Guide to Healthier Energy Efficient Housing Products

FOCUS ON INSULATION

BLUEGREEN ALLIANCE FOUNDATION


Fiberglass Batt

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BLUEGREEN ALLIANCE FOUNDATION

Introduction

Insulation is recognized as the primary energy efficiency product that can be harmful to tenants and installation workers. This has led many housing organizations to focus on ensuring that the materials used in new construction and retrofits do not create health hazards. Our goal is to raise awareness of these issues and help people make better informed product decisions.

To this end, we have collected the latest information on:

- Chemicals in insulation products that may be harmful to building occupants;
- Insulation products and materials that may contain these chemicals;
- Potential health hazards from these chemicals or materials; and
- Opportunities to reduce or eliminate exposure to these harmful chemicals.

Research is always generating new information on these issues and we recommend that you periodically refer to our **Energy Efficiency Housing Products website** as well as the other resources recommended in our guide. We recognize that simply using safer insulation will not eliminate health concerns for tenants if other toxic products—such as wall and floor coverings—are present and plan to produce additional guides to address these materials in the coming year.

Our work complements a broader national effort to create a cleaner economy by building and retrofitting multifamily housing that is more energy efficient and uses healthier materials. We want to thank a number of partners and colleagues who are working with us to make the built environment safer and healthier, including:

- ***Energy Efficiency For All***—National Housing Trust, Natural Resources Defense Council, Elevate Energy and Energy Foundation
- **BuildingGreen**
- **Cradle to Cradle**
- **Healthy Building Network**
- **Green & Healthy Homes Initiative**
- **International Living Future Institute**

Various Insulation Types

This guide is intended as a starting point for understanding the potential dangers posed by harmful chemicals used in energy efficient housing products. It is designed to assist contractors, building owners and other housing professionals as they make product decisions for affordable multifamily retrofit projects.

This project was made possible through the generous support of:

THE JPB FOUNDATION

Energy Efficient Products Containing Harmful Chemicals

Most professionals look to insulation as the primary material to help reduce energy costs and make a building more energy efficient. However, insulation is also the primary energy efficient product that can create health hazards for tenants and installers.

Insulation provides a number of benefits: it can lower energy usage, reduce air pollution, increase comfort, improve indoor air quality and, of course, save money. Insulation also can keep occupants healthier by helping to prevent mold growth and producing a healthy air exchange within a building.

Choosing the type of insulation to use is often a complicated process, as there are a wide variety of materials and formats, different regional climate demands and significant cost variations. Applications depend on where materials are to be used in a building. Factors such as moisture control, durability and ability to stop heat flow are all key.

But the question of tenant health impacts rarely enters the equation when selecting insulation products, particularly for low income retrofits.

This is unfortunate, because for all the good insulation does, it can be harmful. The concern comes from the chemicals used to bind, formulate or even make insulation "safer" through fire resistance.

Even insulation products labeled as "green" may contain dangerous chemicals. For example, spray polyurethane foam (SPF) is often promoted as a "green" product. While it insulates better per inch than fiberglass or cellulose, it also contains chemicals known to be hazardous. The American Chemistry Council cautions that a green claim "should never be confused with the toxicity profile of a product."

Insulation remains a key component of efficiency retrofits, but when considering the type of material to use, selecting healthy insulation products should be just as important—if not more important—than cost and comfort.

The American Chemistry Council cautions that a green claim "should never be confused with the toxicity profile of a product."

Obsolete Insulation

When considering the type of material to use selecting healthy insulation products should be just as important—if not more important—than cost and comfort.

What we don't know can hurt us. With insulation, it's not always easy to be assured of a safe product. It is important to know what products, materials or components are red flags so that you are better able to make good, informed choices.

Harmful Chemicals & Health Hazards

There currently are seven major harmful chemicals found in various types of insulation material. They are **brominated flame retardants, chlorinated flame retardants, ethanolamine, formaldehyde, isocyanates, polyethylene glycol nonylphenyl ether and styrene**. The chart on the opposite page lists these chemicals, what the top hazards are for each (see **Appendix B** for definitions) and the type of insulation in which they might be found.

Note that just because a chemical is linked to a certain insulation material, it is not definitely found in all products. This is especially true in the case of formaldehyde used as a binder in fiberglass insulation. Formaldehyde has been linked to cancer, asthma and developmental harm through off-gassing into living spaces.

This concern about formaldehyde and indoor air quality led all four U.S. fiberglass insulation manufacturers to develop new formulas that are formaldehyde free. As of 2015, formaldehyde is no longer used in the production of lightweight residential fiberglass insulation.

Instead, manufacturers are using bio- or acrylic-based chemicals to bind the fiberglass together in their batt and blanket products. Not all the ingredients in the new binders are known, but human health concerns from the new binders appear to be nowhere near as significant as those from formaldehyde.

Formaldehyde, however, is still used in some heavy-density and board fiberglass production, so caution is warranted as those products could also off-gas harmful fumes. This is a concern for multifamily retrofits where commercial insulation sometimes is used. When discussing the health effects of any harmful chemical, it's important to recognize that these effects may play out over both the short and long term. With a better sense of how a chemical might affect us, we can work to take the best preventive action.

An acute, or short-term, health effect occurs when symptoms—such as a cough—develop rapidly after exposure to a substance. For some, exposure to specific chemicals may result in effects that are minimal or are readily alleviated. However, for those that are predisposed or sensitized to these triggers, the effects can be quite harmful, severe and even persistent.

A chronic, or long-term, health effect—such as asthma—has symptoms that develop slowly over a long period of time or recur frequently.

Appendix C contains chemical data sheets that distinguish between acute and chronic conditions.

Striving to provide healthier, safer, more sustainable homes for everyone means making good product choices by selecting materials that not only perform their functions, but also don't harm the individuals constructing, living, working, learning and playing in those buildings.


