BuildingGreen

BuildingGreen's Guide to

BUILDING ENVELOPE PRODUCTS

Simple, clear criteria for selecting energy-efficient and healthier materials

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Bullitt Center under construction.
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About BuildingGreen

BuildingGreen combines insight with information, creating knowledge that informs practice. We provide design and construction professionals with practical insights, engagement opportunities, and software resources to exceed clients' energy and environmental performance expectations.

Readers of this guide are eligible for continuing education credits from the AIA, ILFI, and GBCI. To claim your credits, take the quiz at BuildingGreen.com/ThermalMoistureGuide.

Published by BuildingGreen, Inc.
122 Birge St., Suite 30
Brattleboro, Vermont 05301

(Updated April 2018)

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What Makes the Building Envelope Green?

From insulation to flashing tape to cladding, we look at the attributes of the greenest thermal & moisture protection products.

By Tristan Roberts

If the only time you think about insulation choices is when you're figuring out how to meet code for your design, you're missing the point.

The building envelope isn't just there to hang the façade on. It makes the space a space—protecting us from the elements, enabling comfort, and ultimately allowing us to be home at home, to be productive at the office, to learn in school, or to heal in the hospital.

A building envelope should:

- support comfort
- not poison us or other species
- allow us to breathe clean air

When possible, it should do all this while using resources effectively—durably, energy-efficiently, and with low embodied impacts. Fiber insulation, for example, provides a great opportunity to use recycled content or renewable, biobased materials. It insulates well, thus keeping us comfortable, and doesn't use a persistent organic pollutant as a flame retardant, keeping these toxic substances out of our environment.

How This Guide Can Help You Manage Tradeoffs

In this guide, we discuss what makes a building envelope product green.

Rigid boardstock insulation illustrates the kinds of tradeoffs we see in insulation and building envelope materials—and how the industry is gradually improving our choices.

Photo: Alex Wilson

Green Products and Our Mission

Part of BuildingGreen's mission since 1992 has been to look for the greenest building products available and to share that knowledge to build more liveable, more effcient, healthier buildings.

Once housed in three-ring binders and then in a database focused only on green products, our green building products expertise is now embedded in BuildingGreen.com.

We rely on third-party testing and other criteria when vetting products (see What Makes a Product Green?). So readers can better understand why we choose the products we do, we have created a series of product guides that explain the problems with the industry norms and how we have selected green building products that mitigate those problems.

Why mineral wool?

Only a few years ago, if you needed rigid insulation, your go-to choice was polystyrene. Now, mineral wool is BuildingGreen's most commonly recommended insulation choice; it's not that hard to get, and it comes with a minimal cost premium.

Why mineral wool?

- It offers the same R-value—about R-4—as other common choices like polystyrene (although neither insulates as well as polyisocyanurate).
- It contains up to 90% recycled content from iron ore blast-furnace slag.
- It's impervious to pests, fire, and moisture with no added toxic chemicals. In comparison, polystyrene uses the toxic flame retardant HBCD. Polyisocyanurate also avoids HBCD, but it uses another, less-known halogenated flame retardant instead. And polyiso is not as forgiving around moisture as mineral wool. Mineral wool does contain formaldehyde as a binder, but some products meet Greenguard Gold standards for low emissions.
- It is a vapor retarder but does not act as a vapor barrier, so it can be used in wall and roof assemblies to allow drying.

In this mineral wool sample, you can see flecks of black—bits of residual iron from the blast furnace.

Thermal and moisture protection are an important job for insulation and other building envelope materials, but mineral wool and other products give us choices that perform well and that don't require us to compromise on other points. To the contrary, mineral wool's flame resistance offers an inherent benefit that becomes even stronger when you consider how it avoids toxic chemicals commonly used in other products.

Toxic chemicals in the envelope

Should we care about toxic chemicals in building envelope products, or should it just be about energy performance? After all, occupants aren't usually in contact with insulation.

While energy savings are our first concern, it's shortsighted to consider only one narrow impact of our products. Flame retardants like HBCD are found in the blood of people and animals all over the world. Once these chemicals are created, they can find a way into the environment and into our bodies in multiple possible ways:

- during manufacturing, when workers may be exposed
- as chemical releases from factories
- in dust created during installation
- by offgassing or sloughing off in dust during use
- in the course of demolition and disposal

When we have a ready alternative to the most-toxic chemicals (especially persistent, bioaccumulative toxicants) we should use it—and we should keep searching for alternatives if they aren't available yet.

In this guide, we also encourage the use of ingredient transparency and disclosure protocols like Health Product Declarations (HPDs), which can alert us to the presence of toxic chemicals in building materials.

Photo: Tristan Roberts

In this assembly, mineral wool is being used as a firebreak between blocks of polystyrene.

How It All Comes Together

Of course, buildings are made up of products, but they come together in assemblies: the foundation systems, above-grade walls, and roofs that make up the enclosure. Effective management of the cracks and transitions between materials and assemblies can spell the difference between a building that works and one that falls victim to moisture and mold problems. Green building envelope products should contribute to effective air and weather barriers, continuous insulation, and assemblies that keep moisture at bay.

In this guide, we consider not just insulation but also foundations, weather barriers, and products that package it all together: fabricated wall assemblies, insulating concrete forms (ICFs), and structural insulated panels (SIPs). For these categories, we sometimes relax our concerns about chemicals in recognition of the special benefits of products that come as a detailed package.

For example, BuildingGreen does not generally recommend expanded polystyrene (EPS) as an insulation material because it is made with several problematic materials, including benzene and HBCD, but we list EPS-core SIPs because they provide a relatively easy way to create walls with superb energy performance. We draw the line, however, at SIPS with extruded polystyrene (XPS), because it uses a blowing agent with very high global warming potential.

Building envelope products: Green attributes

The following green attributes are the key ones BuildingGreen considers in screening building envelope products.

Reduces heating and cooling loads

Before specifying efficient heating and cooling equipment, it's important to do what we can to reduce heating and cooling loads. Insulation is one of the key products to consider here, but because there are so many insulation products on the market, we look for additional benefits.

Examples include cellulose insulation with recycled content, mineral wool insulation with no flame retardants, and fiberglass insulation with no formaldehyde binders.

Prevents moisture or air-quality problems

Moisture brings durability and air-quality problems with it, and myriad green products are designed to manage moisture and keep it out. Given the variety of products available, we look for those that meet key performance standards and that make sense in a whole building assembly—such as "smart" vapor retarders and vapor-permeable weather-resistive barriers that not only prevent moisture from entering the building envelope but also allow drying when the envelope gets wet.

Reduced manufacturing impacts

It may be that the product itself was redesigned to require less-hazardous inputs or use raw materials with lower embodied carbon, or perhaps the manufacturing process was redesigned to reduce waste, emissions, and material or energy inputs. The green chemistry movement is pushing manufacturers to redesign products to avoid hazardous inputs in the first place. However it's accomplished, products with reduced manufacturing impacts relative to alternatives tend to be environmentally preferable.

Avoids hazardous ingredients

Some materials provide a better alternative in an application dominated by products for which there are concerns about toxic constituents, intermediaries, or by-products. An example is insulation that avoids HBCD or other halogenated flame retardants.

