebuilding editor. Photos by Charles Bickford.



FRAMED WALLS ARE ISOLATED

An insulated band joist stops thermal bridging

Insulating the joist bays with 2-in.-thick EPS will keep air leaks and cold spots to a minimum. Minimal amounts of expanding foam applied around the edges of each piece act as both a sealant and an adhesive.



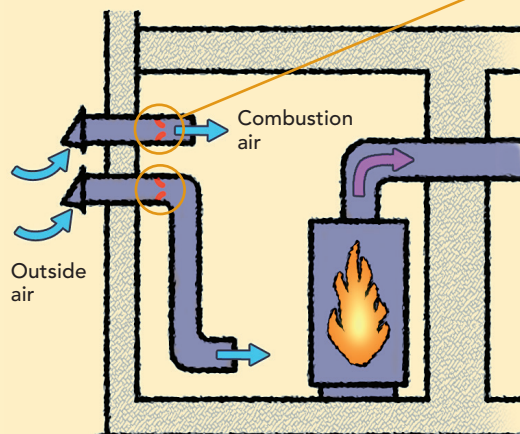
Blocking air infiltration

A strip of plywood is screwed to the underside of the floor joists. Extending from the edge of the mudsill to the inside of the wall plate, this plywood creates an air barrier. Gaps are filled with expanding foam.

Air quality and fire safety in the basement

One of the effects of finishing a basement is to cut off leaks that may have been supplying combustion air for the boiler, furnace, or water heater. Failure to replace this air supply could contribute to backdrafting and the possible buildup of lethal amounts of carbon monoxide.

Unless the appliance manufacturer provides specs that say otherwise, the rule of thumb is to provide makeup-air ducts leading to the outside that are twice the size of the combined flues. In this basement, the boiler and water heater share a 6-in.-dia. flue. I provided two 6-in. supplies,



Fabric damper

FROM THE FOUNDATION'S MOISTURE

Make the foam on the walls as tight as possible

After the floor is done, the walls are insulated with EPS sheets trimmed for a friction fit and glued to the foundation with expanding foam (1, 2).

Seams and gaps are filled with the foam and taped. Plywood scraps keep the sheets in place until the glue sets (3). Unlike furring strips, a stud wall goes in plumb and straight, and allows room to run any utilities normally (4).



one that ended at the ceiling level and one that ended near the floor in the mechanical room. To prevent these ducts from chiming nice, warm air to the outside, they were fitted with fabric dampers (photo facing page) made for this low-pressure application.

One other safety consideration is basement egress. Most building codes require habitable basements to have two exits in case of fire. This basement already had two doors, so that requirement wasn't an issue. Lacking the second door, I'd have had to provide a code-approved egress window (a 5.2-sq.-ft. opening within 44 in. of the floor, leading to a 36-in. by 36-in. well with ladder rungs leading to grade). Last, if your home isn't already so equipped, install hard-wired smoke and carbon-monoxide detectors in the basement.

Air-sealing a Basement

BY MARTIN HOLLADAY

Once you've sealed the air leaks in your attic floor—the cracks where warm air escapes from your house during the winter—it's time to turn your attention to the basement or crawlspace, where cold air leaks in. If you turn off the basement lights and look for daylight, you might be surprised to find some large holes.

Weatherization contractors often use a blower-door test to help pinpoint leaks in the building envelope. Once your house is depressurized, you can use your bare hands to feel for air infiltration. The most common places to find air entering basements are around windows and doors and between the concrete foundation and the mudsill. But some air-leakage paths may surprise you: Air can even seep through the crack at the perimeter of your basement slab or through a sump in the basement floor. Here are five places to check for air leaks in your basement and some advice on how best to seal them.

Foundation walls

Walls made of poured concrete or concrete blocks are usually fairly tight. However, if your basement walls have any obvious cracks, fill them with silicone caulk. If the walls are made of stone and mortar, don't use canned spray foam or caulk to seal cracks. Instead, remove any loose material from these areas, and repair them with mortar and small stones.

Use caulk or canned spray foam to seal leaks near wall penetrations for your electrical service, water service, cable service, or natural-gas service. Your home also may have penetrations for a fuel-oil filler pipe, an oil-tank vent, or a clothes-dryer vent. If basement access is awkward, some cracks may be easier to seal from the exterior.