Polystyrene

HARMFUL CHEMICALS IN INSULATION

CHEMICAL	PURPOSE	TOP HAZARDS	HIGHEST WARNING*	TYPE OF INSULATION
BROMINATED FLAME RETARDANTS (BFR)	Fire protection	Bioaccumulation toxin; endocrine disruptor	Purple - very high concern	Expanded and extruded polystyrene foam (EPS and XPS)
CHLORINATED FLAME RETARDANTS (CFR)	Fire protection	Bioaccumulation toxin	Purple - very high concern	Spray polyurethane foam (SPF); polyisocyanurate (polyiso)
ETHANOLAMINE	Binder	Developmental; asthma	Orange - medium concern	Spray polyurethane foam (SPF)
FORMALDEHYDE	Binder	Cancer; asthma	Red - high concern	Fiberglass**; mineral wool
ISOCYANATES	Building block of polyurethane foam	Respiratory; cancer	Red - high concern	Spray polyurethane foam (SPF)
POLYETHYLENE GLYCOL NONYLPHENYL ETHER	Foaming aid in spray polyurethane foam (SPF)	Bioaccumulation toxin; reproductive toxin	Purple - very high concern	Spray polyurethane foam (SPF)
STYRENE	Building block of polystyrene foam	Cancer; reproductive toxin	Red - high concern	Expanded and extruded polystyrene foam (EPS and XPS)

**As calculated for the chemical in Healthy Building Network's Pharos Chemical and Material Library*

***Heavy-density and board applications only, usually for commercial or industrial application.*

What We Know About Insulation Materials

Though it is not always easy, careful consideration of insulation products can lead to improved tenant health through use of safer choices.

Following are some widely used types of insulation materials that would be appropriate for multifamily retrofits and what we know about potential dangers they may pose.

FIBERGLASS*

Fiberglass fibers can irritate the skin and respiratory system. Make sure the area is cleaned properly after installation.

* lightweight residential

HEALTH THREAT: LOW

MINERAL WOOL

Mineral wool fibers can irritate the skin and respiratory system. Products typically use formaldehyde as a binder, but manufacturers say it burns off during production. Check for air quality or VOC (volatile organic compound) certifications to ensure low or no off-gassing.

HEALTH THREAT: LOW

CELLULOSE

Fibers can cause respiratory concerns. A small number of people are sensitive to fumes from the ink on the old newspapers and/or the borate used to treat the fibers for fire and pest prevention.

HEALTH THREAT: LOW

NATURAL WOOL

Some products contain borate flame retardants, which are now under review by the European Union.

HEALTH THREAT: LOW

COTTON

Dust can be a respiratory irritant. The insulation is treated with borate flame retardants, which are now under review by the European Union.

HEALTH THREAT: LOW

POLYISOCYANURATE

The rigid boardstock form of SPF, nearly all polyiso contains the fire retardant TCPP, though one roofing product promotes that it is free of halogenated flame retardants.

HEALTH THREAT: MEDIUM

SPRAY POLYURETHANE FOAM

(SPF FOAMED-IN-PLACE)

The chemical isocyanate found in SPF can cause cancer and asthma. Little is known about the toxicity of the fire retardant TCPP, however structural similarity to other flame retardants that are carcinogenic raises concerns. Special protection is needed for installation. See **page 10** on the controversy over curing periods. Alternatives include cellulose, mineral wool, fiberglass, cotton, cementitious foam and natural wool.

HEALTH THREAT: MEDIUM

POLYSTYRENE FOAM

(EPS OR XPS RIGID BOARDSTOCK)

The fire retardant HBCD contains bioaccumulation toxins which build up in the environment and can cause reproductive and developmental problems, cancer, nervous system damage and genetic impacts. There also is fear that styrene, which is suspected of being carcinogenic, could off-gas. Alternatives include cork, rigid mineral wool, rigid fiberglass and cellular glass. See **page 13** on substitutions for HBCD.

HEALTH THREAT: HIGH

The lack of a wider range of alternatives points to the need for the industry to be more responsive to concerns over tenant health and not just product performance.

Uncommon Forms Of Insulation

Some safer specialty materials on the U.S. market are not well known. These alternatives also face the burden of having a higher price tag, being more difficult to source, or both. Here are some examples:

CELLULAR GLASS – This doesn't sound very durable, but in fact this mixture of sand, limestone and soda ash has a high compressive rate and extreme heat resistance. It also isn't that new—under the brand name Foamglas it's been in production since 1937. Good for wall, roof and below ground use.

HEALTH THREAT: NONE KNOWN

CORK – The byproduct from wine cork production is superheated and then cut into various depths. Heating activates a naturally occurring binder, and the material is inherently flame resistant. Since cork forests are renewable, this may be the greenest boardstock insulation around.

HEALTH THREAT: NONE KNOWN

CEMENTITIOUS FOAM – The only non-petroleum based spray foam on the market, Air Krete mixes magnesium oxychloride cement (from seawater) with heated water, compressed air and an expanding agent. Natural qualities make it fireproof and resistant to pests, moisture and mold. The foam is only for use in wall or ceiling cavities.

HEALTH THREAT: NONE KNOWN

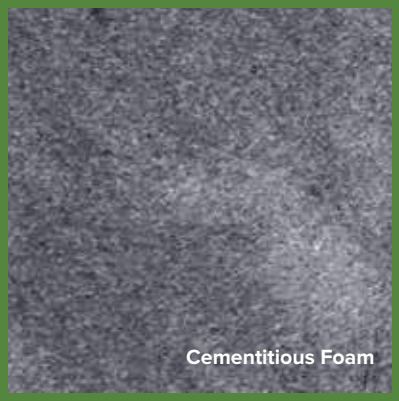
These alternative materials could be joined by soybeans and mushrooms. Soybean oil already is in use as part of the Side B polyls in SPF. This slightly reduces the use of petroleum-based ingredients in SPF, but so far does not translate into any significant health benefits.