Improves acoustical performance

Background noise, whether from indoor or outdoor sources, adds to stress and discomfort, and poor acoustical design inside can exacerbate problems from background noise and reverberation of sounds.

Insulation products that absorb sound and prevent sound transmission can be considered green, although there are so many such products available that we also look for especially innovative products as well as products with additional green attributes, such as recycled content and strong energy performance.

CAPILLARY BREAKS: HOW TO GET THEM RIGHT THE FIRST TIME

Most people understand that they need drainage—but they forget to plan for the water that flows uphill, and disaster can result.

By Paula Melton and Peter Yost

Water moves through buildings in four ways. *Capillary movement*, or wicking, is special—and not just because the water defies gravity. Capillary movement is also the simplest moisture issue to predict and prevent, *and* it's the most often overlooked.

It's also the hardest to remediate if you forget to design and build it into your details the first time.

Wicking occurs whenever porous materials are in contact with a source of liquid water—like soil, or another porous material that's wet. That's because these porous materials are full of tiny-diameter tubes that water molecules find irresistible. This creates capillary action and gradually draws water into the building envelope.

The problem of capillary movement from foundations into the rest of the building has been around for a long time—long enough that we have the quaint term "rising damp" to describe it. This term is still in active use for two reasons: because rising damp in existing buildings is extremely harmful and difficult to fix, and because we keep building *new* structures that have the same problem.

Preventing it, however, is quite simple: ensure there's 1) a free-draining air space or 2) a non-wicking material between two porous materials.

When water gets into organic materials, it can cause mold, degrade performance, or compromise structural integrity. Inorganic materials like concrete can tolerate quite a bit of moisture absorption, but without a capillary break, the water just keeps wicking until all porous materials that communicate with one another become damp or wet. This water can also evaporate and create indoor air quality problems.

Additionally, in colder climates, freeze-and-thaw patterns can damage concrete, brick, or stone that's absorbed a lot of water. Since the most common incidence of capillary movement is in the foundation, this can become a serious problem for anyone who likes a building to continue to stand up instead of falling down.

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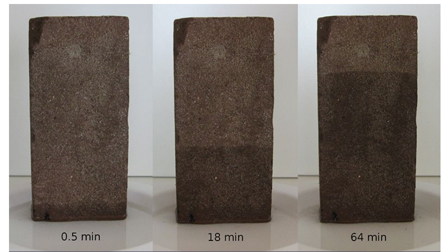


This photo shows wicking in a brick sitting in a pool of water. It does not take long for a porous material like brick to absorb a great deal of moisture.

More from BuildingGreen

» How Rainscreens Work

» How Water Moves Through Buildings

» Go with the Flows: The Promise and Peril of Hygrothermal Modeling

» Choosing the Right Hygrothermal Modeling Tool

» Fundamentals of High-Performance Building Assemblies

Some common places where a capillary break is needed (and is sometimes forgotten) are between:

- soil and concrete slabs
- concrete footings and concrete walls
- cladding and sheathing
- basement slabs and bottom plates of basement walls

Wicking materials include:

- concrete
- some types of stone
- brick
- gypsum board
- wood
- paper
- low-density open-cell foams
- soil

Some non-wicking materials include:

- steel
- aluminum
- glass
- flexible membranes (wet-applied, or sheet)
- solid plastics
- high-density closed-cell foams

The most overlooked capillary breaks are between the slab and the foundation walls (where a sill sealer is called for), and airspaces between cladding and the rest of the exterior wall. In all but the driest climates, that airspace should take the form of a rainscreen.

To ensure quality detailing of capillary breaks, architects should remember that details that aren't drawn correctly don't get built correctly. Contractors should remember that quality workmanship requires oversight. See The Hidden Science of High-Performance Building Assemblies for more guidance on moisture management in buildings.

ACOUSTIC INSULATION

Noise disrupts work, learning, and healing and can create stress and discomfort.

BuildingGreen-Approved Acoustic Insulation

We look for products with:

- Greenguard Gold certification or similar third-party testing indicating low VOC emissions

- *and* no halogenated flame retardants

Many products offer both acoustic and thermal insulating properties. BuildingGreen has additional criteria for thermal insulation products, depending on type. Products must meet both sets of criteria to be approved.

Health Considerations for Acoustic Insulation

Whether it's a passing train, a rumbling air-handling unit, or a coworker's takeout order, unwanted sounds can disrupt work and learning; persistent noise can even affect our health. In schools and conference rooms, poor acoustics prevent people from hearing teachers and presenters.

Best practices for addressing these issues start with early design decisions such as locating mechanical rooms away from occupied spaces, and locating spaces like classrooms away from sources of outdoor noise. Acoustic insulation materials can supplement these strategies.

When choosing these materials, a project team should consider metrics such as sound transmission class (STC) and outdoor-indoor transmission class (OITC). Those metrics are project-specific, however, so they don't play a role in our criteria. We approve acoustic insulation products that minimize toxic ingredients and VOC emissions.

Photo: Stramit

CAFboard is a compressed-fiber panel manufactured from wheat straw. The company markets the boards for many applications, including acoustical panels.

More from BuildingGreen

» The Sound of Sustainability: Acoustics in High-Performance Design

» Demountable Walls: Here to Redeem the Open Office

» Building Acoustics: The Basics of Managing Sound and Noise

» New Concepts in LEED v4

» CAFboard Compressed-Straw Panel Is Back

» QuietRock and QuietWood: Innovative Sound-Control Products

BLANKET & BATT INSULATION

Conventional batt or blanket insulation is made from virgin materials and may incorporate formaldehyde-based binders.

BuildingGreen-Approved Batts

Blanket, or batt, insulation provides reasonable R-value using relatively low-impact materials like fiberglass, mineral wool, or cotton rather than fossil-fuel-based plastics.

Products approved by BuildingGreen have:

- high recycled content
- *or* reduced indoor air quality concerns
- *or* superior performance in particular applications, based on their airtightness or management of moisture

Health and Performance Considerations

Blanket insulations that install between studs or joists are typically inexpensive but require meticulous installation to minimize air leaks around openings and where wires or pipes extend through wall cavities.

In light-frame construction with OSB (oriented-strand board) sheathing as the basis for the air-barrier system, some projects have turned to spray-foam to fill cracks in the assembly while also providing insulation, a *flash-and-batt* system.

Newer latex alternatives to spray-foam are also being used to seal cracks, but all flash-and-batt installations still require quality workmanship.

Aerogel

Approved products include aerogel-impregnated blankets that are designed to reduce thermal bridging in certain applications. Aerogel provides the highest R-value of any non-vacuum insulation material—about R-10 per inch—in a blanket that is less than one inch thick.

Cellulose

Cellulose batts are made from recycled paper but also require other fibers, binders, and borate-based and/or ammonium sulfate flame retardants. Look for low-VOC binders containing no formaldehyde.

(continued)

Photo: Knauf Insulation

EcoBatt is produced without any dyes, giving the fiberglass a mottled brown appearance.