Rim joists

Air can leak through

the crack between the top of the foundation wall and the mudsill, the crack between the mudsill and the rim joist, and the crack between the rim joist and the subfloor. The best way to seal leaks in the rim-joist area is with a high-quality caulk.

Once these cracks are caulked, you may want to reduce air leaks further by installing a layer of closed-cell spray foam at the rim-joist area using a two-component spray-foam kit. (See "Spray Foam for the Rest of Us," *FHB* #221.)

Although spray foam is effective, it is expensive and sometimes messy. If you would rather not use it, you can insulate rim joists with rectangles of 2-in.-thick rigid foam (polyisocyanurate or extruded polystyrene). Seal the perimeter of each foam rectangle with caulk or canned spray foam. Don't use fiberglass batts; they do nothing to slow airflow.

Windows and doors

If your basement has old single-pane windows, they may need new glazing compound and weatherstripping. If the windows are in bad shape, consider replacing them with new double-glazed units.

If you rarely open your basement windows, consider sealing them shut with screws and caulk, or even covering them with rigid foam. (Of course, this advice applies only to small basement windows, not to any egress windows in a basement bedroom.) Don't forget to caulk between the window frame and the concrete.

Every bulkhead entry needs a tight, weatherstripped exterior door at the base of the stairs. Be sure to caulk or to foam the gap between the door jamb and the foundation. If the door is warped or difficult to weatherstrip, it's time to replace it. Most lumberyards can order a custom insulated entry door to fit any size opening. If you're framing the rough