Meanwhile, mushrooms are being used to create sustainable packaging instead of expanded polystyrene foam, or EPS. The next step is to replace EPS used for insulation. In one demonstration project, the creators took mycelium, or mushroom roots, and placed it between two walls. The mycelium then grew in place around such agricultural byproducts as seed hulls and cornhusks. The resulting insulation not only had good thermal properties, but was also fire and water resistant—and chemical free.

Any small-scale demonstration can appear promising: for the last several years mushroom insulation has been just out of reach of commercial viability. But you never know when one little breakthrough can shine a light on a whole new way to make healthier insulation.


Cellular Glass


Cork


Cementitious Foam

SPF CURING DEBATE

Spray polyurethane foam, or SPF, is full of chemicals. After all, chemicals are what create the foaming process.

Professional SPF systems have two separate mixtures, commonly known as the A and B sides. The combining of chemicals from these sides causes a heat reaction that produces the foam.

Chemicals in the A side known as isocyanates are particularly dangerous, and can cause asthma, sensitization, lung damage and skin and eye irritation. Isocyanates comprise 50 percent of all SPF foams.

Chemicals in the B side are frequently proprietary and not disclosed, but also can pose harm. In most cases they include TCPP, a chlorinated flame retardant under review by the U.S. Environmental Protection Agency (EPA).

No one disagrees with the warning that installers should wear the equivalent of hazmat suits to apply SPF. But when it comes to the safety and health of tenants, the guidance gets a little hazy.

The main point of dispute is how long to wait before allowing tenants back into a space where SPF has been sprayed.

While SPF is being applied, no residents or other trade workers should be in the spraying area—and neither should tenants in adjacent apartments unless a barrier has been put up.

Manufacturers argue that SPF foam becomes inert—and thus safe—once it has been applied and dried. This is referred to as the "curing" time—or the time it takes for the chemicals in the product to fully react. Recommended reoccupancy times can range from one hour to 72 hours depending on the type of SPF being applied. Different formulations mean that each manufacturer's cure rates can vary. Plus, there can be pressure to allow tenants back into their home too quickly.

Manufacturer guidelines are just estimates. Other factors to be considered include applicator technique, temperature, humidity and ventilation. It takes an experienced installer to calculate re-occupancy times accounting for all these variables.

Improper mixing, too thick of an application of foam or insufficient drying time between passes also can cause toxic fumes to be released much longer than the recommended curing times. There is an installation problem if the foam is discolored, remains sticky or crumbles easily.

Additionally, chemical components can migrate elsewhere in the building if the application area is not properly ventilated. And, proper clean-up is required to get rid of dust that may contain unreacted isocyanates and other chemicals, especially if the foam was cut, trimmed or otherwise disturbed.

Once the insulation is in place, workers and tenants must not undertake any heat-generating processes without appropriate personal protective equipment. Examples of problematic repairs around SPF include drilling, welding, soldering, grinding, sawing or sanding. All could cause release of chemicals.

Occupant sensitization to SPF chemicals is a major concern. "Once sensitized, continuing exposure can cause persistent or progressive symptoms and even life-threating asthmatic reactions," observes the American Chemistry Council's Spray Foam Coalition, in relation to typical exposure scenarios.

However, anecdotal reports of occupant reactions in buildings where SPF recently had been applied suggest that as some individuals become sensitized they cannot stand exposure to SPF, regardless of whether it is properly installed.

In 2014, the National Institute of Standards and Technology published a study that found off-gassing from TCPP one and a half years after the foam had been applied.

According to the EPA, there needs to be "more research" to account for the differences in curing rates. "The potential for off-gassing of volatile chemicals from spray urethane foam is not fully understood and is an area where more research is needed," says the EPA.

What We Don't Know About Insulation Products

A number of national organizations and manufacturers are working on the issue of insulation safety and sustainable chemistry. See **Appendix D** for nonprofits leading the charge in this area.

There are differences of opinion concerning hazardous substances and to what extent they can cause health problems. Disagreement can happen with a specific chemical or simply the approach to determine whether a chemical is safe to use.

For example, boric acid and borate compounds—used in cellulose, natural wool and cotton insulation—had been considered nontoxic and one of the safest fire retardants around. Then, in 2010, boric acid was added to the candidate list for the European Union's list of Substances of Very High Concern. U.S. green building groups are monitoring what happens, but are taking a more cautious approach to the notion that borate is toxic.

Because of limited research, there is a lot of uncertainty around another flame retardant—TCPP—which is used in spray polyurethane foam and polyisocyanurate. TCPP has been regarded as safer than other halogenated flame retardants, but that opinion is now questionable.

Since TCPP falls into a grouping of chemicals with similar structures that are carcinogenic, there are fears it is hazardous as well. The state of California has named TCPP as a candidate for its Safer Consumer Product Regulations. Meanwhile, the 2008 EU risk assessment for TCPP did not identify any unacceptable risks for the chemical, and states no further testing is needed. The U.S. Environmental Protection Agency began its own risk evaluation of TCPP, and its cousins TDCPP and TCEP, in August 2015.

For the most part there is basic agreement on the hazards a chemical represents—the primary dispute comes regarding risk of exposure. This is the risk versus hazard approach to chemical safety analysis. Those who worry about hazardous chemicals say they should be eliminated if they are dangerous to humans and the environment. That way there can be no accidental exposure or release.

From the risk perspective, the argument is made that if precautions are in place to ensure minimal opportunity for exposure to a hazardous chemical, then there is no reason to eliminate it. This side believes that there are acceptable exposure levels where there are no adverse effects to those exposed.

Fiberglass Batt

Eliminating/Substituting for Harmful Chemicals

It isn't easy to eliminate harmful chemicals from insulation. Often a chemical provides a needed function and there is no information on how it can be removed or replaced with a less harmful substance.

Substituting one chemical for a recognized harmful chemical isn't always better. Often, less is known about the substituting chemical, so it may be just as harmful or more so. This is known as a "regrettable substitution."

For example, in the 1970s, PCBs, or polychlorinated biphenyls, were phased out because PCBs were found to cause cancer and adversely impact the immune, reproductive, nervous and endocrine systems. But replacement flame retardants repeatedly have been found to have similar toxic effects on both humans and wildlife.