More from BuildingGreen

- » Mineral Wool Batts Now Formaldehyde-Free
- » Batt Insulation: Fiberglass, Mineral Wool, and Cotton
- » More Sloppy Cotton Batt Installations from Bonded Logic
- » CertainTeed Introduces a Formaldehyde-Free Batt Insulation
- » Mineral Wool Insulation Entering the Mainstream
- » Tests Verify Airtightness of Spray-Foam Alternatives
- » Knauf Introduces Ecose Biobased Binder

Cotton

Made from recycled blue jeans, cotton insulation is typically recyclable at the end of its service life. It contains borates for fire and pest resistance.

Fiberglass

Fiberglass is made primarily from silica spun into glass fibers that are held together with a binder. For years, phenol-formaldehyde (PF) was the most common binder, but most manufacturers now offer formaldehyde-free products.

Most fiberglass insulation today has at least 30% recycled-glass content, with some manufacturers using as much as 40% post-consumer recycled glass from bottles.

Fiberglass may be less effective than many insulation types under very cold conditions due to its relatively low density and its tendency to allow air movement through it.

Mineral wool

Made from molten slag (a waste product of steel production), natural rock (such as basalt and diabase), or a combination of the two, mineral wool batts have a phenol-formaldehyde binder to hold the fibers together.

Mineral wool has a higher density than fiberglass, so it has better sound-blocking properties. It is also more fire resistant than fiberglass.

Because of the formaldehyde content, look for products meeting Greenguard Gold or an equally rigorous emissions standard.

Sheep wool

Wool doesn't require a binder and is inherently fire resistant, though some products may contain borates to discourage pests.

BLOWN INSULATION

Many insulation materials are petroleum-based, are made with hazardous ingredients, or contain virgin materials.

BuildingGreen-Approved Insulation

Products approved by BuildingGreen avoid potentially hazardous additives and binders and:

- have high recycled content
- *or* offer superior energy performance

Approved cellulose insulations are derived from agricultural waste, offer superior moisture or air leakage performance, or impart lower indoor air quality concerns than other products.

Types of Materials

Blown insulation can include any fiber insulation material that is blown into place, usually in a wall cavity or roof. Many insulation materials that are installed as loose-fill can also be spray-installed when mixed with moisture, a binding agent, or both.

The most common blown insulation materials (aside from spray polyurethane foam) are cellulose and fiberglass, but mineral wool, sheep's wool, and other materials are also used.

Cellulose

Cellulose insulation has several environmental advantages. Most products contain 75%–85% recycled newspaper (usually post-consumer) and borate and/or ammonium sulfate flame retardants, which are benign in comparison with other common flame retardants.

Cellulose can be blown into a closed framing cavity under pressure in a "dense-pack" application, or blown or poured into the floor cavity of a roof or ceiling as loose fill.

"Stabilized" cellulose, used primarily in roofs, contains a small amount of acrylic binder to prevent settling and shrinkage.

The energy performance of dense-pack cellulose is comparable to that of high-density fiberglass batts, at roughly R-3.7 per inch, but cellulose insulation generally fills cavities more completely—especially around wires or pipes, or in oddly sized framing cavities—and so is more effective at preventing air leakage.

(continued)

Photo: Alex Wilson

Spider insulation being sprayed into an open wall cavity

More from BuildingGreen

» Can We Replace Foam Insulation?

» Toxicological Riddles: The Case of Boric Acid

» Getting to Know Spider Insulation

» Installing Insulation With the X-Floc Ventilated Dry Injection System

» EPA Takes Action on Spray-Foam Health Risks

» Avoiding the Global Warming Impact of Insulation

» PBT Chemicals-Persistent, Bioaccumulative, Toxic

Fiberglass

Loose fiberglass is most commonly blown into closed cavities or applied through a specialized mesh that has been stretched across the inner face of framing members; a form that includes a binder can also be sprayed into an open cavity.

Fiberglass and mineral wool can release respirable fibers into the air that are respiratory irritants. Blown fiberglass and mineral wool should be installed only if the fibers can be prevented from getting into occupied space or air-distribution systems.

Installation

Some materials are sprayed into open cavities and then covered (as with damp-spray cellulose or fiberglass with a binder—see above) while others are sprayed onto exposed surfaces and left exposed.

With cavity-fill installations, a screeding tool is used to trim off excess insulation flush with the inner face of the framing members.

With blown insulation systems that add moisture, make sure that the installer keeps the moisture level at or below the level specified by the cellulose insulation manufacturer.

With damp-spray cellulose, which has the highest moisture content of these systems, some drying is required before drywall is applied. Manufacturers typically recommend at least two days of drying before drywall installation, though more time may be required in areas with high humidity. Dryers or dehumidifiers may be called for.

Benefits

Dense-pack insulation applications are typically very effective at reducing air leakage in addition to reducing conductive heat loss or gain. These materials also do a good job around wires and pipes that run through framing cavities—thus solving a common installation problem with batt insulation.

Blown insulation can be used on its own in framed walls, although thermal bridging may be a problem. A layer of rigid board insulation is sometimes used with cavity-fill blown insulation to provide a thermal break.

Alternately, a framing system can be used that results in minimal thermal bridging, such as a double stud wall separated by an air space, or a deep, non-structural "curtain truss" or modified Larsen Truss frame that hangs off a structural wall.

(continued)

Insulation Baffles

In vented roof and attic assemblies, insulation baffles are often used to ensure that a properly sized air space is maintained between the top of the insulation and the roof decking. Made from corrugated cardboard, foam, or plastic, or built onsite from wood, these baffles maintain airflow between soffit and gable end or ridge vents. Roof ventilation removes moisture that may migrate upward in the building, prevents snowmelt and ice dams on the roof, and maintains insulation performance (the highly conductive nature of water renders wet insulation much less effective).

More detail is offered in the BuildingGreen Guide to Insulation Products and Practices.

BOARD INSULATION

Plastic foam insulation's manufacturing process can be polluting, its global warming impact can be stratospheric, it is laden with toxic flame retardants, and it is highly flammable, even with those chemical additives.

BuildingGreen-Approved Rigid Insulation

We do not approve any rigid insulation boards made with polystyrene. Approved products have *at least* one of the following attributes:

- recycled content
- low emissions
- avoidance of common hazardous ingredients
- high durability
- blowing agents with little or no global warming potential

Environmental and Health Considerations

Extruded and expanded polystyrene (XPS and EPS) are manufactured using a number of hazardous chemicals, including benzene, styrene, and the brominated flame retardant HBCD—a persistent, bioaccumulative toxic chemical that is slated for elimination in Europe.

Because of the health and environmental concerns surrounding these materials, BuildingGreen does not approve rigid polystyrene insulation as a standalone product. However, because energy performance is a high priority with any building, use of XPS or EPS may be appropriate when those are the only options available to meet functional performance goals.

Alternatives to foam

Alternatives to rigid foam include:

- rigid mineral wool
- expanded cork
- rigid fiberglass
- foamed cellular glass

When considering material choice early in design, building enclosure systems can be designed to use spray polyurethane foam (SPF) or minimize thermal bridging in other ways so that cellulose or other fiber insulation products can be used without an energy penalty.

(continued)

Photo: Amorim Isolamentos, S.A.

With this fire testing, expanded cork insulation lasts more than an hour before burn-through, compared with 5 seconds for polystyrene.