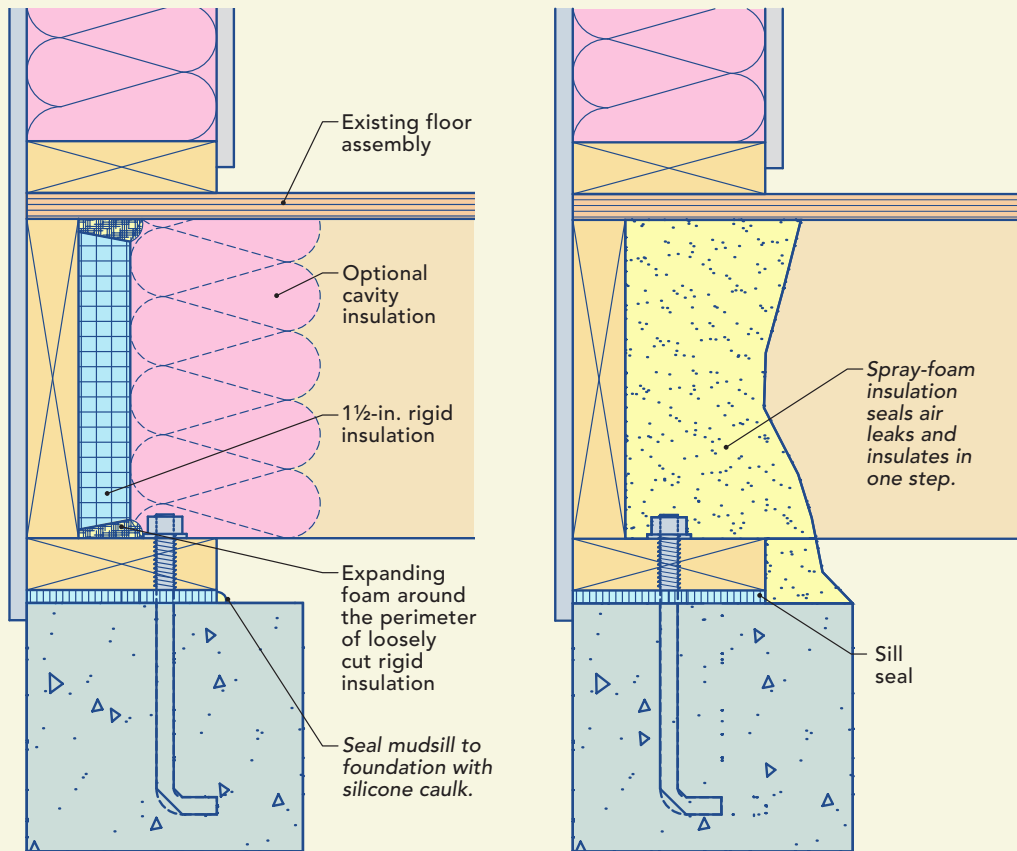
Combustion safety in a tight basement

Atmospherically vented appliances—for example, water heaters, furnaces, or boilers attached to old-fashioned brick or metal chimneys—depend on air leaking through cracks in your walls to supply combustion air. If your basement is very tight, atmospherically vented appliances could be starved for air, and exhaust gases may struggle to exit through the chimney. That's why the best appliances for tight homes are sealed-combustion appliances equipped with ducts that supply outdoor air directly to the burners.

Because flue gases sometimes include carbon monoxide, it's always important to be sure that your combustion appliances have adequate combustion air and that your chimneys draw well. If you plan to seal cracks in your basement, arrange for a combustion-safety test of any atmospherically vented appliances once air-sealing work is complete. Contact your gas utility or a home-performance contractor certified by RESNET or BPI for more information on combustion-safety testing.

TWO WAYS TO AIR-SEAL AND INSULATE A RIM JOIST

Rim joists are a common source of air leakage in basements and are often left uninsulated. The first step toward an energy-smart rim joist is to caulk gaps between the foundation wall and the mudsill, the mudsill and the rim joist, and the rim joist and the subfloor. As seen in the details shown here, you then can use rigid foam or spray foam to add another layer of air-sealing and to insulate the area.



Rigid foam

You can cut the pieces of rigid foam roughly and somewhat undersize because the perimeter of each rectangle should be sealed in place with canned spray foam. With the rim joist air-sealed and covered with rigid foam, you can now add cavity insulation like fiberglass batts or, better yet, a second layer of rigid foam.

Spray foam

Extend spray foam from the top of the foundation wall to the underside of the subfloor above. In addition to sealing leaks, 2 in. of cured foam will insulate to R-13. Most building codes, including the International Residential Code, allow spray foam installed at rim joists to remain exposed—without protection from a thermal barrier like drywall—as long as the foam is no thicker than 3 1/4 in.

opening, use pressure-treated lumber, and seal the frame to the concrete with canned spray foam.

Basement floors

After a new foundation is backfilled, the fill often shrinks away from the foundation, leaving a gap next to the basement wall that allows outdoor air to reach the footings. That's one way for outdoor air to enter a home through cracks in the basement floor or sump pit. Even if a home has no shrinkage gap, air can still reach the footings, especially in areas with porous soil.

If there's a crack at the perimeter of your basement slab, clean the crack with compressed air or a vacuum cleaner, and then fill it with caulk. If you have a sump pit without a tight lid, replace it with a new airtight lid. Sumps that have airtight lids are available from Jackel (www.jackelinc.com).

Basement ceilings

Chases and chimneys that extend from the basement to the attic should certainly be capped at the top, but the bottom of these chases should be sealed as well. After all, once air gets into a chase, it can move sideways into joist bays and partition walls until it finds an exit crack. This belt-and-suspenders approach is the best way to prevent the stack effect from stealing your home's heat.

Cover large ceiling holes with plywood, drywall, or rigid foam, and seal the edges with caulk, spray foam, or housewrap tape. While you're at it, check for holes under first-floor bathtubs or showers. Plumbers typically cut out a big piece of the subfloor to accommodate drain lines and traps; these air pathways should be sealed.

Martin Holladay is a senior editor.

Test for radon

Radon is a colorless, odorless, naturally occurring gas that can seep through soil into your basement. High radon levels can damage human health. While most homes have relatively low radon levels, some have dangerously high levels.

Sealing cracks in your basement can affect radon levels in your home, either for better or worse, depending on several factors. If necessary, a radon-remediation contractor can install plastic pipes under your basement slab to lower the radon to safe levels.

The best way to determine whether your home needs radon-remediation work is to test the air in your home. For more information on radon testing and remediation, visit <http://epa.gov/radon>.

For details on radon mitigation, see GreenBuildingAdvisor.com/radon.