Before we can seek safer alternatives to harmful chemicals we need content transparency—or knowing what materials comprise a given product. Unfortunately, chemical transparency has been difficult to achieve. Manufacturers often cite proprietary concerns or simply fail to recognize the need to disclose detailed information on materials.

Though some content information is widely available through government-mandated Material Safety Data Sheets (MSDS). These MSDS regulations do not require manufacturers to provide actual chemical names. Nor do they include ingredients found in lower quantities, some of which can be quite hazardous.

The newer form of MSDS, the SDS, or Safety Data Sheets, contains some improvements. This system does a better job of capturing substances that represent risks from long-term exposure in addition to the acute exposure risks. But it also allows for the protection of confidential business information and non-reporting of low-concentration ingredients. Additionally, only substances that have been well documented to represent a health or safety risk are listed—not those for which the evidence of such risks is just emerging.

To ensure the health and safety of tenants, installers and other individuals exposed to insulation materials, it is critical that manufacturers become proactive at sharing information. They can do this by voluntarily getting certified by third-party organizations and/or completing an in-depth inventory of the chemical makeup of their products.


Denim Fibers


Polystyrene Beads

FLAME RETARDANTS: SUBSTITUTE OR REMOVE?

In late November 2014, parties to the Stockholm Convention on Persistent Organic Pollutants, a United Nations body, took a bold step to protect the health of their citizens: they outlawed the use of the toxic flame retardant HBCD. In August 2015, the European Union's ban took effect, and Canada is looking to ban HBCD by January 2017. Where is the United States? Good question.

Not a party to the U.N. treaty, the United States has, as a practical matter, limited ability to ban any chemical. The U.S. law governing chemical regulation, the 1976 Toxic Substances Control Act (TSCA), hasn't been updated for nearly 40 years.

In 2015, the House of Representatives and the Senate passed different versions of a TSCA reform bill. A coalition of some 450 progressive groups believes neither version addresses all the issues.

Among many other reforms, the groups seek to require businesses to provide transparent information on the health and environmental impacts of their chemicals and to require the U.S. Environmental Protection Agency (EPA) to take immediate action to reduce public exposure from the most harmful chemicals. Ultimately this would help the United States take more meaningful action on the use of HBCD in insulation.

Meanwhile, HBCD isn't going anywhere despite international action. The Stockholm Convention includes a five-year exemption period where HBCD can be used to produce styrene-based insulation, which is its primary application. In the interim, products containing HBCD must be clearly marked. Imports are not regulated under the European system, and anything manufactured before December 2016 is allowed in Canada. Plus there is plenty of insulation containing HBCD in thousands of buildings worldwide with a lengthy amount of lifecycle remaining to poison the environment during use and disposal.

HBCD is well documented as a persistent, bioaccumulative and toxic (PBT) chemical. That means it gets into the environment and stays there, with no natural breakdown of its ingredients. The compound also accumulates in plants and animals, getting more concentrated on each rung of the food chain. Studies have found HBCD in its highest concentration in marine mammals and birds of prey.

For humans, HBCD impacts reproductive, developmental and neurological systems. It also can cause cancer. Outside of occupational exposure, most people will eat contaminated food—fish, in particular—or inhale dust containing the chemical.

As part of its 2010 Action Plan on HBCD, the EPA released in 2014 an analysis of safer alternatives. Only one—butadiene styrene brominated copolymer, or PolyFR—was found to meet the physical properties needed for insulation effectiveness as well as flame retardant standards.

The problem is that PolyFR is still a brominated compound so no one knows exactly what the effect of the substitution will be. The EPA states the chemical is "persistent" but not bioaccumulative. However, the agency also admits, "long-term fate in the environment is not understood."

Without any legislative action motivating them, industry officials estimate it could take up to 2019 to switch from HBCD to PolyFR in the production of polystyrene insulation in the United States.

Beyond all the questions of HBCD use or substitution, some have an even better idea: just eliminate it. The Safer Insulation coalition say foams without flame retardants can be used safely with a thermal barrier such as a wall. The group argues that flame retardant foams add a negligible safety benefit in those circumstances, but release a huge amount of toxic gases. Chemicals released during fires are thought to be a major cause of cancer for firefighting professionals.

In most cases building codes require the thermal barrier, but those same codes also mandate flame retardant standards. Changing building codes is difficult since they are governed on a local basis though there are standards from an international council.

Still, there is precedent. In 2004 Norway changed its building codes to allow the use of foam without flame retardants. The country has seen no increase in fires.

Moving to Transparency in Insulation Products

This effort is under way. The primary document that architects, designers and many housing organizations are now demanding is a **Health Product Declaration,** or HPD. For this, manufacturers are urged to provide a list of every ingredient in the finished product, and then reveal the percentage of each substance in the product and any known health hazard.


Natural Wool

A HPD is no guarantee of a healthy product; it is simply a giant first step to give consistent baseline information on product content. Manufacturers then use tools such as the GreenScreen List Translator to check a product's chemical makeup against some 850 lists of chemicals of concern. These lists—from governments and authoritative sources worldwide—represent everything from outright bans to chemicals that should be avoided.

From there, certification programs from **Declare** and **Cradle to Cradle**—which are among the organizations that prioritize what they see as the worst chemicals in their own "red lists"—can use the data to provide an assessment of the product's hazards. In some cases the results—including content—are made public, but this decision is frequently left to the manufacturer. See **Appendix E** for a list of certification/chemical reporting systems.

More and more, building industry professionals are recognizing companies that provide HPDs and moving them to the top of the list for product purchases. Chemical content rarely is the only factor in specifying a product, but is an increasingly important consideration. See **Appendix F** for a list of companies with products that have certifications or ingredient disclosure.

A better awareness of insulation's adverse effects can lead to better choices—both among current insulation products and by creating a stronger demand for improved and safer products that don't use harmful chemicals.