More from BuildingGreen

- » Can We Replace Foam Insulation?
- » The Great Eight: High-Impact Material Choices for Green Building
- » Move Over, Foam: Sub-Slab Mineral Wool Is Here
- » Polyiso Insulation Without Halogenated Flame Retardant
- » New Insulated Metal Panels without Halogenated Flame Retardants
- » Mineral Wool Insulation Entering the Mainstream
- » Foamglas Insulation: A Great Option for Below Grade
- » Foamglas – My New Favorite Insulation Material
- » Cork Insulation on Our Farmhouse
- » Expanded Cork: All-Natural Rigid Boardstock Insulation

(continued)

Mineral wool

Mineral wool board is a versatile insulation made from molten slag (a waste product of steel production) or natural rock (such as basalt or diabase), held together with a phenol-formaldehyde binder.

Mineral wool has a higher density than fiberglass, is more resistant to fire, and is better at blocking sound. It is appropriate for foundation wall insulation and, in highest-density form, may be considered for use under concrete slabs (although such applications may need special approval by building code officials).

Expanded cork

Cork is natural, it sequesters carbon, and it is produced through a sustainable silviculture process with a 2,000-year tradition. The material regenerates itself and can be harvested every nine years. It insulates well, absorbs sound, and is durable in use but ultimately biodegradable.

In building applications, cork is best known as a floor-tile product and a sound-control underlayment, but it's a good insulator as well. Rigid cork boardstock insulation has been available in Europe for several decades and is now available in North America.

More from BuildingGreen (continued)

- Polyiso Impacts Are High, but Performance May Make Up for Them
- Polyiso Manufacturers Turn Blind Eye to Problems at Cold Temperatures
- Flame Retardant Used in Polystyrene to be Banned by EU
- Polystyrene Insulation: Does It Belong in a Green Building?

Polyiso

Of the rigid plastic foam insulations on the market, polyisocyanurate, or polyiso, may have the smallest footprint—though its impacts are still significant.

Polyiso manufacturers were among the first to move away from ozone-depleting blowing agents, and they are the first to have removed halogenated flame retardants.

Cellular glass

Although expensive, cellular glass is another option. It is naturally flame retardant, but its high compressive strength and moisture properties make it appropriate for below-grade applications, especially sub-slab applications—where XPS currently dominates the market.

Fiberglass

Rigid fiberglass is similar to fiberglass batts but formed into denser boardstock.

A shift to non-formaldehyde binders has not been as rapid with rigid insulation products as it has with batts, but some manufacturers are making that transition. Concentration of the binder is higher in rigid boardstock than in batt insulation.

Complexities of selection

Note that board insulation products vary widely not only in R-value but also in permeability, moisture resistance, insect resistance, fire resistance, need for flame-retardant additives, and end-use applications.

Selection of these products can be complex and confusing. More detail is offered in the BuildingGreen Guide to Insulation Products and Practices.

FABRICATED EXTERIOR WALL PANELS

Wall assemblies are made up of a number of different materials and systems, and installing each of them requires considerable time and labor and can introduce errors that compromise the building's weather resistance and thermal performance.

BuildingGreen-Approved Exterior Wall Panels

Products approved by BuildingGreen contain all the component parts for exterior wall assemblies that integrate thermal insulation.

Life-Cycle Impacts and Energy Performance

Fabricated wall panel assemblies can reduce waste and save time and money on the jobsite while helping prevent workmanship flaws by integrating a variety of systems, such as thermal insulation or rainscreens. With a thin metal skin and foam insulation for a core, insulated metal wall panels provide excellent thermal protection and efficient use of materials.

The materials, themselves, however, have relatively high embodied energy and may contain materials that can have a negative impact on health and the environment. Panels made with an expanded polystyrene (EPS) foam cores contain the brominated fire retardant HBCD, a persistent, bioaccumulative toxic chemical, and are made from benzene and styrene.

BuildingGreen approves these panels because of their superior thermal performance. But when possible, choose a core made from mineral wool or polyisocyanurate or polyurethane foams; these do not contain benzene or HBCD.

Installation

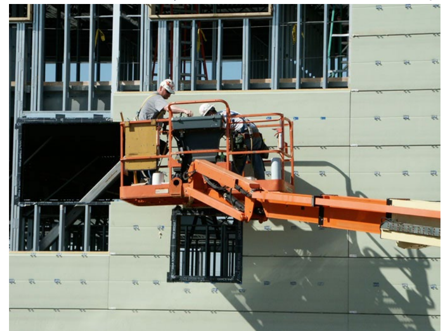
The details at the joints between these panels are critical for maintaining the air and moisture barriers as well as insulation value, so proper installation—including sealing, alignment, and allowing for expansion—is critically important.

Rainscreens

Rainscreens consist of exterior cladding attached by way of a frame to a structural exterior wall that is typically covered by an air barrier (which also serves as a drainage plane), rigid board insulation, or both. Insulation types include mineral wool, XPS, or polyisocyanurate, and spray polyurethane foam (SPF) insulation can also be used in some systems.

(continued)

Photo: Alyssa Peconi, Centria Service Group



Metl-Span panels are secured to steel studs using anchors that also hold the masonry veneer or terra-cotta cladding. This saves time on the jobsite while minimizing penetrations and thermal bridging through the insulation.

More from BuildingGreen

- The Hidden Science of High-Performance Building Assemblies
- How Rainscreens Work
- Retrofitting Exterior Foam on Existing Walls
- New Insulated Metal Panels without Halogenated Flame Retardants
- Invelope: A Breakthrough in Exterior Commercial Wall Assemblies?
- Continuous Insulation Rainscreen System from Knight Wall Systems

The space between the cladding and the weather barrier supports ventilation of the cladding and drying of moisture in the wall cavity, and can reduce moisture drive into the structure.

Rainscreen systems that incorporate continuous insulation—which only allows minimal penetrations through the insulation for service openings or support clips—keep moisture from being driven into the building while reducing thermal bridging and improving the R-value of the building shell.

FOUNDATIONS

Conventional excavation practices can harm ecosystems, while improper foundation and slab drainage can allow water to build up and compromise the structure and integrity of the building.

BuildingGreen-Approved Foundation Products

While many conventional materials can get the job done, BuildingGreen approves foundation products that:

- reduce environmental impact
- *or* contain recycled content
- *or* require less-extensive excavation or transport of materials

For drainage and waterproofing, we approve:

- products that contain no VOCs and require no solvent-based primers or adhesives
- sheet waterproofing products that are manufactured using materials with reduced environmental impact, such as HDPE
- cold fluid-applied, below-grade waterproofing products that comply with *ICC AC29 Cold liquid-applied, Below-grade, Exterior waterproofing materials* and have a VOC content less than 50 g/l, or can demonstrate exceptional durability or other positive environmental attributes
- bentonite products

Performance and Environmental Considerations for Foundations

Installing foundation and slab drainage is relatively inexpensive to do during construction but impossible or very expensive to do as a retrofit. The same goes for adding capillary breaks to prevent wicking.

Proper drainage design is site-specific, taking into account the location of the water table, soil type, grades around the building, and other factors, and requires careful attention to detail.

Preventing capillary movement, or wicking, is much more straightforward but is too often overlooked. Wicking occurs whenever porous materials are in contact with a source of liquid water—like soil, or another porous material that's wet. Capillary breaks can be products that create a free-draining space or are non-porous, such as sill sealers, flexible membranes, or liquid-applied sealers.