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APPENDICES

Spray Polyurethane Foam

Fiberglass

Mineral Wool

Cellulose

Appendix A

Abbreviations

EPA:	U.S. Environmental Protection Agency
EPS:	expanded polystyrene foam, a type of board insulation
EU:	European Union
HBCD:	hexabromocyclododecane, a type of flame retardant
HPD:	health product declaration
MSDS:	material safety data sheets
PCBs:	polychlorinated biphenyls, a type of flame retardant
PolyFR:	butadiene styrene brominated copolymer, a type of flame retardant
Polyiso:	polyisocyanurate, the rigid boardstock form of SPF
SDS:	safety data sheets
SPF:	spray polyurethane foam, a type of foamed-in-place insulation
TCEP:	tris (2-carboxyethyl) phosphine, a type of flame retardant
TCPP:	tris (1-chloro-2-propyl) phosphate, a type of flame retardant
TDCPP:	tris (1,3-dichloroisopropyl) phosphate, a type of flame retardant
TSCA:	1976 U.S. Toxic Substances Control Act
VOC:	volatile organic compound
XPS:	extruded polystyrene foam, a type of board insulation

Appendix B

What Do Hazards Mean?

ASTHMA is a chronic lung disease that inflames and narrows individuals' airways, commonly resulting in wheezing, coughing, shortness of breath and chest tightness. Symptoms can range from minor where you develop some of the main symptoms, but it does not interfere with normal activities; to severe where without treatment your lungs function only about 60 percent or less and symptoms limit daily physical activity.

BIOACCUMULATION TOXINS occur when an organism takes in a toxic chemical, and the chemical accumulates at higher concentrations as it moves up the food chain. These toxins do not break down readily from natural processes and are harmful in small quantities. Bioaccumulation toxins are associated with various health effects including reproductive and developmental problems, cancer, nervous system damage and genetic impacts.

CANCER is a chronic disease where body cells divide without stopping to form growths, also known as tumors. There are over 100 different types of cancers and they are commonly named after the organ they affect; lung cancer, breast cancer and brain cancer to name a few. There are also five stages of cancer ranging from 0-4. The most minor form is stage 0 which is defined by abnormal cells present only where they developed, and the most severe is stage 4 defined as the cancer has spread to distant tissues or organs.

DEVELOPMENTAL HAZARDS alter the structure or function of a developing embryo or fetus. For example, some outcomes result in birth defects, low birth weight and biological or behavioral problems that appear as the child grows. These effects are present both before and after birth.

ENDOCRINE DISRUPTORS are chemicals that interfere with the endocrine system by imitating or blocking hormones. Some of the health effects caused by endocrine disruptors are inhibiting male or female reproductive systems, decreasing fertility, losing the fetus during pregnancy or changing sexual development, behavior or functions.

REPRODUCTIVE TOXINS alter male or female fertility (ability to produce offspring). They can disrupt the male or female reproductive systems, change sexual development, behavior or functions, decrease fertility or result in loss of the fetus during pregnancy.

RESPIRATORY HAZARDS are commonly in the form of a gas, vapor, dust, mist, fumes, smoke, sprays, and fog. Inhaling these substances can result in various health effects. Some substances, due to chronic exposures, can make an individual sick by causing lung cancer or asthma. Other substances can be extremely toxic and with an acute exposure they can cause unconsciousness or death.

APPENDIX C

Chemical Data Sheets

Brominated Flame Retardants

Foam insulation expanded polystyrene (ESP) and extruded polystyrene (XPS) are both treated with HBCD (hexabromocyclododecane), a halogenated flame retardant using bromine. XPS typically contains 2.5 percent HBCD, while EPS has .5-.7 percent.

HOW CAN THIS CHEMICAL AFFECT MY HEALTH?

CHRONIC (LONG TERM) EFFECTS

PBT (Persistent Bioaccumulative Toxicant) – Does not break down readily from natural processes, accumulates in organisms concentrating as it moves up the food chain, and is harmful in small quantities.

Endocrine Disruption – Can interfere with hormone communication between cells which controls metabolism, development, growth, reproduction and behavior (the endocrine system).

WHAT ARE SAFER ALTERNATIVES?

GOOD – Only use EPS and XPS for below grade applications, which virtually eliminates exposure to off-gassing.

BETTER – Support efforts to change building codes to eliminate the need for flame retardants in EPS and XPS behind thermal barriers, as the chemicals do little to improve fire safety but can have serious health impacts.

BEST – Consider other forms of insulation, such as rigid mineral wool, cellular glass or cementitious foam.

Note: The U.S. Environmental Protection Agency's Design for the Environment division has identified butadiene styrene brominated copolymer as a potentially less toxic substitute for HBCD. Currently production is limited to a single manufacturer so it is not widely available. Health and safety groups remain concerned about the chemical as it is still a type of brominated flame retardant.

Effects detailed above can occur at various stages of the product's lifetime, not just during usage. All have been included to provide a complete picture of the chemical's danger.

APPENDIX C

Chemical Data Sheets

Chlorinated Flame Retardants

Polyisocyanurate and spray polyurethane foam (SPF) are treated with a chlorinated flame retardant known as TCPP (tris 1-chloro-2-propyl phosphate). While not as much is known about the health impacts of TCPP as is known for HBCD, it is under study as a potential carcinogen by the Environmental Protection Agency. Polyiso contains 2.5-5.5 percent TCPP; SPF has 12.5 percent in open-cell applications, and 4 percent in closed cell.

HOW CAN THIS CHEMICAL AFFECT MY HEALTH?

ACUTE (SHORT TERM) EFFECTS

Toxic to Humans & Animals – Can be fatal on contact, ingestion or inhalation for humans and other mammals.

CHRONIC (LONG TERM) EFFECTS

PBT (Persistent Bioaccumulative Toxicant) – Does not break down readily from natural processes, accumulates in organisms concentrating as it moves up the food chain, andis harmful in small quantities.

WHAT ARE SAFER ALTERNATIVES?

GOOD – Limit use to specialty areas for SPF or polyiso, such as interior foundation walls.

BETTER – Support efforts to change building codes to eliminate the need for flame retardants in insulation behind thermal barriers, as the chemicals do little to improve fire safety but can have serious health impacts.

BEST – Consider other forms of insulation, such as rigid mineral wool, cellular glass or cementitious foam.

Effects detailed above can occur at various stages of the product's lifetime, not just during usage. All have been included to provide a complete picture of the chemical's danger.

Ethanolamine

Ethanolamine is used as a blowing agent to increase the stability of spray polyurethane foam (SPF).

HOW CAN THIS CHEMICAL AFFECT MY HEALTH?

ACUTE (SHORT TERM) EFFECTS

Toxic to Humans & Animals – Can be fatal on contact, ingestion or inhalation for humans and other mammals.

Irritates the Eyes – Can cause irritation or serious damage to the eye.

Irritates the Skin – Can cause irritation or serious damage to the skin.

CHRONIC (LONG TERM) EFFECTS

Asthma Trigger – Can result in high sensitivity so that small quantities trigger asthma, nose or sinus inflammation or other allergic reactions in the respiratory system.

Sensitizes the Skin – Can lead to allergic reactions on the skin.

Birth Defects – Can cause harm to the developing child including birth defects, low birth weight and biological or behavioral problems that appear as the child grows.

Brain/Nervous System Harm – Can cause damage to the nervous system including the brain.

WHAT ARE SAFER ALTERNATIVES?

GOOD – Exposure occurs during installation and curing, so remain outside the home during that time.

BETTER – Use in limited circumstances where SPF is the only viable option, such as uneven interior foundation walls.

BEST – Consider other types of insulation, such as formaldehyde free mineral wool or fiberglass, cellulose, sheep's wool, cotton or cementitous foam.

Other chemicals in SPF cannot be avoided simply by waiting for insulation to cure, so consider all aspects before deciding to use SPF.

Effects detailed above can occur at various stages of the product's lifetime, not just during usage. All have been included to provide a complete picture of the chemical's danger.

APPENDIX C

Chemical Data Sheets

Formaldehyde

Formaldehyde is a chemical used to bind together commercial fiberglass and mineral wool batt insulation.

HOW CAN THIS CHEMICAL AFFECT MY HEALTH?

ACUTE (SHORT TERM) EFFECTS

Toxic to Humans & Animals – Can be fatal on contact, ingestion or inhalation for humans and other mammals.

Irritates the Eyes – Can cause irritation or serious damage to the eye.

Irritates the Skin – Can cause irritation or serious damage to the skin.

CHRONIC (LONG TERM) EFFECTS

Cancer – Can cause or increase the risk of cancer.

Gene Damage – Can cause or increase the rate of mutations, which are changes in genetic material in cells.

Asthma Trigger – Can result in high sensitivity so that small quantities trigger asthma, nose or sinus inflammation or other allergic reactions in the respiratory system.

Sensitizes the Skin – Can lead to allergic reactions on the skin.

Birth Defects – Can cause harm to the developing child including birth defects, low birth weight and biological or behavioral problems that appear as the child grows.

PBT (Persistent Bioaccumulative Toxicant) – Does not break down readily from natural processes, accumulates in organisms concentrating as it moves up the food chain, andis harmful in small quantities.

WHAT ARE SAFER ALTERNATIVES?

GOOD – Select a fiberglass/mineral wool insulation product with a GREENGUARD™ certificate so it has been tested and third-party certified to have no or minimal off-gassing of formaldehyde.

BETTER – Select fiberglass/mineral wool products that use chemical or bio-based substitutes for formaldehyde.

BEST – Consider other types of insulation, such as cellulose, cotton and natural wool.

Note: Typical exposure comes from off-gassing of the chemical; however, poorly installed fiberglass/mineral wool insulation or poor cleanup after installation could leave dust and fibers that may be a respiratory irritant as well.

Effects detailed above can occur at various stages of the product's lifetime, not just during usage. All have been included to provide a complete picture of the chemical's danger.

Isocyanates

Isocyanates are chemicals used as hardening agents in the mixing of spray polyurethane foam (SPF). One of the most commonly used is methylene diphenyl diisocyanate, or MDI.

HOW CAN THIS CHEMICAL AFFECT MY HEALTH?

ACUTE (SHORT TERM) EFFECTS

Toxic to Humans & Animals – Can be fatal on contact, ingestion or inhalation for humans and other mammals.

Irritates the Eyes – Can cause irritation or serious damage to the eye.

Irritates the Skin – Can cause irritation or serious damage to the skin.

CHRONIC (LONG TERM) EFFECTS

Cancer – Can cause or increase the risk of cancer.

Asthma Trigger – Can result in high sensitivity so that small quantities trigger asthma, nose or sinus inflammation or other allergic reactions in the respiratory system.

Sensitizes the Skin – Can lead to allergic reactions on the skin.

Other Health Effects – Can cause serious damage on contact or ingestion.

Birth Defects – Can cause harm to the developing child including birth defects, low birth weight and biological or behavioral problems that appear as the child grows.

WHAT ARE SAFER ALTERNATIVES?

GOOD – Use in limited circumstances where SPF is the only viable option, such as uneven interior foundation walls.

BETTER – Use non-chemical applications such as mortar, if possible, on smaller projects.

BEST – Consider other forms of insulation, such as mineral wool, cellulose or polyisocyanurate.

Effects detailed above can occur at various stages of the product's lifetime, not just during usage. All have been included to provide a complete picture of the chemical's danger.

APPENDIX C

Chemical Data Sheets

Polyethylene Glycol Nonylphenyl Ether

Polyethylene glycol nonylphenyl ether (NPE) is used as a foaming aid in spray polyurethane foam (SPF).

HOW CAN THIS CHEMICAL AFFECT MY HEALTH?

ACUTE (SHORT TERM) EFFECTS

Irritates the Eyes – Can cause irritation or serious damage to the eye.