(continued)

Foundation excavation can disturb plants, displace large amounts of soil, and sometimes lead to erosion problems.

More from BuildingGreen

- » How Water Moves Through Buildings
- » Capillary Breaks: How to Get Them Right the First Time
- » 30 Years Later – Fixing Those Drainage Problems
- » EPA Primer on Moisture Control Filled With Strategies, Checklists
- » Geopier's Low-Impact Foundation Support for Poor Soils
- » Pin Foundations: No Excavation Required

Some common places where a capillary break is needed:

- between soil and concrete slabs
- between concrete footings and concrete walls
- between basement slabs and bottom plates of basement walls

One feature that is often not included, but which BuildingGreen recommends, is an at-grade cleanout.

Problems with conventional excavation

Conventional foundation excavation can disturb plants and soil and cause sediment runoff and erosion—especially in fragile environments (such as boardwalks and decking in wetlands) and in erosion-prone areas.

When soil conditions are poor, soil is sometimes removed entirely, trucked to a landfill, and replaced with engineered fill, requiring the expenditure of energy to remove and transport the loads to and from the building site.

Other foundation support systems in poor-soil conditions typically require use of steel or concrete.

Foundation waterproofing

Waterproofing products should be selected primarily based on durability and end use, but BuildingGreen recommends avoiding products that contain petroleum distillates and other hazardous ingredients, and does not approve hot fluid-applied products.

Bentonite waterproofing

Bentonite is a highly expansive natural clay. When exposed to moisture, it swells "shut," providing effective waterproofing. Products are available in sheets or panels. Bentonite membranes may be used beneath concrete slabs, against backfilled foundation walls, and for property line construction, such as lagging and metal sheet piling retention walls. Some companies provide bentonite-based concrete joint waterstops that activate and swell to form a positive seal.

Bentonite waterproofing can be installed on "green" concrete as soon as the forms are removed in a wide range of weather conditions, including in freezing temperatures.

Cementitious and reactive waterproofing

Although most conventional concrete sealers and waterproofing agents have very high VOC levels, some products react with the concrete or otherwise provide a seal without resorting to solvents that emit VOCs.

(continued)

Sheet waterproofing

Sheet waterproofing is usually made from rubberized asphalt, isobutylene-isoprene rubber, or EPDM. Sheet waterproofing is generally designed for use below grade to prevent capillary movement (a.k.a. rising damp). See page 6 to learn about proper detailing to prevent wicking.

Fluid-applied waterproofing

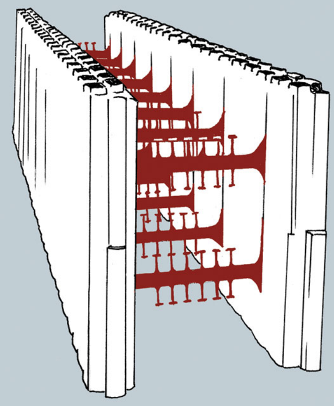
Fluid-applied waterproofing products are installed on concrete and other porous materials to prevent moisture from passing into the building. Many of these products, such as hot-applied rubberized asphalt mixes, are used on concrete below grade, but some are intended only for use above grade.

Cold-applied products have lower VOC levels and contain fewer hazardous ingredients than hot-applied products. They can be acrylics, polyurethanes, asphalts, silyl-terminated polyether polymers, or other materials.

Waterproofing vs. damp proofing

Products labeled as "damp proofing" provide little or no resistance to hydrostatic pressure, but "waterproofing" products demonstrate their moisture performance according to ASTM D5385 (Standard Test Method for Hydrostatic Pressure Resistance of Waterproofing Membranes).

Image: BuildingGreen, Inc.



INSULATING CONCRETE FORMS

Concrete is extremely durable but has a big carbon footprint, so optimizing material use and thermal performance is ideal.

BuildingGreen-Approved ICFs

We approve non-XPS insulating concrete forms with high recycled content or unique environmental performance properties.

Environmental and Energy Performance of ICFs

Both expanded polystyrene (EPS) and extruded polystyrene (XPS) are produced from benzene, a known carcinogen, and both contain the brominated flame retardant HBCD, which is a persistent, bioaccumulative toxic chemical. Styrene is highly toxic and a likely human carcinogen, making it a significant occupational hazard.

In addition, XPS is manufactured with blowing agents that have very high global warming potential, which can cancel out most of the energy savings from this material.

We do not approve XPS-based ICFs. We do approve certain EPS-based ICFs, despite concerns about halogenated flame retardants, because of their energy performance and other environmental attributes, such as reduced portland cement use compared to that of conventionally formed concrete walls.

To protect against potential damage from wood-boring insects, some EPS foam used in ICFs contains low-toxicity borates or other insecticides.

R-value caveat

Insulating concrete forms feature excellent thermal resistance, but be aware that some manufacturers inflate these claims.

The R-values touted by ICF manufacturers are not always arrived at in a consistent manner and may be misleading. We recommend only using "steady-state" R-values for comparing products, when that information is available.

Mass-enhanced or "effective" R-values take thermal mass into account and are only relevant in certain climates or under certain conditions. But they're often listed in product literature in a way that fails to distinguish them clearly from steady-state R-values.

(continued)

More from BuildingGreen

- Thermal Mass and R-value: Making Sense of a Confusing Issue
- Considerations of Insulating Concrete Forms (ICFs)
- Primer: Insulated Concrete Forms

In general, claims about the benefit of the thermal mass in ICFs may be exaggerated; the insulation interior to the concrete core of some or most ICFs dampens the ability of the concrete thermal mass to transfer heat to and from the interior environment of the building—and it's this heat transfer that is key to the effective use of thermal mass.

Due to these issues, some ICF products may not be approved by BuildingGreen because of misleading energy performance information from manufacturers.

RADIANT BARRIERS

Radiant barriers work by reflecting heat from a heat source. When faced away from a heat source, radiant barriers also work because of their low emissivity, which means that they allow relatively little heat to radiate from them.

Though they can be effective for lowering the cooling load in warm climates and limited applications, BuildingGreen does not review or screen specific radiant barrier products because:

- they are not a substitute for conventional insulation
- there are minimal differences between products
- it is common for radiant barrier manufacturers to exaggerate thermal performance claims and mislead consumers on best practices

Materials

Radiant barrier products can be foil-faced kraft paper, foil-faced polyethylene film, foil facings on rigid insulation or wood-fiber sheathing, or aluminized paints (though these paints normally don't meet emissivity standards). If the radiant surface is touching another material, it won't work; an air space is required on at least one side of a radiant barrier in order for it to function as designed. Radiant surfaces must also be kept clean; dust and dirt significantly reduce the reflective and emissivity properties of radiant surfaces.

If feasible, reflective roofing is a better option for reducing cooling loads in hot climates, but where reflective roofing is not an option for cost or aesthetic reasons, a radiant barrier in an attic can be beneficial. Radiant barriers are typically less effective than insulation in reducing heating loads.

Beware of paints that are sold as radiant barriers. These are typically not true radiant barriers because they do not meet emissivity standards, and they *are never* a replacement for wall insulation.