Toxic to Humans & Animals – Can be fatal on contact, ingestion or inhalation for humans and other mammals.

Irritates the Skin – Can cause irritation or serious damage to the skin.

CHRONIC (LONG TERM) EFFECTS

Reproductive Harm – Can disrupt the male or female reproductive systems, changing sexual development, behavior or functions, decreasing fertility, or resulting in loss of the fetus during pregnancy.

Endocrine Disruption – Can interfere with hormone communication between cells which controls metabolism, development, growth, reproduction and behavior (the endocrine system).

WHAT ARE SAFER ALTERNATIVES?

GOOD – Use in limited circumstances where SPF is the only viable option, such as uneven interior foundation walls.

BETTER – Use non-chemical applications such as mortar, if possible, on smaller projects.

BEST – Consider other forms of insulation, such as mineral wool, cellulose or polyisocyanurate.

Effects detailed above can occur at various stages of the product's lifetime, not just during usage. All have been included to provide a complete picture of the chemical's danger.

Styrene

Styrene is the molecular building block of polystyrene, a plastic used in expanded polystyrene (EPS) and extruded polystyrene (XPS), both types of foam insulation.

HOW CAN THIS CHEMICAL AFFECT MY HEALTH?

ACUTE (SHORT TERM) EFFECTS

Toxic to Humans & Animals – Can be fatal on contact, ingestion or inhalation for humans and other mammals.

Irritates the Eyes – Can cause irritation or serious damage to the eye.

Irritates the Skin – Can cause irritation or serious damage to the skin.

CHRONIC (LONG TERM) EFFECTS

Cancer – Can cause or increase the risk of cancer.

Reproductive Harm – Can disrupt the male or female reproductive systems, changing sexual development, behavior or functions, decreasing fertility, or resulting in loss of the fetus during pregnancy.

Endocrine Disruption – Can interfere with hormone communication between cells which controls metabolism, development, growth, reproduction and behavior (the endocrine system).

Gene Damage – Can cause or increase the rate of mutations, which are changes in genetic material in cells.

Asthma Trigger – Can result in high sensitivity so that small quantities trigger asthma, nose or sinus inflammation or other allergic reactions in the respiratory system.

Other Health Effects – Can cause serious damage on contact or ingestion.

Birth Defects – Can cause harm to the developing child including birth defects, low birth weight andbiological or behavioral problems that appear as the child grows.

Brain/Nervous System Harm – Can cause damage to the nervous system including the brain.

Breast Cancer – Known to increase mammary gland tumors in animals.

PBT (Persistent Bioaccumulative Toxicant) – Does not break down readily from natural processes, accumulates in organisms concentrating as it moves up the food chain, andis harmful in small quantities.

WHAT ARE SAFER ALTERNATIVES?

GOOD – Only use EPS and XPS for below grade applications, which virtually eliminates exposure to off-gassing.

BETTER – No option available.

BEST – Consider other forms of insulation, such as cellular glass or rigid mineral wool.

Effects detailed above can occur at various stages of the product's lifetime, not just during usage. All have been included to provide a complete picture of the chemical's danger.

APPENDIX D

Resources for Healthier Insulation Products

The research for safer chemical alternatives is a slow-moving field, but one that is moving in the right direction. The following organizations have been leading that charge:

BUILDINGGREEN

www2.buildinggreen.com

BuildingGreen is an independent publishing company that focuses on accurate, unbiased and timely green design information. It publishes the Environmental Building News and an email bulletin. BuildingGreen also screens and approves products based on their environmental and health certifications, their performance and the transparency of their information. BuildingGreen doesn't charge manufacturers for reviews or listings.

CLEAN PRODUCTION ACTION

www.cleanproduction.org

Clean Production Action translates a systems-based vision of clean production into the tools and strategies non-government organizations, governments and businesses need to advance green chemicals, sustainable materials and environmentally preferable products. The organization runs the widely used and respected GreenScreen method for chemical hazard assessment.

CHEMHAT

www.ChemHat.org

ChemHAT, the Chemical Hazard and Alternatives Toolbox, is designed to give users easy-to-use and accurate information on what we know about chemicals and to help the effort to get more information so we can all make better decisions about chemical use. ChemHAT is based on the idea that when we know how a chemical can hurt us we can take protective action. ChemHAT doesn't just focus on what engineering controls and personal protective equipment are needed to lower the levels of exposure to a "safe" level, but instead asks whether there is a way to get the job done without using dangerous chemicals.

CRADLE TO CRADLE CERTIFIED PRODUCTS PROGRAM

www.c2ccertified.org

The Cradle to Cradle Certified™ Product Standard guides designers and manufacturers through a continual improvement process that looks at a product through five quality categories—material health, material reutilization, renewable energy and carbon management, water stewardship, and social fairness. A product receives an achievement level in each category—Basic, Bronze, Silver, Gold, or Platinum—with the lowest achievement level representing the product's overall mark. The Gold and Platinum levels guarantee that the product is free of substances which may pose a significant risk to humans or the environment. Product assessments are performed by a qualified independent organization. Every two years, manufacturers must demonstrate good faith efforts to improve their products in order to have their products recertified.

HEALTH PRODUCT DECLARATION COLLABORATIVE

www.hpdcollaborative.org

The Health Product Declaration® (HPD) Open Standard consists of a defined format and rules for reporting about the contents of building products along with the potential associated hazards and other related information. The HPD makes clear what information is being shared and what information is not shared by allowing for varying levels of information disclosure. A completed HPD is created and published by product companies/manufacturers about their products. A fully-completed HPD will include a report of hazard associations, based on the HPD Priority Hazard Lists, the GreenScreen List Translator, and when available, full GreenScreen assessments. HPDs allow for the reporting of these hazard screening results, even when the underlying chemical substances may not be fully disclosed due to intellectual property and/or other concerns.

HEALTHY BUILDING NETWORK

www.healthybuilding.net

The Healthy Building Network was founded to reduce the use of hazardous chemicals in building products as a means of improving human health and the environment. Its primary product, The Pharos Project, offers in-depth independent analysis and information on more than 1,600 building products and 34,000 chemicals. It helps building owners, product manufacturers and designers identify products with suspect chemicals, avoid products known or suspected to impact health and substitute healthier choices. HBN also recently released the CompAIR volatile ingredients calculator to help users identify building products that release fewer chemicals into the air, and is researching ways to optimize recycling to reduce contaminants in recycled feedstock.

INTERNATIONAL LIVING FUTURE INSTITUTE

www.living-future.org

The Institute runs programs aimed to lead and support the transformation toward communities that are socially just, culturally rich and ecologically restorative. They are:

- The Living Building Challenge, a rigorous and progressive building performance standard;
- The Living Community Challenge to help planners and developers rethink how they design community-scale projects;
- The Living Product Challenge to push sustainable product manufacturing toward the creation of products that are truly regenerative;
- The Net Zero Energy Building Certification to verify net zero energy building performance;
- Declare, a “nutrition-label” for products, providing a clear and informative method to disclose ingredients;
- Just, a transparency platform for organizations to reveal much about their operations, including how they treat their employees and where they make financial and community investments; and
- Reveal, for projects to showcase how efficient they are relative to other buildings.

APPENDIX E

Certification and Chemical Reporting Systems

PROGRAM	DESCRIPTION	PRO	CON
Material Safety Data Sheets (MSDS)	Required reporting that provides basic information about chemical ingredients and emissions.	Captures short-term risks.	Does not capture long-term risks, chemical names, or risks from chemicals in low quantities.
Safety Data Sheets (SDS)	The reporting format that is replacing MSDS sheets, with mandates taking effect in June 2015.	Captures acute and chronic risks.	Protects identity of low-concentration ingredients. Does not require listing emerging chemicals of concern.
Health Product Declaration (HPD)	A format to disclose product contents, emissions and health hazards.	Discloses product contents and known hazards from those contents, based on the GreenScreen framework.	Exposure pathways are not considered. Ingredient names may be withheld.
Cradle to Cradle (C2C)	A multi-attribute certification that uses five categories of evaluation criteria: energy use, water use, corporate social responsibility, material reutilization and material toxicity.	Rigorous screening by trained auditors based on multiple tiers of red list, including some based exposure assessment.	Chemical ingredients are not disclosed publically.
C2C Material Health Certificate	A new certification option from C2C that just addresses materials toxicity (one of the five categories of impacts addressed by C2C).	Same as above.	Same as above; also tradeoffs with impact other than materials toxicity is not incorporated.
Declare	A database of products with at least 99 percent of their ingredients publically disclosed.	Even proprietary ingredients constituting greater than 1 percent of the product must be disclosed; flags any ingredients on the Living Building Challenge Red List of highly dangerous chemicals.	Products can be listed regardless of toxicity.
GREENGUARD	A certification that proves a product meets set emissions thresholds based on actual testing off-gassing from the product.	Actual testing is a good way to determine air quality impacts from having a product in a space.	Doesn't address exposure routes for toxic ingredients other than inhalation; doesn't address product contents that are not volatile and listed on relevant lists.
SCS Indoor Advantage	Similar to GREENGUARD Children and Schools	Same as above.	Same as above.

Appendix F

Insulation Companies with at Least One Product Under Certification/Chemical Reporting Systems

COMPANY	BG	C2C	DECLARE	GG	HPD	PHAROS	SCS
Advanced Fiber Technology						x	
Air Krete	x					x	
American Lime Technology						x	
Amorim Isolamento, SA	x						
Anco				x		x	
Applegate Insulation						x	
BASF				x			
Bayer Material Science						x	
Benolec				x			
Bonded Logic					x	x	
Cabot Aerogel		x					
Can-Cell Industries						x	
Caragreen Ultratouch					x		
Cellulose Material Solutions	x						
CertainTeed	x			x	x	x	
Champion Insulation						x	
Demilec USA						x	
DiversiFoam						x	
Dow		x				x	
Dyplast Products						x	
Elastochem				x			
Fi-Foil Company	x						
Foametix						x	
Fomo Products				x			
GACO Western				x			
GAF					x		
GreenFiber			x			x	
Guardian Building Products	x					x	
Havelock Wool			x				

See key on page 30

BG = BuildingGreen Approved

C2C = Cradle to Cradle

GG = GREENGUARD

HPD = Health Product Declaration

SCS = SCS Global Services

Listings accurate as of September 2015

COMPANY	BG	C2C	DECLARE	GG	HPD	PHAROS	SCS
Henry					x	x	
Icynene						x	
Igloo Cellulose				x		x	
Insulfoam						x	
Isolofaom						x	
Johns Mansville	x		x	x		x	x
Knauf	x		x	x		x	
Lapolla Industries						x	
Mountain Fiber Insulation						x	
National Fiber			x				
Oregon Shepherd	x						
Owens Corning		x		x		x	
Pittsburgh Corning	x		x				
Plasti-Fab				x			
Polar Industries						x	
Quad-Lock Building Systems						x	
Rhino Linings Corp				x		x	
Rmax						x	
Roxul	x			x		x	
Styropek				x			
Superior Products		x					
SWD Urethane				x			
Thermafiber	x					x	
Thermal Foams						x	
Thermo-Kool of Alaska						x	
Urethane Technology						x	
Western Fibers						x	

The **BlueGreen Alliance Foundation** is a non-profit, 501(c)(3) organization that conducts research and educates the public and media about solutions to environmental challenges that create economic opportunities for the American people.

The **BlueGreen Alliance Foundation** works with the BlueGreen Alliance—a national partnership that unites America's largest labor unions and its most influential environmental organizations to identify ways today's environmental challenges can create and maintain quality jobs and build a stronger, fairer economy— to achieve its mission.

BLUEGREEN ALLIANCE FOUNDATION

www.bgafoundation.org