Recycled content

Radiant barrier products usually do not include significant recycled content because of the lower reflectivity (higher emissivity) of recycled aluminum compared with virgin aluminum, and the difficulty of producing very thin foils from recycled aluminum.

(continued)

Photo: SOLEC-Solar Energy Corporation

While not as effective as foils, low-emitting and reflective coatings can, if properly chosen, help reduce solar gain in attics. They are also easier to install.

More from BuildingGreen

» Radiant Barriers and Reflective Insulation

» A Low-Emissivity Coating That Really Works

» How Insulation Works

The sheathing portion of insulated sheathing typically comes from pre-consumer recycled wood fiber and is often made from low-emitting phenol formaldehyde.

The structural specifications of insulating sheathing boards vary. When incorporating these products into your design, make sure that they meet your performance needs.

R-values

A word of caution: As a general rule, do not rely on "effective" or "equivalent" R-values for radiant barriers that include insulation; these adjusted R-values are only relevant in certain climates and under certain conditions.

SPRAY-FOAM INSULATION

Standard spray polyurethane foam (SPF) insulation is made using blowing agents with extremely high global warming potential (GWP), which can cancel out much of the potential energy savings from use over its life span.

BuildingGreen-Approved Spray Foams

Approved products include:

- some water-blown SPF products
- some SPF with alternative blowing agents made with low-GWP hydrofluoroolefins (HFOs)
- foamed-in-place products made with alternative, polyurethane-free materials

Environmental and Health Issues with Foam-in-Place Insulation

Foam insulation is sprayed in place into walls, ceilings, and foundation areas, where it expands and cures, providing high R-values (3.6 to 6.5 per inch) while generally being effective at blocking air leakage. Application of these products requires special equipment and is usually done by licensed contractors.

Spray polyurethane foam (SPF) accounts for the vast majority of foam-in-place insulation, while a less common, inorganic foamed-cement insulation offers some attractive features for health-conscious building occupants. There is also one *grown*-in-place product, made from mushrooms, under development.

Most SPF insulation is foamed with two parts (conventionally called the "A" and "B" components): usually polyol and isocyanate, the latter of which is known to be highly toxic during application. Supplied-air respirators are required during installation, and the U.S. Environmental Protection Agency (EPA) recommends that buildings should not be occupied for at least 48 hours after installation to minimize health risk during curing.

Improperly cured SPF can cause highly offensive odors and has been associated with myriad health problems, including the onset of asthma and chemical sensitization.

Foamed phenol-formaldehyde and urea-formaldehyde foamed insulation (UFFI) remain in use, primarily for insulating concrete masonry cavities. Due to potential formaldehyde emissions, these materials are not approved by BuildingGreen.

(continued)

Photo: Air Krete

Air Krete is installed in cavities, typically behind webbing, as shown here.

More from BuildingGreen

- » EPA Raises Health Concerns with Spray Foam Insulation
- » Foam-In-Place Insulation: 7 Tips for Getting Injection and Spray Foam Right
- » Avoiding the Global Warming Impact of Insulation
- » Massachusetts Fires Tied to Spray Foam Incite Debate
- » Passive House Group Bans Certain Spray Foam Insulation
- » Spray Foam with Minimal Global Warming Impact Now Available

(continued)

Closed-cell SPF

Closed-cell SPF is typically installed at a density between 2.0 and 3.0 pounds per cubic foot and achieves the highest R-value of any foamed-in-place insulation. It can be used in place of XPS as an exterior foundation insulation, as long as proper drainage is provided, and may even be used as sub-slab insulation.

While the blowing agent used for most closed-cell SPF, HFC-245fa, is non-ozone-depleting, it is a very potent greenhouse gas, with a global warming potential (GWP) of 1,030 (CO_2 has a GWP of 1). Closed-cell SPF produced with HFC-245fa is not approved by BuildingGreen.

New HFO (hydrofluoroolefin) blowing agents (HFO-1234zd and HFO-1234ze) are now available that have a GWP of less than 5.0. SPFs produced using HFOs have higher R-values, better compressive strength, and higher yield than standard HFC products and are approved by BuildingGreen.

Alternative, water-blown formulations that produce carbon dioxide as the blowing agent are less common and do not provide as high an R-value, but these are preferable from an environmental standpoint and are also approved by BuildingGreen.

More from BuildingGreen (continued)

- The Global Warming Potential of Insulation Materials – New Calculator
- New Chemical to Reduce Climate Impact of Foam Insulation
- Low Climate Impact of New Blowing Agents Confirmed
- "What About Air Krete?" A Deeper Look at the Insulation Alternative
- Air Krete: Foam Without Plastics

Closed-cell SPF is typically installed in a layer up to two inches thick. Because foam curing is an exothermic process, thicker applications may result in excessive heat build-up and have even caused fires. Although additional layers can be applied after the first has cured, usually the cavity is not completely filled, leaving an air space.

Open-cell SPF

Open-cell, low-density SPF (typically 0.5 lbs. per cubic foot) is foamed with water, which produces carbon dioxide as the blowing agent.

Compared to closed-cell SPF, open-cell products use significantly less material, making them less expensive and more attractive from a resource standpoint. They also remain flexible and are less likely to crack with seasonal movement of a building.

However, they achieve lower R-value per inch and are not as effective at stopping moisture flow, so they cannot be used below grade or in other high-moisture applications. Some low-density SPF products are formulated with partial use of materials such as soybean oil in place of petrochemicals—though the percentage of biobased content is very low.

Note that water-blown products, though they may sound more benign, still contain isocyanates and are still highly toxic during installation.

(continued)

Chlorinated flame retardant

Most SPF insulation materials contain the chlorinated flame retardant TCPP, which was banned from children's sleepwear in the 1970s.

Our research shows that this flame retardant may be less hazardous than the brominated flame retardants used in other plastics, including polystyrene insulation, but there are still significant concerns about its health and environmental impacts.

Air Krete

An inorganic, foamed magnesium-oxide cement insulation, Air Krete, is the foamed-in-place insulation material of choice for people with chemical sensitivities.

There is no offgassing from this foamed-cement insulation, and it requires no flame retardants to remain noncombustible. However, the product requires very careful installation by company-trained installers to ensure proper performance. The cured foam is quite friable, does not function as an air barrier, and remains a very uncommon niche product.

More detail is offered in the BuildingGreen Guide to Insulation Products and Practices.

STRUCTURAL INSULATED PANELS

Stick-framed walls are labor intensive and have to be sealed and insulated in the field, where conditions are not ideal; this can lead to poor thermal performance.

BuildingGreen-Approved Structural Insulated Panels (SIPs)

BuildingGreen lists SIPs because of their excellent thermal performance and ease of installation. We do not list those with extruded polystyrene (XPS) cores due to environmental concerns.

Health, Performance, and Environmental Considerations for SIPs

Most structural insulated panels (SIPs; also known as stressed-skin panels) consist of an insulating foam core sandwiched between sheets of oriented-strand board (OSB). SIPs have gained market share in the residential and light commercial building markets because they are quick to assemble and provide excellent energy performance. The insulating core of SIPs is most commonly made from expanded polystyrene (EPS), but extruded polystyrene (XPS), rigid polyurethane foam, mineral wool, and even compressed straw can be used.

SIPs are manufactured in a range of thicknesses providing varying R-values. With some EPS-core products, borate compounds or other pesticides are added to deter insects from burrowing into the foam. Even with such treatment, it may be necessary to use insect mesh, trap systems, and other insecticides on an ongoing basis.

SIP buildings can be quickly assembled, particularly when panels are factory-cut for door and window openings. SIPs are not moisture tolerant, so care must be taken to properly seal panel joints during installation to prevent air and moisture flow through walls and ensure durability.

Holistic assembly details

High-performance buildings aren't just those that offer superior energy performance: we also need them to provide a durable, safe, comfortable, and healthy space in which to live and work. Meticulously designed, specified, and installed assemblies are an integral part of building performance—and because some of the tiniest assembly details can affect all these functions, achieving project goals will require cooperative input and accountability from architects, engineers, building scientists, and contractors.

(continued)

Photo: SIPschool

More from BuildingGreen

- » The Hidden Science of High-Performance Building Assemblies
- » Polystyrene Insulation: Does It Belong in a Green Building?
- » Structural Insulated Panels: An Efficient Way to Build

BuildingGreen recommends the following installation details for SIP structures:

- rainscreen wall assemblies (dedicated free-draining space that is open at the top and bottom to promote convective drying)
- top-side venting of roof assemblies
- mechanical ventilation systems that comply with ASHRAE 62.1 or ASHRAE 62.2

All SIP joints, in addition to the manufacturer sealant details, should be backed up by a pressure-sensitive adhesive (PSA) tape as an air-sealing detail.

Issues with polystyrene

BuildingGreen does not generally recommend EPS as an insulation material because it is made with several problematic materials, including benzene and the brominated flame retardant HBCD, but we list EPS-core SIPs because they provide a relatively easy way to create walls with superb energy performance.

We do *not* currently approve extruded polystyrene (XPS) products due to their use of the blowing agent HFC-134a, which has high global warming potential (GWP) that can completely cancel out the carbon benefits of the insulation over its lifetime.

VAPOR RETARDERS

Vapor retarders are meant to protect our building assemblies from getting wet, but they can also slow drying, contributing to mold and structural degradation.

BuildingGreen-Approved Vapor Retarders

We approve only "smart" vapor retarders whose permeance changes with moisture levels to allow drying in the wettest conditions.

Vapor Profiles and Performance Considerations

"Do I need a vapor barrier?"

It's a perennial question, but there's no simple answer: heat and moisture interact with each other and with building assemblies in complicated ways, so the first thing you need is a *vapor profile* of the building assembly. This means looking at the vapor permeance of each material and ensuring that the assembly can dry should water get into it from leaks or air movement and condensation.

Vapor retarders are generally sheet goods that are added to either the interior (cold climates) or exterior (hot, and particularly hot–humid, climates) to prevent moisture from moving by diffusion into wall, roof, and foundation assemblies.

Dedicated vapor retarders are broken down into classes:

I. (0.1 perms or less) = vapor impermeable
II. (0.1–1.0 perm) = vapor semi-impermeable
III. (1–10 perms) = vapor semi-permeable

If a material has a vapor permeability greater than 10 perms, it is considered vapor permeable. (Use of the term "vapor barrier" should be restricted to impermeable membranes installed as part of concrete floor assemblies.)

Vapor management can be best accomplished with an integrated approach to material selection for an entire building assembly, rather than just the performance properties of one dedicated layer, the "vapor retarder." In fact, the best defense against water vapor in interstitial cavities is often a continuous air barrier.

(continued)

Photo: CertainTeed

The MemBrain vapor retarder becomes more permeable at higher relative humidity, so it will be less likely to trap moisture in mixed climates.

More from BuildingGreen

» How "Smart" Vapor Retarders Work
» The Hidden Science of High-Performance Building Assemblies
» Using WUFI to Prevent Moisture Problems
» Go with the Flows: The Promise and Peril of Hygrothermal Modeling
» Talk Perms Like a Pro: The Science of Water Vapor

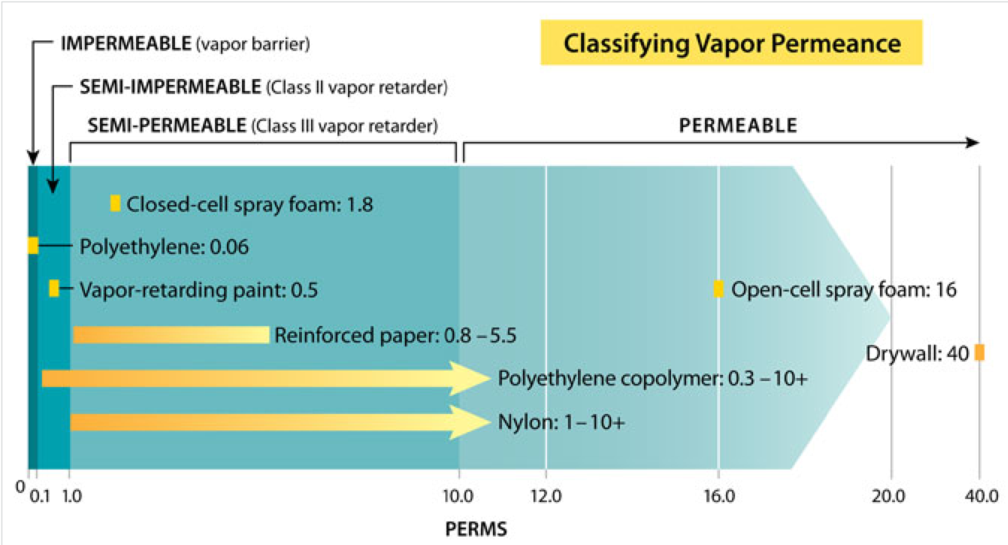


Image: BuildingGreen, Inc.

Although codes can be slow to catch up, the design world is moving away from dedicated vapor retarders and toward the concept of a *vapor profile*, assessing the permeance of each material in a building assembly and ensuring that any water leaks or condensation can diffuse readily through at least one side of the assembly.

That said, certain climate conditions and assemblies do call for a dedicated vapor retarder. Because conventional vapor-retarding products can prevent drying in the event of a bulk-water leak (which is a much more likely scenario than vapor drive into the assembly), we approve only those vapor retarders that have variable permeance to reduce the risk of trapping moisture inside the building envelope.

WEATHER & AIR BARRIERS

Water and air that penetrate building assemblies can damage materials, cause energy loss, and lead to mold, mildew, or other problems. The products used to address these may contain materials that are potentially hazardous.

BuildingGreen-Approved Weather Barriers

BuildingGreen lists a wide variety of products used to keep moisture and outdoor air out of buildings, including the following:

- weather-resistive sheet barriers (WRBs) that are neither cross-woven nor perforated and meet ASTM E2556-10 Type II Minimum Performance Requirements
- liquid-applied WRB products complying with AC 212
- sheet or fluid-applied air barriers designed to limit air infiltration into the building envelope while meeting the Air Barrier Association of America (ABAA) standard
- solvent-free flexible flashing tapes made with solid or modified acrylic
- airtight electrical boxes designed to minimize air infiltration into the building's interior
- durable gaskets and weatherstripping made of Santoprene, EPDM, or silicone
- foam joint sealants that have exceptional performance, meet unique air-sealing challenges, or have formulations that avoid key chemicals of concern
- foam tapes that expand without blowing agents and use low-emitting acrylic or latex resins
- caulk joint sealants with low VOCs and reduced chemicals of concern
- high-performance joint sealants made from silicone, MS polymers, or other low-emitting materials

Performance and Environmental Considerations for Weather & Air Barriers

With such a wide variety of materials and systems, the performance and environmental considerations are equally diverse—but material selections need to be made in the context of the whole assembly and building.

(continued)

Prosoco Cat 5 products were eligible to be used on the Living Building Challenge-certified Bullitt Center in Seattle.

More from BuildingGreen

- » Mind the Gaps: Making Existing Buildings More Airtight
- » The Hidden Science of High-Performance Building Assemblies
- » Our Real-World Flashing Tape Tests Find a Clear Winner
- » Seal, Tape, Gasket: A Sticky Search for Better Materials
- » Sealing Without Stickum: Gaskets Make a Place for Themselves
- » An Air Barrier Engineered for Real-World Jobsites
- » All-in-One Sheathing and Air Barrier Speeds Construction
- » Tremco: Getting the Devil Out of Air and Water Details
- » Silicone Air Barrier Offers Simple, Systematic Approach
- » Verifying Performance with Building Enclosure Commissioning

The building enclosure manages everything that might get into and out of a building: water, wind, light, sound, air, pests, and people. Assemblies are the foundations, above-grade walls, and roofs that make up the enclosure, and how they're put together makes all the difference to how well the building performs—and for how long.

High-performance buildings aren't just those that offer superior energy performance: we also need them to provide a durable, safe, comfortable, and healthy space in which to live and work. Meticulously designed, specified, and installed assemblies are an integral part of building performance—and because some of the tiniest assembly details can affect all these functions, achieving project goals will require cooperative input and accountability from architects, engineers, building scientists, and contractors.

Weather barriers

Weather barriers are materials intended to resist air and moisture that has penetrated the cladding system. Standards and building codes refer to materials that resist liquid water as either water barriers or weather-resistive barriers (WRBs). When combined with flashings, WRBs are part of a continuous system of bulk-water resistance sometimes called the concealed drainage plane.

Any rigid sheathing, sheathing membrane, or flexible sheet good that resists bulk water can be combined with flashings to create the concealed drainage plane. WRBs are typically flexible sheet goods (often house wraps and building paper that come in wide rolls) whose sole or primary purpose is resisting bulk water. WRBs can also be fluid-applied. Either type of WRB may also perform as a primary component of a continuous air-barrier system.

What we think of as the continuous water barrier—weather-resistive sheet goods, flashing tapes, and sealants—should actually be the second line of defense, managing only the leftover bulk water that claddings can't handle (see Seal, Tape, Gasket: A Sticky Search for Better Materials).

Air barriers

Made up of materials and components that are integrated into a system to restrict airflow through the building envelope, these products contribute to an air-barrier assembly by providing key connections where two materials or systems meet, or by filling holes at common weak points in an air-barrier assembly.

Any material that has an air permeance equal to or less than 0.02L(s•m2) @ 75Pa (equal to the air permeance of drywall) can form part of an air-barrier system. However, just having air-barrier materials in a building does not create an airtight building.

These materials and components must be joined into air-barrier assemblies, which are then tied together with additional components to create a complete, continuous system.

According to the ABAA, air-barrier materials must be integrated to create assemblies with maximum air leakage no more than 0.20 L(s•m2) @ 75 Pa (per ASTM E2357). Note that the air-leakage rate for enclosures is about 10 times greater than the air leakage standard for individual materials.

Air barriers may or may not also act as a vapor retarder or weather barrier. The air barrier can be on the exterior, the interior of the assembly, or both.

(continued)

Flashing tapes

Flexible flashing improves a building's energy efficiency and longevity by keeping air and moisture out of the building envelope. One of the most effective products, self-adhering pressure-sensitive adhesive (PSA) tapes, are used at penetrations, margins, and transitions in water- and air-barrier systems.

Though there currently is no standardized, credible way to assess either performance or relative service life of flexible flashings, BuildingGreen has conducted field tests of various tapes and currently lists only solvent-free solid- or modified-acrylic PSA tapes because they have a low environmental burden and bond well to most substrates (including OSB) at a wide range of temperatures and moisture levels, often without primers.

Raceways and boxes for electrical systems

Penetrations in exterior walls—such as dryer vents and electrical service entrances—are common sources of air infiltration into buildings.

Standard electrical boxes, although they don't penetrate the exterior of the building envelope, can be significant sources of air leakage.

Pre-formed joint seals

Quality weatherstripping (air-filled bulb gaskets) and structural gaskets (cellular foam) can be essential in achieving airtight, low-energy buildings. Gaskets are also used in dry-set glazing in commercial storefront and curtainwall construction.

Gaskets usually contain no volatile solvents and are used in areas unlikely to expose occupants to emissions.

Many are made of EPDM (ethylene propylene diene monomer), which poses few health risks to workers or building occupants. Santoprene, a cross between EPDM and polypropylene, is thought to be safe as well, but because it contains proprietary ingredients, it is difficult to assess the product's full environmental and health impacts.

By contrast, polychloroprene (better known as Neoprene) contains a chlorinated plastic made from chloroprene, a known carcinogen and suspected persistent, bioaccumulative toxic chemical.

Foam joint sealants

The challenge of sealing building envelopes against air infiltration is made easier with foam sealants, but it is important to seek out durable, high-performing products and to use them correctly.

Homeowners and builders often use spray polyurethane foam (SPF) sealants to seal window and door rough openings. Found in small cans or kits at the local hardware store, these products contain isocyanates (which can cause serious respiratory problems and are suspected carcinogens) as well as chlorinated flame retardants whose health and environmental impacts are not fully understood.

(continued)

BuildingGreen does not list these products because there is little to differentiate one from the next, and because of their associated risks. Homeowners and contractors who use these products should use proper ventilation and skin protection.

Expanding foam tapes

Expanding foam tapes, on the other hand, can provide excellent sealing performance without the hazards associated with polyurethane spray foams.

These tapes typically expand without blowing agents and use low-emitting acrylic resins. Latex-based foam products can also provide joint sealing without isocyanates or phthalates.

Caulk joint sealants

The driving environmental attributes of a liquid sealant are chemical constituency and durability.

Caulk joint sealants should have low VOCs, reduced chemicals of concern compared with industry norms, and other green attributes, but proper installation is critical to maximize their performance and lifespan.

High-performance sealants

The durability of liquid sealants is a function of their appropriate field application and designed service life.

Low-VOC products are readily available, but one of the standout products is made from MS polymers (MS stands for silyl-modified), which are hybrids of polyurethane and silicone and combine some of the strengths of each.

Their chemical profiles are better because they are solvent- and isocyanate-free.

BuildingGreen's Guide to

BUILDING ENVELOPE PRODUCTS

Simple, clear criteria for selecting energy-efficient and healthier materials

Published by BuildingGreen, Inc.